Course Structure
&
Detailed Syllabus

B. Tech.
Electrical and Electronics Engineering

Academic Regulations - R24

Applicable for the Batches Admitted from 2024 - 2025

AVANTHI
INSTITUTE OF ENGINEERING AND TECHNOLOGY
(Autonomous)

(Approved by AICTE., New Delhi, & Permanently Affiliated to JNTU-GV, Vizianagaram)

NAAC "A+" Accredited Institute

Cherukupally (Village), Near Tagarapuvalasa Bridge, Vizianagaram (Dist)-531162

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www.aietta.ac.in, principal@aietta.ac.in

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Structure

Program: B. Tech Electrical and Electronics Engineering

Regulations-R24

(Applicable from the academic year 2024-2025 to 2026-2027)

Induction Programme

S.No	Course Title	Category	L-T-P-C
1	Physical Activities--Sports, Yoga and Meditation, Plantation	MC	0-0-6-0
2	Career Counseling	MC	2-0-2-0
3	Orientation to all branches -- career options, tools, etc	MC	3-0-0-0
4	Orientation on admitted Branch -- corresponding labs, tools and platforms	EC	2-0-3-0
5	Proficiency Modules & Productivity Tools	ES	2-1-2-0
6	Assessment on basic aptitude and mathematical skills	MC	2-0-3-0
7	Remedial Training in Foundation Courses	MC	2-1-2-0
8	Human Values & Professional Ethics	MC	3-0-0-0
9	Communication Skills -- focus on Listening, Speaking, Reading, Writing skills	BS	2-1-2-0
10	Concepts of Programming	ES	2-0-2-0

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Program: B. Tech Electrical and Electronics Engineering Regulation: R24

I Year I Semester- Course Structure

S.No	Category	Course Code	Course Title	Hours per Week			
				Lecture	Tutorial	Practical	Credits
1	BS	R24BS01	Linear Algebra & Calculus	3	0	0	3
2	BS	R24BS05	Applied Chemistry	3	0	0	3
3	ES	R24ES02	Problem Solving& Programming with C	3	0	0	3
4	ES	R24ES06	Engineering Graphics	1	0	4	3
5	ES	R24ES05	Basic Electrical & Electronics Engineering	3	0	0	3
6	BS	R24BS06	Applied Chemistry Lab	0	0	2	1
7	ES	R24ES03	Problem Solving & Programming with C Lab	0	0	3	1.5
8	ES	R24ES07	Basic Electrical and Electronics Engineering Lab	0	0	3	1.5
9	ES	R24ES08	Engineering Workshop	0	0	3	1.5
10	MC	R24MC01	Health and Wellness, Yoga and Sports	0	0	1	0.5
			Total	**13**	**0**	**16**	**21**

Category	Courses	Credits
BS -Basic Science Courses	3	7
ES-Engineering Science Courses	6	13.5
MC-Mandatory Courses	1	0.5
Total	**10**	**21**

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Program: B. Tech Electrical and Electronics Engineering Regulation: R24

I Year II Semester- Course Structure

S.No	Category	Course Code	Course Title	Lecture	Tutorial	Practical	Credits
1	BS	R24BS04	Differential Equations and Vector Calculus	3	0	0	3
2	BS	R24BS02	Engineering Physics	3	0	0	3
3	HS	R24HS01	Communicative English	2	0	0	2
4	ES	R24ES01	Basic Civil & Mechanical Engineering	3	0	0	3
5	PC	R24EEPC01	Electrical Circuit Analysis-I	3	0	0	3
6	HS	R24HS02	Communicative English Lab	0	0	2	1
7	BS	R24BS03	Engineering Physics Lab	0	0	2	1
8	ES	R24ES04	IT Workshop	0	0	2	1
9	PC	R24EEPC02	Electrical Circuits Lab	0	0	3	1.5
10	MC	R24MC02	NSS/NCC/Scouts & Guides/Community Service	0	0	1	0.5
			Total	**14**	**00**	**10**	**19**

Category	Courses	Credits
BS -Basic Science Courses	3	7
HS-Humanities Management & Social Sciences Courses	2	3
ES -Engineering Science Courses	2	4
PC-Professional Core Courses	2	4.5
MC-Mandatory Courses	1	0.5
Total	**10**	**19**

Chairperson
Board of Studies (EEE)

AVANTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Program: B. Tech Electrical and Electronics Engineering **Regulation: R24**

II Year I Semester- Course Structure

S№	Cate-gory	Course Code	Course Title	Hours per Week			
				Lecture	Tutorial	Practical	Credits
1	BS	R24BS10	Numerical Methods and Transform Techniques	3	0	0	3
2	HS	R24HS03	Universal Human Values–Understanding Harmony & Ethical Human Conduct	2	0	0	2
3	PC	R24EEPC03	Electrical Circuit Analysis-II	3	0	0	3
4	PC	R24EEPC04	DC Machines & Transformers	3	0	0	3
5	PC	R24EEPC05	Electromagnetic Field Theory	3	0	0	3
6	PC	R24EEPC06	DC Machines & Transformers Lab	0	0	3	1.5
7	PC	R24EEPC07	Electrical Circuit Simulation Lab	0	0	3	1.5
8	SC	R24CSSC04	Computing Skills Using C	0	0	3	1.5
9	HS	R24HS04	Logical Reasoning & Corporate Skills	0	0	2	1
10	MC	R24MC03	Environmental Science	2	0	0	-
			Total	**16**	**0**	**11**	**19.5**

Category	Courses	Credits
BS –Basic Science Courses	1	3
HS-Humanities Management & Social Sciences Courses	2	3
PC-Professional Core Courses	5	12
SC- Skill Course	1	1.5
MC-Mandatory Courses	1	-
Total	**10**	**19.5**

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Program: B. Tech Electrical and Electronics Engineering **Regulation: R24**

II Year II Semester- Course Structure

S№	Cate-gory	Course Code	Course Title	Lecture	Tutorial	Prac-tical	Credits
1	BS	R24BS09	Complex Variables and Statistical Methods	3	0	0	3
2	PC	R24EEPC08	Electric Power Generation, Transmission and Distribution	3	0	0	3
3	PC	R24EEPC09	Induction and Synchronous Machines	3	0	0	3
4	PC	R24EEPC10	Control Systems	3	0	0	3
5	ES	R24ES10	Analog Electronic Circuits Design	3	0	0	3
6	ES	R24ES13	Design Thinking & Innovation	0	1	2	2
7	PC	R24EEPC11	Control Systems Lab	0	0	3	1.5
8	PC	R24EEPC12	Induction and Synchronous Machines Lab	0	0	3	1.5
9	SC	R24CSSC01	Python Programming	0	0	3	1.5
10	HS	R24HS05	Numerical Ability & Professional Communication Skills	0	0	2	1
			Total	**17**	**01**	**12**	**22.5**
Mandatory Community Service Project Internship of 08 weeks duration during summer vacation							

Category	Courses	Credits
BS -Basic Science Courses	1	3
HS-Humanities Management & Social Sciences Courses	1	1
ES-Engineering Sciences Courses	2	5
PC-Professional Core Courses	5	12
SC- Skill Course	1	1.5
Total	**10**	**22.5**

Chairperson
Board of Studies (EEE)

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Program: B. Tech Electrical and Electronics Engineering **Regulation: R24**

Course Structure: III Year I Semester or Semester-V

S№	Cate-gory	Course Code	Course Title	Hours per Week			
				Lectu re	Tutori al	Pract ical	Credits
1	ES	R24ES14	Microprocessors and Microcontrollers	3	0	0	3
2	PC	R24EEPC13	Power Electronics	3	0	0	3
3	PC	R24EEPC14	Renewable Energy Systems	3	0	0	3
4	PE-I	R24EEPE01 R24EEPE02 R24EEPE03 R24EEPE04 R24EEPE05	1. Electrical Machine Design 2. Advanced Control Systems 3. AI Techniques in Electrical Engineering 4. Utilization of Electrical Energy 5. 12 Week MOOC Swayam /NPTEL Course recommended by the BoS	3	0	0	3
5	OE-I	R24EEOE01 R24EEOE02 R24EEOE03 R24EEOE04 R24EEOE05	1. Industrial Automation 2. Electrical Design, Estimation and Costing 3. Concepts of Renewable Energy Sources 4. Basics of Control Systems 5. Fundamentals of Power Systems	3	0	0	3
6	PC	R24EEPC15	Power Electronics Lab	0	0	3	1.5
7	PC	**R24EEPC16**	Renewable Energy systems Lab	0	0	3	1.5
8	SC	R24EESC01	Design of Electrical Systems using Auto-CAD Lab	0	0	3	1.5
9	HS	R24HS07	Quantitative Aptitude & Effectual Communication Skills	0	0	2	1
10	CSP	R24CSP01	Evaluation of Community Service Project	0	0	0	1
			Total	**15**	**00**	**11**	**21.5**

Category	Courses	Credits
HS-Humanities Management & Social Sciences Courses	1	1
ES- Engineering Science	1	3
PC-Professional Core Courses	4	9
PE- Professional Elective	1	3
OE- Open Elective	1	3
SC- Skill Course	1	1.5
CSP-Community Service Project	1	1
Total	**10**	**21.5**

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Program: B. Tech Electrical and Electronics Engineering **Regulation: R24**

Course Structure: III Year II Semester or Semester-VI

S№	Cate-gory	Course Code	Course Title	Lecture	Tutorial	Practical	Credits
1	PC	R24EEPC17	Power System Analysis	3	0	0	3
2	PC	R24EEPC18	Electrical Measurements and Instrumentation	3	0	0	3
3	HS	R24HS08	Managerial Economics and Financial Accounting	2	0	0	2
4	PE-II	R24EEPE06 R24EEPE07 R24EEPE08 R24EEPE09 R24EEPE10	1. Machine Learning & Deep Learning and Its Applications 2. Switch Gear & Protection 3. Power Semiconductor Drives 4. High Voltage Engineering 5. 12 Week MOOC Swayam/NPTEL Course recommended by the BoS	3	0	0	3
5	OE-II	R24EEOE06 R24EEOE07 R24EEOE08 R24EEOE09 R24EEOE10	1. Basics of Electrical Machines 2. Fundamentals of Electrical Measurements and Instrumentation 3. Applications of Electrical Energy 4. Fundamentals of Utilization of Electrical Energy 5. Electrical Safety	3	0	0	3
6	PC	R24EEPC19	Electrical Measurements and Instrumentation Lab	0	0	3	1.5
7	PC	R24EEPC20	Power Systems Lab	0	0	3	1.5
8	SC	R24EESC02	IoT Applications in Electrical Engineering Lab	0	0	3	1.5
9	HS	R24HS09	High Level Reasoning & Employability Skills	0	0	2	1
10	AC-I	R24AC01	Technical Paper Writing and Intellectual Property Rights	2	0	0	0
			Total	**16**	**00**	**11**	**19.5**
Mandatory Community Service Project Internship of 08 weeks duration during summer vacation							

Category	Courses	Credits
HS-Humanities Management & Social Sciences Courses	2	3
PC-Professional Core Courses	4	9
PE- Professional Elective	1	3
OE- Open Elective	1	3
SC- Skill Course	1	1.5
AC-Audit Course	1	0
Total	**10**	**19.5**

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Program: B. Tech Electrical and Electronics Engineering **Regulation: R24**

Course Structure: IV Year I Semester or Semester-VII

S№	Category	Course Code	Course Title	Hours per Week			
				Lecture	Tutorial	Practical	Credits
1	PC	R24EEPC21	Power System Operation and Control	3	0	0	3
2	HS	R24HS11	Entrepreneurship and Development	2	0	0	2
3	PE-III	R24EEPE11 R24EEPE12 R24EEPE13 R24EEPE14 R24EEPE15	1. Programmable Logic Controllers 2. Flexible AC Transmission Systems 3. IoT Applications in Electrical Engineering 4. VLSI Technology 5. 12 Week MOOC Swayam/NPTEL Course recommended by the BoS	3	0	0	3
4	PE-IV	R24EEPE16 R24EEPE17 R24EEPE18 R24EEPE19 R24EEPE20	1. Special Electrical Machines 2. Soft Computing Techniques in Electrical Engineering 3. Electric Mobility Systems 4. Power Quality 5. 12 Week MOOC Swayam/NPTEL Course recommended by the BoS	3	0	0	3
5	OE-III	R24EEOE11 R24EEOE12 R24EEOE13 R24EEOE14 R24EEOE15	1. Energy Auditing and Management 2. Fundamentals of Power Electronics 3. Optimization Techniques 4. Electrical Wiring Estimation and Costing 5. Instrumentation	3	0	0	3
6	PC	R24EEPC22	Power Systems Simulation Lab	0	0	3	1.5
7	SC	R24EESC03	Electric Mobility Systems Lab	0	0	3	1.5
8	SI	R24EESI01	Evaluation of Industry Summer Internship	0	0	0	2
9	PJ	R24EEPJ01	Project Topic, Problem Statement, Literature Survey	0	0	6	0
10	AC-II	R24AC01	Constitution of India	2	0	0	0
			Total	**16**	**00**	**12**	**19**

Category	Courses	Credits
HS-Humanities Management & Social Sciences Courses	1	2
PC-Professional Core Courses	2	4.5
PE- Professional Elective	2	6
OE- Open Elective	1	3
SC- Skill Course	1	1.5
SI- Summer Internship	1	2
PJ- Project Phase-I	1	0
AC-Audit Course	1	0
Total	**10**	**19**

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Program: B. Tech Electrical and Electronics Engineering **Regulation: R24**

Course Structure: IV Year II Semester or Semester-VIII

S№	Cate-gory	Course Code	Course Title	Lectu re	Tutor ial	Practi cal	Credi ts
1	PE-V	R24EEPE21 R24EEPE22 R24EEPE23 R24EEPE24 R24EEPE25	1. Hybrid Electric Vehicles 2. HVDC Transmission 3. Smart Grid Technologies 4. Electrical Distribution Systems 5. 12 Week MOOC Swayam/NPTEL Course recommended by the BoS	3	0	0	3
2	OE-IV	R24EEOE16 R24EEOE17 R24EEOE18 R24EEOE19 R24EEOE20	1. Concepts of Smart Grid Technologies 2. Fundamentals of Electric Vehicles 3. IoT in Energy Systems 4. Concepts of Power Quality 5. Concepts of Programmable Logic Controllers	3	0	0	3
3	PJ	R24EEPJ02	Internship &Project Work	0	0	24	12
			Total	6	0	24	18

Category	Courses	Credits
PE- Professional Elective	1	3
OE- Open Elective	1	3
PJ- Internship &Project Work	1	12
Total	3	18

Chairperson
Board of Studies (EEE)

24BS01 **Linear Algebra and Calculus** **3 0 0 3**

(Common to all Branches)

Course Objectives:

1. To equip the students with standard concepts and tools of mathematics to handle various real- world problems and their applications.
2. To enable the students to apply linear algebra to solve engineering problems.
3. To enable the students to apply calculus to solve engineering problems.

Course Code	Course Outcomes	Mapping with POs			Dok
		PO1	PO2	PO12	
R24BS01.1	Develop matrix algebra techniques that are needed by engineers for practical applications.	3	2	1	L1,L2,L3
R24BS01.2	To find the eigen values and eigen vectors and solve the problems by using linear transformation.	3	2	1	L1,L2,L3
R24BS01.3	Apply the knowledge of mean value theorems, solve inequality.	3	2	1	L1,L2,L3
R24BS01.4	Familiarize with functions of several variables which is useful in optimization.	3	2	1	L3,L4
R24BS01.5	Familiarize with double and triple integrals of functions of several variables in two and three dimensions.	3	2	1	L4,L5

SYLLABUS

UNIT-I: Matrices and Linear System of Equations **10 Hours**

Matrices: Vector Space, Linear independent, dependent (only definitions).

Rank of a matrix by echelon form, normal form. Cauchy-Binet formulae (without proof). Inverse of Non- singular matrices by Gauss- Jordan method.

System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations by Gauss elimination method. **COs-CO1**

Self-Learning Topic: Encoding and Decoding messages by using matrices

UNIT- II: Linear Transformation and Orthogonal Transformation **10 Hours**

Eigen values and Eigen vectors and their properties(without proof), Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley–Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation. **COs-CO2**

Self-Learning Topic: Google's page rank Algorithm.

UNIT–III: Calculus **10 Hours**

Mean Value Theorems: Rolle's Theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin theorems with remainders (without proof), problems on the above theorems. **COs-CO3**

Self-Learning Topic: Application of mean value theorems

UNIT- IV: Partial differentiation and Applications **10 Hours**

Partial derivatives, total derivatives, chain rule, change of variables, Taylor's and Maclaurin's series expansion of functions of two variables. Jacobian, maxima and minima of functions of two variables, method of Lagrange multipliers. **COs-CO4**

Self-Learning Topic: Jacobian of implicit functions.

UNIT-V: Multiple Integrals **10 Hours**

Double integrals - change of variables (Cartesian and Polar coordinates), change of order of integration, Cylindrical and Spherical coordinates, triple integrals. Finding areas (by double integrals) and volumes (by double integrals and triple integrals). **COs-CO5**

Self-Learning topic: Calculating Centers of Mass and Moment of inertia

Board of Studies : Mathematics-Basic Science and Humanities
Approved in BOS No:01, August, 2024
Approved in ACM No: 01, August, 2024

Text Books:

1. B.S.Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.

Reference Books:

1. Dennis G. Zill and Warren S. Wright , Advanced Engineering Mathematics, Jones and Bartlett, 2018.
2. Michael Green berg, Advanced Engineering Mathematics, 9th edition, Pearson edn.
3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 14/e, Pearson Publishers, 2018.
4. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5/e, Alpha Science
5. International Ltd., 2021 (9th reprint).
6. B.V. Ramana, Higher Engineering Mathematics, McGraw Hill Education, 2017.

Web References:

1. http://onlinecourses.nptel.ac.in
2. https://nptel.ac.in/courses/111105121
3. https://onlinecourses.nptel.ac.in/noc24_ma91/course
4. https://onlinecourses.nptel.ac.in/noc24_ma53/course
5. https://onlinecourses.nptel.ac.in/noc24_ma11/course

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	10
L2	30	10
L3	40	30
L4	--	25
L5	--	25
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

UNIT-I

1. State Cauchy-Binet formulae (L1)
2. Define Echelon form of a matrix(L1)
3. Test for consistency and solve $2x+3y+7z=5;3x+y-3z=12;2x+19y-47z=32(L2)$
4. Discuss for what value of λ,μ the simultaneous equations

$x+y+z=6, x+2y+3z=10, x+2y+\lambda z=10$ have (i)no solution(ii) a unique solution (iii) an infinite number of solutions.(L2)

5. Reduce the matrix $\begin{bmatrix} 8 & 1 & 3 & 6 \\ 0 & 3 & 2 & 2 \\ -8 & -1 & -3 & 4 \end{bmatrix}$ into its normal form and hence find its rank.(L2)
6. Find the value of k such that the rank of $\begin{bmatrix} 1 & 2 & 3 \\ 2 & k & 7 \\ 3 & 6 & 10 \end{bmatrix}$ is 2. (L2)

UNIT-II

1. State Cayley-Hamilton theorem (L1)
2. Find the sum and product of the eigen values of $\begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$ (L1)
3. Find the latent roots and latent vectors of $A=\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$ (L2)
4. Use Cayley-Hamilton theorem to express $A^5-4A^4-7A^3+11A^2-A-10I$ as a linear polynomial in A. where $A=\begin{bmatrix} 1 & 4 \\ 2 & 3 \end{bmatrix}$ (L3)

UNIT-III

1. State Lagrange's mean value theorem(L1)
2. Verify Rolle's theorem for the function $f(x)=(x-a)^m(y-b)^n$ where m.n are positive integers in $[a,b]$ (L2)
3. Calculate approximately $\sqrt[5]{245}$ by using Lagrange's mean value theorem (L3)

UNIT-IV

1. Find the maximum and minimum values of $3x^4-2x^3-6x^2+6x+1$ in $(0,2)$ (L4)
2. If $x+y+z, uv=y+z, uvw=z$, show that $\frac{\partial(x,y,z}{\partial(u,v,w)}=u^2v$ (L4)
3. In plane triangle, finds the maximum value of $\cos A\cos B\cos C$ (L4)

UNIT-V

1. $\int_0^\infty\int_0^\infty e^{-(x^2+y^2)}dxdy$ (L5)
2. Evaluate $\iint(x^2+y^2)dxdy$ over the area bounded by the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ (L5)

Chairperson
Board of Studies (Mathematics)

R24BS05 **APPLIED CHEMISTRY** **3 0 0 3**

(Common to EEE, ECE, CSE, CSE (AI&ML), CSE (DS))

Course objectives:

1. To familiarize Applied Chemistry and its application.
2. To train the students on the principles and applications of electrochemistry and polymers
3. To elucidate the Structure and bonding of molecules
4. To impart Basic concepts of Semiconductors
5. To introduce modern engineering materials
6. To introduce instrumental methods, chromatographic technique

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with Pos		DOK
		PO1	PO12	
R24BS05.1	Describe Molecular orbital diagrams	3	1	L1, L2, L4
R24BS05.2	Importance of Graphenes. Apply the principle of band diagrams in the applications of Super conductors and semiconductors.	3	1	L1, L2, L4,L5
R24BS05.3	Compare the Materials of Construction for Battery and Electro Chemical Sensors.	3	1	L1, L2, L3
R24BS05.4	Explain the Preparation, Properties and applications of thermos plastics and thermo setting plastics, Elastomers and conducting polymers.	3	1	L1, L2, L3
R24BS05.5	Summarize the concepts of instrumental methods	3	1	L1, L2, L4, L5

SYLLABUS

UNIT- I: Structure and Bonding models **10 Hours**

Fundamentals of Quantum mechanics, Schrodinger Wave equation, significance of Ψ and Ψ2, LCAO theory, molecular orbital theory – bonding in homo and hetero nuclear diatomic molecules – energy level diagrams of O2,N2 and CO, NO etc. π-molecular orbitals of butadiene and calculation of bond order. **COs-CO1**

Self-Learning Topics: Energy Level Diagrams of H2 & CN Molecules.

UNIT- II: Modern Engineering materials **10 Hours**

Semiconductors – Introduction, Classification semiconductor devices P-N junction diode as a rectifier and transistor, applications. Super conductors-Introduction basic concept, Classification, applications. Super capacitors: Introduction, Basic Concept-Classification – Applications. Nanomaterials: Introduction, Sol-gel method, classification, properties and applications of Fullerenes, carbon nano tubes and Graphenes **COs-CO2**

Self Learning Topics: Band Theory of Solids, Preparation of Fullerenes.

UNIT- III: Electrochemistry and Applications **14 Hours**

Electrochemical cell, Nernst equation, cell potential calculations and numerical problems, potentiometry- potentiometric titrations (redox titrations), Conductometry- conduct metric titrations (acid-base titrations).

Primary cells – Zinc-air battery, Secondary cells –Lead-acid and lithium-ion batteries- working of the batteries including cell reactions.

Fuel cells- hydrogen-oxygen and Methanol-Oxygen fuel cells. **COs-CO3**

Self Learning Topics: Galvanic Cell, Differences between Primary Cells & secondary cells.

UNIT- IV: Polymer Chemistry **14 Hours**

Introduction to polymers, functionality of monomers, chain growth and step growth polymerization, coordination polymerization, with specific examples and mechanisms of polymer formation (Freeradical).

Plastics –Thermo and Thermosetting plastics, Preparation, properties and applications of – PVC, Teflon, Bakelite, Nylon-6 6.

Elastomers– Buna-S, Buna-N–preparation, properties and applications.

Conducting polymers – polyacetylene mechanism of conduction and applications. Bio-Degradable polymers - PolyGlycolicAcid (PGA), PolyLacticAcid (PLA). **COs-CO4**

Self Learning Topics: Differences between Thermo and Thermo Setting Plastics. Vulcanization of rubber.

UNIT- V: Instrumental Methods and Applications **10 Hours**

Electromagnetic spectrum. Absorption of radiation: Beer-Lambert's law. UV-Visible Spectroscopy, electronic transition, Instrumentation, IR spectroscopies, fundamental modes and selection rules, Instrumentation. Chromatography-Basic Principle, Classification-HPLC: Principle, Instrumentation and Applications. **COs-CO5**

Self Learning Topics: Intensity Shifts in UV-Spectroscopy, Gas Chromatography.

Board of Studies : Basic Sciences and Humanities-Chemistry
Approved in BOS No: 5th, August, 2024
Approved in ACM No: 01

Text Books:

1. Jain and Jain, Engineering Chemistry,16/e, DhanpatRai,2013.
2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10/e, Oxford UniversityPress,2010

Reference Books:

1. Skoog and West, Principles of Instrumental Analysis,6/e,Thomson,2007.
2. J.D.Lee,Concise Inorganic Chemistry ,5thEdition,WileyPublications,Feb.2008
3. Text book of Polymer Science, FredW.BillmayerJr,3rdEdition

.Web References:

1. https://swayam.gov.in/nc_details/NPTEL
2. https://onlinecourses.nptel.ac.in/noc19_cy29
3. https://archive.nptel.ac.in/noc/courses/noc21/SEM2/noc21-cy50

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	20	20
L2	30	30
L3	30	30

L4	10	10
L5	10	10
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Level

UNIIT I: **Structure and Bonding models**

1. Write is the Significance of Ψ and Ψ2 (L1)
2. Derive Schrodinger Wave equation? (L4)
3. Explain about the Molecular orbital theory Give any two examples?(L2)
4. Draw the Energy level diagram of Homo diatomic molecules? (L2)

UNIT- II: Modern Engineering materials

1. Describe the Semiconductors and its Applications? (L1)
2. Explain about the Superconductors with examples? (L2)
3. Discuss the Super capacitors? Classification of Super capacitors? Mention the applications of Super capacitor? (L2)
4. Write a short note on Fullerenes, properties and Applications? (L1)
5. Importance of Graphene (L5)

UNIT III: Electrochemistry and Applications.

1. Write the Nernst equation and calculate the cell potential for single electrodes? (L1)
2. Discuss the Potentiometric titrations (redox titrations)? (L2)
3. Discuss the Conductometric titrations (acid-base titrations)? (L2)
4. Write the construction & working of Zinc-air battery? (L1)
5. Classify Primary and Secondary cells? (L3)

UNITIV: **Polymer chemistry**

1. Write the functionality of monomers? (L1)
2. Discuss the mechanism of Chain growth and coordination polymerization . (L2)
3. Comparison between the Thermo Plastics and Thermosetting plastics? (L3)
4. Explain about the Preparation, properties and applications (L2)
   a. Bakelite
   b. Nylon-6,6
5. Uses of Bio-Degradable polymers? (L3)

UNIT-V: Instrumental Methods and Applications

1. Explain the Beer-Lambert's law? (L4)
2. Discuss the Instrumentation of IR spectroscopy? (L2)
3. Write the fundamental modes and selection rules of IR spectroscopy? (L1)
4. Explain Instrumentation of HPLC? (L4)
5. Compare various Chromatographic techniques (L5)

Chairperson
Board of Studies (Chemistry)

R24ES02 **Problem Solving & Programming with C** **3 0 0 3**
(Common to all Branches)

Course Objectives:

1. To impart adequate knowledge on the need of programming languages and problem-solving techniques and develop programming skills.
2. To express algorithms and draw flowcharts in a language independent manner.
3. To enable effective usage of Operators &Control Structures.
4. To learn about the design concept of Arrays, Strings and Functions.
5. To understand Structures and Unions and their usage.
6. To assimilate about Pointers, Dynamic Memory Allocation and know the significance of Pre-processors, perform operations on files.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs					Dok
		PO1	PO2	PO3	PS01	PS02	
R24ES02.1	Illustrate the fundamental concepts of computers and basic computer programming and problem-solving approach.	3	3	2	3	2	L1, L2
R24ES02.2	Understand the Control structures, Branching and Looping.	3	3	3	3	2	L1, L2 L3
R24ES02.3	Make use of Arrays and Develop Programs on modular programming using functions and strings.	3	3	3	2	3	L1, L2, L3
R24ES02.4	Demonstrate the ability to write programs using Structures and Unions.	3	3	3	3	2	L4
R24ES02.5	Apply File handling operations.	3	3	3	3	3	L4, L5

SYLLABUS

UNIT-I: Introduction to Programming and Algorithm for Problem Solving: 10 Hours

Introduction to Programming: The Basic Model of Computation, Algorithms, Flow-charts, Programming Languages, Compilation, Linking and Loading, Testing and Debugging, Documentation,

Algorithm for Problem Solving: Exchanging values of two variables, summation of a set of numbers, Decimal Base to Binary Base conversion, Reversing digits of an integer, GCD (Greatest Common Division) of two numbers, Test whether a number is prime, Organize numbers in ascending order, Find square root of a number, factorial computation, Fibonacci sequence, Evaluate 'sin x' as sum of a series, Reverse order of elements of an array, Find largest number in an array, Print elements of upper triangular matrix, multiplication of two matrices, Evaluate a Polynomial

COs–CO1

Self-Learning Topics: Compilation and Interpretation

UNIT- II: Introduction to the 'C' Programming **15 Hours**

Introduction: Character set, Variables and Identifiers, Built-in Data Types, Input/output statements, Variable Definition, Arithmetic operators and Expressions, Constants and Literals, Simple assignment statement, Basic input/output statement, Type Casting and Type def Simple 'C' programs

Conditional Statements and Loops: Decision making within a program, Conditions, Relational Operators, Logical Connectives, if statement, if-else statement, Loops: while loop, do while, for loop, Nested loops, Infinite loops, Switch statement, Break statement, Go to statement. **COs-CO2**

Self-Learning Topics: Escape Sequences

UNIT – III: Arrays, Strings and Functions **15 Hours**

Arrays: One dimensional array: Array manipulation; Searching, Insertion, Deletion of an element from an array; Finding the largest/smallest element in an array; two dimensional arrays with examples.

Strings: Concepts, String Types, String Input / Output functions, String manipulation functions, Null terminated strings as array of characters, Standard library string functions.

Functions: Top-down approach of problem solving, Modular programming and functions, Standard Library of C functions, Prototype of a function: Formal parameter list, Return Type, Function call, Block structure, passing arguments to a Function: call by reference; call by value, Recursive Functions, arrays as function arguments. **COs–CO3**

Self-Learning Topics: String Pattern Matching

UNIT- IV: Structures and Unions **10 Hours**

Structures and Unions: Structure variables, initialization, structure assignment, nested structure, structures and functions, structures and arrays: arrays of structures, structures containing arrays, unions, Enumeration.

Storage Classes**:** Scope and extent, Storage Classes in a single source file: auto, extern and static, register, Storage Classes in multiple source files: extern and static **COs–CO4**

Self-Learning Topics: How do you pass a structure to a function?

UNIT-V: Pointers & File Processing **10 Hours**

Pointers: Address operators, pointer type declaration, pointer assignment, pointer initialization, pointer arithmetic, functions and pointers, Arrays and Pointers, pointer arrays, pointers and structures, dynamic memory allocation.

File Processing: Concept of a file, streams, text files and binary files, Differences between text and binary files, State of a file, Opening and Closing files, file input/output functions (standard library input/output functions for files), file status functions (error handling), Positioning functions

COs-CO5

Self-Learning Topics: Binary Files and operations on Binary files

Board of Studies : Computer Science and Engineering

Approved in BOS No: 01, 30th July, 2024

Approved in ACM No: 01, 30th July, 2024

Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Logic Develop using C Programming	CO1–CO5,	PO1,PO2,PO3,PO12,PSO1,PSO2
2. Real Time Applications of C Programming	CO1–CO5,	PO1, PO2,PO3,PO12,PSO1,PSO2

TEXT BOOKS:

1. Byron S Gottfried "Programming with C" Second edition, Tata McGrawhill, 2007 (Paperback)
2. R.G. Dromey, "How to solve it by Computer", Pearson Education, 2008.
3. Kanetkar Y, "Let us C", BPB Publications, 2007.
4. 4. Hanly J R & Koffman E.B, "Problem Solving and Program design in C", Pearson Education, 2009.

REFERENCE BOOKS:

1. E. Balaguruswamy, "Programming with ANSI-C", Fourth Edition, 2008, Tata McGraw Hill.
2. Venugopal K. R and Prasad S. R, "Mastering 'C'", Third Edition, 2008, Tata McGraw Hill.
3. B.W. Kernighan & D. M. Ritchie, "The C Programming Language", Second Edition, 2001, Pearson Education
4. ISRD Group, "Programming and Problem-solving Using C", Tata McGraw Hill, 2008.
5. Pradip Dey, Manas Ghosh, "Programming in C", Oxford University Press, 2007.

Web References:

1. http://www.c4learn.com/
2. http://www.geeksforgeeks.org/c/
3. http://nptel.ac.in/courses/122104019/
4. http://www.learn-c.org/
5. https://www.tutorialspoint.com/c programming/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	35	--
L2	40	--
L3	25	40
L4	--	35
L5	--	25
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What are the five key features of the C programming language?
2. What are the top 5 applications of C programming language?
3. What do you mean by reserved words in C programming language?
4. What do you mean by library functions?
5. List the name of the tokens

6. What is static() function in C programming?
7. What is the difference between operators = and ==?
8. What are 3 main drawbacks of C language?
9. What is the difference between R-value and L-value?
10. How does const char*p differ from the char const* p

L2: Understand

1. What is the importance of function?
2. Explain the function prototype with an example.
3. What do you mean by error? Discuss types of errors() in C language.
4. What do you mean by function pointer?
5. What is a header file in the C programming language?
6. How can you implement decision-making processes in C language?
7. What are the 4 primary sections to define a function in C language?
8. What are modifiers? List the C programming modifiers?
9. What is an array, and why does it play a major role in C programming?
10. Is sizeof( ) a function or operator?

L3: Apply

1. Program to find Factorial of number?
2. Fibonacci Series Program?
3. Palindrome Program?
4. Program to reverse a String?
5. Find a given number is Armstrong Number?
6. Print first n Prime Numbers?
7. Find Largest among n Numbers?
8. LCM of Two Numbers?
9. GCD of Two Numbers?
10. Reverse a String?

L4: Analysing

1. Swapping Two Numbers using Bitwise operators?
2. Copy File to another File?
3. C program to get and set system current system date and time?
4. C program to run DOS command?

L5: Evaluating

1. C program to find two smallest elements in a one-dimensional array?
2. C program to find odd or even numbers using Bit masking?
3. Swapping two bits of byte using C program?

Chairperson
Board of Studies (CSE)

R24ES06 **ENGINEERING GRAPHICS** **1 0 4 3**

(Common To All Branches)

Course Objectives:

1. Understand the fundamentals of engineering drawing, including lines, lettering, and dimensioning.
2. Develop skills in geometrical constructions, including regular polygons and curves.
3. Learn orthographic projection techniques, including projections of points, lines, and planes.
4. Understand how to project solids in simple positions and create sectional views.
5. Develop skills in converting isometric views to orthographic views and vice versa.
6. Apply computer-aided design (CAD) techniques using AutoCAD to create 2D and 3D drawings.
7. Understand the importance of reference planes and reference lines in orthographic projection.
8. Develop problem-solving skills in engineering drawing, including creating and interpreting drawings.

Course Code	Course Outcomes	Mapping with POs and PSOs					Dok
		PO1	PO2	PO3	PO5	PO10	
R24ES06.1	Understand the basics of Engineering Graphics to construct the polygon, curves, and scales.	3	2	2	1	1	L1, L2, L3
R24ES06.2	Draw the orthographic projections of points and straight lines inclined to both the planes.	3	2	2	1	1	L2, L3
R24ES06.3	Draw the projections of planes in various conditions.	3	2	2	1	1	L2, L3
R24ES06.4	Draw the projections of regular solids, with its axis inclined to one plane and sections of solids.	3	2	2	1	1	L3,
R24ES06.5	Visualize the 3D isometric views from 2D orthographic views and vice versa along with basic introduction to CAD.	3	2	3	1	1	L2, L4

SYLLABUS

UNIT-1 **12 Hours**

Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general method.

Curves: construction of ellipse, parabola, and hyperbola by general method, Normal and tangent to Curves.

Scales: Plain scales, diagonal scales and vernier scales. **COs: CO1**

UNIT-2 **16 Hours**

Orthographic Projections: Reference plane, importance of reference lines or Plane, Projections of a point situated in any one of the four quadrants.

Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane. Projections of Straight Line Inclined to both the reference planes. **COs: CO2**

UNIT-3 **10 Hours**

Projections of Planes: Regular planes Perpendicular to both reference planes, parallel to one reference plane and inclined to the other reference plane; plane inclined to both the reference planes. **COs: CO3**

UNIT-4 **16 Hours**

Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to another plane.

Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of sections for simple position only. **COs: CO4**

UNIT-5 **12 Hours**

Conversion of Views: Conversion of isometric views to orthographic views and Conversion of orthographic views to isometric views for simple objects only.

Computer graphics: Creating 2D&3D drawings of objects including PCB and Transformations using Auto CAD (Not for end examination). **COs: CO5**

Textbook:

1. N. D. Bhatt, Engineering Drawing, Charotar Publishing House.

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill.
2. Engineering Drawing, M.B.Shah and B.C. Rana, Pearson Education Inc.
3. Engineering Drawing with an Introduction to AutoCAD, DhananjayJolhe, Tata McGraw Hill.

Board of Studies: Mechanical Engineering
Approved in BOS No: 01, 31st July, 2024
Approved in ACM No: 01

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	20
L2	30	40
L3	40	40
Total (%)	**100**	**100**

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Draw an octagon given the length of side 25mm.
2. Construct a regular hexagon of 40mm side. Using general method?
3. Construct a regular pentagon inscribed in a circle of diameter 80 mm?
4. Construct a pentagon of side 50mm with one side vertical. Attach a non-overlapping hexagon of same side length with common vertical side.

L2: Understand

1. A fixed-point F is 7.5cm from a fixed straight line. Draw the locus of a point P moving in such a way that its distance from the fixed straight line is 2/3 times its distance from F. Plot at least 9 points. Name the curves. Also draw a normal and a tangent to the curve at a point on it 6cm from F.
2. Construct a parabola whose focus is at a distance of 40mm from the directrix. Draw a tangent and a normal to the parabola at point 50mm away from the principal axis. Determine the double ordinate through a point 90mm from the directrix.
3. Construct an ellipse when the distance between the locus and the directrix is 30mm and the eccentricity is 3/4. Draw the tangent and normal at any point P on the curve using directrix.
4. Construct a hyperbola when the distance between the focus and the directrix is 40mm and the eccentricity is 4/3. Draw a tangent and normal at any point on the hyperbola.
5. Draw the involute of hexagon of side 25mm A disc is in the form of a square of side 30mm surmounted by a semi-circle on one of the sides of the square and a half hexagon on the opposite side. Draw the path of the end of a string which is unwound from the circumference of the disc.
6. Draw a vernier scale of R.F = 1/25 to read centimetres up to 4 metres and on it, show lengths representing 3.14m, 2.39 m and 0.91 m.
7. Construct a vernier scale to read distance correct to decimetre on a map in which the actual distances are reduced in the ratio of 1:40000. The scale should be long enough to measure up to 6km. Mark on the scale a length of 3034km and 0.59km.
8. The front view of a line, inclined at 30^0 to the VP is 65mm long. Draw the projections of the line, when it is parallel to and 40 mm above the HP, its one end being 30mm in front of the VP.
9. Mark the projections of the following points on a common reference line, keeping the projectors 35mm apart.
   (i) A, 25mm above H.P and 35mm in front of V.P
   (ii) B, 25mm above H.P and 40 mm behind V.P
   (iii) C, 30mm below H.P and 45 mm behind V.P
   (iv) D, 30 mm below H.P and 40 mm in front V.P
10. Draw the FV, TV of the following points:
    (i) Point P lies in the HP and 20mm behind the VP
    (ii)Point Q lies in the VP and 30mm below the HP
    (iii)Point R lies 35mm below the HP and 25mm behind the VP
11. Draw the involute of hexagon of side 25mm.
12. A 100 mm long line is parallel to and 40mm above the HP. Its two ends are 25 mm and 50 mm in front of the VP respectively. Draw the projections and find its inclination with the VP.
13. Draw the projections of a straight-line AB of 60mm long, in the following positions
    (i)Perpendicular to the HP and in the VP and one end on the HP
    (ii)Parallel to and 30 mm in front of the VP and on the HP

(iii)Inclined at 30^0 to the VP, in the HP and one end on the VP

14. Draw an involute of the circle of 40mm diameter. Also draw a normal and tangent at a point 100mm from the centre of the circle.
15. A rectangular plot of 100sq.km. is represented on a certain map by a similar rectangular area of 4sq.cm. Draw a scale to show km and mark a distance of 43km on it.

L3: Apply

1. A truck is moving at the rate of 1.2 km per min. Construct a diagonal scale with RF value of 1/25000, showing minutes and seconds. Mark the distance moved by the truck in 4 minutes and 27 seconds?
2. A tunnel on the Konkan railway route has a size of 640m × 10m × 10m. It is represented on a model by the volume of 27 cm^3 Find RF. Devise a diagonal scale of this RF to read up to 300 meters. Show the distances of 299 meters, 171 meters and 9 meters on it.
3. A car is running at a speed of 50 km/hour. Construct a diagonal scale to show 1 km by 3 cm and to measure up to 6 km. Mark also on the scale the distance covered by the car in 5 min 28 seconds.

L4: Analyze

1. Analyze the importance of orthographic projection in CAD and explain how it aids in the visualization of 3D objects from 2D views. Provide examples and diagrams to support your answer.
2. Compare and contrast 2D orthographic views and 3D isometric views. How do they differ in terms of representation and application? Explain with examples and illustrations.
3. Explain the process of creating a 3D isometric view from 2D orthographic views. Use a simple object (e.g., a cube or a cylinder) as an example and provide step-by-step diagrams to illustrate the process.
4. Discuss the advantages and limitations of using CAD software for creating 2D orthographic views and 3D isometric views. How does CAD improve the design process, and what are its limitations?
5. Analyze a given 2D orthographic view (front, top, and side views) and create a 3D isometric view from it. Explain the process and provide diagrams. Then, reverse-engineer the process by creating 2D orthographic views from the 3D isometric view.
6. Explain the concept of dimensioning and annotation in CAD. How are dimensions and annotations added to 2D orthographic views and 3D isometric views? Provide examples and illustrations.

Chairperson
Board of Studies (ME)

R24ES05 Basic Electrical and Electronics Engineering 3 0 0 3

Course Objectives:

1. To expose to the field of electrical & electronics engineering, laws and principles of electrical/ electronic engineering
2. To acquire fundamental knowledge in the relevant field.
3. To teach the fundamentals of semiconductor devices and its applications.
4. To teach the working process and analysis of different rectifying and Amplifying Circuits.
5. To teach the fundamental principles and rules of digital electronic circuits like gates, Sequential and Combinational Circuits.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs							
		PO1	PO2	PO3	PO6	PO7	PO8	PO12	Dok
R24ES05.1	Understand the problem-solving concepts associated to AC and DC circuits	2	2	1	-	-	-	1	L1, L2,L3
R24ES05.2	Remember the fundamental laws, construction and operation of AC and DC machines, instruments.	2	2	1	-	-	-	1	L2,L3
R24ES05.3	Understand different power generation mechanisms, Electricity billing concept and important safety measures related to electrical operations.	3	1	2	3	2	1	1	L1,L2
R24ES05.4	Understand the fundamental principles of electronic devices, analyzing the different rectifying and Amplifying Circuits.	1	2	3	-	-	-	1	L1, L2,L3
R24ES05.5	analyze and design different digital electronic circuits like gates, Sequential and Combinational Circuits	1	2	3	-	-	-	2	L1, L3,L4

SYLLABUS

Part A-Electrical Engineering

UNIT- I: DC & AC Circuits 10 Hours

DC Circuits: Electrical circuit elements (R, Land C), Ohm's Law and its limitations, KCL& KVL, series, parallel, series-parallel circuits, Super Position theorem, Simple numerical problems.

AC Circuits: A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor, Voltage and current relationship with phasor diagrams in R, L, and C circuits, Concept of Impedance, Active power, reactive power and apparent power, Concept of power factor (Simple Numerical problems). **COs–CO1**

Self-Learning Topics: Circuit elements

UNIT-II: Machines and Measuring Instruments **10 Hours**

Machines: Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer, (iv) Three Phase Induction Motor and (v) Alternator, Applications of electrical machines.

Measuring Instruments: Construction and working principle of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone bridge. **COs–CO2**

Self-Learning Topics: Magnetic materials

UNIT- III: Energy Resources, Electricity Bill & Safety Measures **10 Hours**

Energy Resources: Conventional and non-conventional energy resources; Layout and operation o various Power Generation systems: Hydal, Nuclear, Solar & Wind power generation.

Electricity bill: Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of ―unit‖ used for consumption of electrical energy, two-part electricity tariff, calculation of electricity bill for domestic consumers.

Equipment Safety Measures: Working principle of Fuse and Miniature circuit breaker (MCB), merits and demerits. Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock. **COs– CO3**

Part B: Electronics Engineering

UNIT-IV: Semiconductor Devices and Basic Electronic Circuits **15 Hours**

Introduction - Evolution of electronics – Vacuum tubes to nano electronics - Characteristics of PN Junction Diode — Zener Effect — Zener Diode and its Characteristics. Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics — Elementary Treatment of Small Signal CE Amplifier. Rectifiers and power supplies: Block diagram description of a dc power supply, Half-Wave Rectifiers, Full-Wave Rectifiers, capacitor filter (no analysis). Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response. **COs –CO4**

Self-Learning Topics: Electronic components and characteristics, Design Amplifier circuit at different R, C Values

UNIT -V: DIGITAL ELECTRONICS and INSTRUMENTTAION **15 Hours**

Overview of Number Systems, BCD codes, Excess-3 code, Gray code, Hamming code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits– Half and Full Adders. Introduction to sequential circuits, Flip flops, Registers and counters (Elementary Treatment only), Electronic Instrumentation: Block diagram of an electronic instrumentation system **COs–CO5**

Self-Learning Topics: Develop digital circuits using minimum no. of gates, design principles of electronic instruments.

Board of Studies : Electrical and Electronics Engineering
Approved in BoS No: 01, 3rd August, 2024
Approved in ACM No: 01

Text Books: Electrical Engineering

1. Basic Electrical Engineering, D. C. Kulshreshtha, TataMcGrawHill,2019, First Edition
2. Power System Engineering, P.V. Gupta,M.L.Soni,U.S.BhatnagarandA.Chakrabarti,Dhanpat Rai & Co, 2013

3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, ThirdEdition

Text Books: Electronics Engineering

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009

Reference Books: Electrical Engineering

1. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Mc Graw Hill, 2019,FourthEdition
2. Principles of Power Systems, V.K. Mehtha, S.Chand Technical Publishers, 2020
3. Basic Electrical Engineering, T. K. Nagsarkar and M. S.Sukhija, Oxford University Press,2017
4. Basic Electrical and Electronics Engineering, S. K. Bhatacharya, Pearson Publications, 2018,Second Edition.

Reference Books: Electronics Engineering

1. R. S. Sedha, A Textbook of Electronic Devices and Circuits, S. Chand & Co, 2010.
2. Santiram Kal, Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall,India, 2002.
3. R.T.Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version,Pearson Education,2009

Web References: (Electrical Engineering)

1. https://nptel.ac.in/courses/108105053
2. https://nptel.ac.in/courses/108108076

Web References: (Electronics Engineering)

1. https://archive.nptel.ac.in/courses/117/102/117102059
2. https://www.tutorialspoint.com/principles_of_communication
3. https://www.geeksforgeeks.org/electronics-and-communication-engineering

Internal Assessment Pattern (Electrical Engineering)

Cognitive Level	Internal Assessment #1(%)
L1	30
L2	30
L3	40
Total (%)	**100**

Internal Assessment Pattern (Electronics Engineering)

Cognitive Level	Internal Assessment #2(%)
L1	30
L2	30
L3	40
Total (%)	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

Part-A: Electrical Engineering

L1: Remember

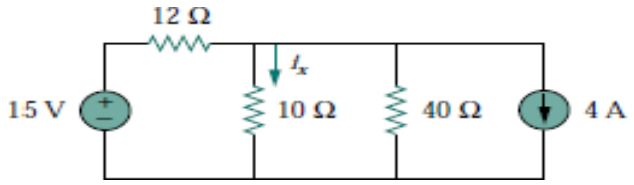
1. State Ohm's law?
2. Define Superposition theorem?
3. Define Active power?
4. Define Reactive power?
5. Define the term tariff?
6. Define form factor?
7. Define RMS value?

L2: Understand

1. Explain the principle and operation of DC Motor?
2. Explain the construction of Alternator?
3. Explain the principle and operation of Moving Iron instruments?
4. What is meant by Earthing and explain about process of earthing?
5. Draw the layout of wind power generating plant?

L3: Apply

1. For the circuit shown below in calculate Ix and the power dissipated by the 10-Ω resistor using superposition.



2. An alternating voltage is given by V=230sin314t.Calculate i)frequency, i)maximum value, iii)average value ,iv)RMS value
3. A Consumer has Maximum demand of 200 KW at 40% load factor. If the tariff is Rs.200per KW of maximum demand plus 10paise per KWH, find the annual charges?

Part-B: Electronics Engineering

L1: Remember

1. Draw the symbol of pn junction of diode
2. What is meant by BJT?
3. Define Avalanche and Zener break down voltages?
4. Draw the symbol of Zener diode.
5. Define Amplifier?
6. Define Rectifier?
7. What is the Zener voltage regulator?
8. Define latch and flip flop?
9. Symbol of JK flip flop?
10. Draw the logic symbols of OR, AND, NOT gate?

L2: Understand

1. Write the Differences between Avalanche and Zener break down voltages?
2. Draw the diagram and explain single input and dual input op-amps?
3. Compare BJT, CB, CE, CC transistor configuration characteristics?
4. Write the notes of PN junction diode?
5. Draw the block diagram of public address system and explain?
6. Discuss the working principal of zener voltage regulator?
7. Draw the block diagram of electronic instrumentation system and explain?

L3: Apply

1. What is doping? Describe P and N type semiconductors with Qualitative theory?
2. Draw the diagram and explain single input and dual input op-amps and design?
3. Design operational amplifier?
4. Explain the block diagram of DC power supply?
5. Explain the circuit diagram and working of RC coupled amplifier?
6. Operation of center tap full-wave rectifier?
7. Explain the operation of full –wave rectifier with capacitor?
8. Explain the JK, SR, D,T flip flops ?
9. Simplify the Boolean expressions to minimum number of literals i) A+B+A'B'C ii) AB + A (B +C) + B'(B+D).

Chairperson
Board of Studies (EEE& ECE)

R24BS06 **APPLIED CHEMISTRY LAB** **0 0 2 1**

(Common to EEE, ECE, CSE, CSE (AI&ML), CSE (DS))

Course Objectives:

1. Verify the fundamental concepts with experiments.
2. Learn and carry out some of the important experiments related to batteries and their properties.
3. Learn the preparation of engineering polymer materials like Bakelite
4. Know the fundamental principles of chemistry lab experiments which include volumetric Analysis, dichrometry, conductometry and potentiometry.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs		
		PO1	PO2	Dok
R24BS06.1	Determine the cell constant and conductance of solutions. Determine redox potentials.	1	3	L1, L2
R24BS06.2	Prepare advanced polymer Bakelite materials. Strength of Mn(II) and Ferrous Iron by dichrometry, Adsorption of acetic acid.	1	3	L1,L3
R24BS06.3	Measure the strength of an acid present in secondary batteries. Calculation of Hardness of Water.	1	3	L1, L4

Board of Studies : Basic Science Humanities (Chemistry)

Approved in BOS No: 01, 5th August, 2024

Approved in ACM No: 01

List of Experiments:

Week 1:

1. Conductometric titration of strong acid vs. strong base
2. Conductometric titration of weak acid vs. strong base
3. Determination of cell constant and conductance of solutions
4. Potentiometry - determination of redox potentials and emfs
5. PH metric titration – determination of Strength of Strong acid vs Strong base **COs:CO1**

Week 2:

1. Conductometric titration of strong acid vs. strong base
2. Conductometric titration of weak acid vs. strong base
3. Determination of cell constant and conductance of solutions
4. Potentiometry - determination of redox potentials and emfs
5. PH metric titration – determination of Strength of Strong acid vs Strong base **COs:CO2**

Week 3:

1. Conductometric titration of strong acid vs. strong base
2. Conductometric titration of weak acid vs. strong base
3. Determination of cell constant and conductance of solutions
4. Potentiometry - determination of redox potentials and emfs
5. PH metric titration – determination of Strength of Strong acid vs Strong base. **COs:CO1**

Week 4:

1. Conductometric titration of strong acid vs. strong base
2. Conductometric titration of weak acid vs. strong base
3. Determination of cell constant and conductance of solutions
4. Potentiometry - determination of redox potentials and emfs
5. PH metric titration – determination of Strength of Strong acid vs Strong base **COs:CO3**

Week 5:

1. Conductometric titration of strong acid vs. strong base
2. Conductometric titration of weak acid vs. strong base
3. Determination of cell constant and conductance of solutions
4. Potentiometry - determination of redox potentials and emfs
5. PH metric titration – determination of Strength of Strong acid vs Strong base **COs:CO1**

Week 6:

6. Determination of Strength of an acid in Pb-Acid battery **COs:CO3**

Week 7:

7. Determination of Hardness of Water **COs:CO3**

Week 8:

8. Determination of Mn (II) by using oxalic acid **COs:CO2**

Week 9:

9. Adsorption of acetic acid by charcoal **COs:CO2**

Week 10:

10. Estimation of Ferrous Iron by Dichrometry **COs:CO2**

Week 11:

11. Preparation of a Bakelite (Demo) **COs:CO4**

Week 12:

12. Preparation of nanomaterials by precipitation method. **COs: CO4**

Additional Experiments

1. Determination of Sodium carbonate by using Hydrochloric acid
2. Determination of Copper (II) using standard hypo solution. **COs:CO1**

Reference:

1."Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition" Pearson Publications by J. Mendham, R.C.Denney, J.D.Barnes and B. Sivasankar
2. Practical Engineering Chemistry by K. Mukkanti, etal, B.S. Publications, Hyderabad.
3. Instrumental methods of chemical analysis, Chatwal, Anand, Himalaya Publications.

Chairperson
Board of Studies (Chemistry)

R24ES03 Problem Solving &Programming with C Lab 0 0 3 1.5
(Common to all Branches)

Course Objectives:

The course aims to give students hands – on experience and train them on the concepts of the C-programming language.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs			
		PO1	PO2	PO3	Dok
R24ES03.1	Read, understand, and trace the execution of programs written in C language.	2	2	2	L1, L2
R24ES03.2	Select the right control structure for solving the problems .and demonstrate the application of arrays functions and strings	3	3	3	L2,L3
R24ES03.3	Develop Debug and Execute programs to demonstrate the applications of Pointers, Structures& Unions, and Files.	3	3	3	L2, L3

Board of Studies : Computer Science and Engineering
Approved in BOS No: 01, 30th July, 2024
Approved in ACM No: 01, 30th July, 2024

Developing the following programs:

Week 1:

1. Write a C program using printf() and Scanf(). COs:CO1
2. Write a C program on swapping of two nos. COs:CO1
3. Write a C program using arithmetic Expressions. COs:CO1

Week 2:

4. Simple interest calculation COs:CO2
5. Finding compound interest COs:CO2
6. Area of a triangle using heron's formulae COs:CO2
7. Distance travelled by an object COs:CO2

Week 3:

8. Find the maximum of three numbers using conditional operator COs:CO2
9. Take marks of 5 subjects in integers, and find the total, average in float COs:CO2
10. Write a C program to shift/rotate using bit fields. COs:CO2
11. Finding the square root of a given number COs:CO2
12. Write a C program using if-else statement. COs:CO2

Week 4:

13. Write a C program to find the max and min of four numbers using if-else. COs:CO2
14. Write a C program to generate electricity bill. COs:CO2
15. Find the roots of the quadratic equation. ` COs:CO2

16. Write a C program to find the given year is a leap year or not. COs:CO2
17. Write a C program to simulate a calculator using switch case. COs:CO2

Week 5:

18. Find the factorial of given number using any loop. COs:CO2
19. Find the given number is a prime or not. COs:CO2
20. Compute sine and cos series. COs:CO2
21. Checking a number palindrome. COs:CO2
22. Construct a pyramid of numbers. COs:CO2

Week 6:

23. Write a C program on Linear Search. COs:CO3
24. Find the min and max of a 1-D integer array. COs:CO3
25. Perform linear search on1D array. COs:CO3
26. The reverse of a 1D integer array. COs:CO3

Week 7:

27. Find 2's complement of the given binary number. COs:CO3
28. Eliminate duplicate elements in an array. COs:CO3
29. Sort array elements using bubble sort. COs:CO3
30. Addition of two matrices. COs:CO3

Week 8:

31. Multiplication two matrices. COs:CO3
32. Write a C program using call by reference. COs:CO3
33. Write a C program to find factorial of n using recursion. COs:CO3
34. Write a C function to calculate NCR value COs:CO3
35. Concatenate two strings without built-in functions. COs:CO3

Week 9:

36. Write a C function to transpose of a matrix. COs:CO3
37. Write a C function to find the length of a string. COs:CO3
38. Reverse a string using built-in and without built-in string functions. COs:CO3
39. Write a C program to find the sum of a 1D array using malloc ( ). COs:CO3

Week 10:

40. Write a recursive function to find the lcm of two numbers. COs:CO3
41. Write a recursive function to find the sum of series. COs:CO3
42. Write a C program to swap two numbers using call by reference. COs:CO3
43. Write a C program using Pointers, Structures and Unions. COs:CO4
44. Write a C program to find the total, average of n students using structures. COs:CO4

Week 11:

45. Enter n students data using calloc() and display failed students list. COs:CO4
46. Read student name and marks from the command line and display the student details along with the total. COs:CO4
47. Write a C program to implement realloc(). COs:CO4
48. Write a C program to copy one structure variable to another structure of the same type. COs: CO4

Week 12:

49. Demonstrate Dangling pointer problem using a C program. COs: CO4
50. Write a C program to copy one string into another using pointer. COs: CO4

51. Write a C program to find no of lowercase, uppercase, digits and other characters using pointers. COs: CO4

Week 13:

52. Write a C program using Files operations. COs:CO5
    a. Sum and average of 3 numbers
    b. Conversion of Fahrenheit to Celsius and vice versa.
53. Write a C program to write and read text into a file. COs:CO5

Week 14:

54. Write a C program to write and read text into a binary file using fread() and fwrite() COs:CO5
55. Copy the contents of one file to another file. COs:CO5
56. Write a C program to merge two files into the third file using command-line arguments. COs: CO5

Week 15:

57. Find no. of lines, words and characters in a file. COs:CO5
58. Write a C program to print last n characters of a given file. COs:CO5

Textbooks:

1. Ajay Mittal, Programming in C: A practical approach, Pearson.
2. Byron Gottfried, Schaum' s Outline of Programming with C, McGraw Hill

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, PrenticeHall of India
2. C Programming, A Problem-Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE

Chairperson
Board of Studies (CSE)

R24ES07 Basic Electrical and Electronics Engineering Lab 0 0 3 1.5
(Common to all branches of Engineering)

Course Objectives:

To impart knowledge on the fundamental laws & theorems of electrical circuits, functions of electrical machines and energy calculations.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs							
		PO1	PO2	PO3	PO4	PO5	PO11	PS01	Dok
R24ES07.1	Apply the theoretical concepts and operating principles to derive mathematical models for circuits, Electrical machines and measuring instruments; calculations for the measurement of resistance, power and power factor.	1	1		3	1			L1, L2, L3
R24ES07.2	Apply the theoretical concepts to obtain calculations for the measurement of resistance, power and power factor and design suitable circuits for measurement of electrical parameters	1	1		3	1	2	2	L2, L3
R24ES07.3	Plot and discuss the characteristics of various electron devices/instruments.	1	1		3	1	2		L1, L2, L3

Board of Studies : Electrical and Electronics Engineering
Approved in BOS No: 01, 3rd August, 2024
Approved in ACM No: 01

Developing the following programs:

List of Experiments

1. Verification of KCL and KVL **COs: CO2**
2. Verification of Superposition theorem **COs: CO2**
3. Measurement of Resistance using Wheatstone bridge **COs: CO2**
4. Magnetization Characteristics of DC shunt Generator **COs: CO2**
5. Measurement of Power and Power factor using Single-phase wattmeter **COs: CO2**
6. Measurement of Earth Resistance using Megger **COs: CO2**
7. Calculation of Electrical Energy for Domestic Premises **COs: CO2**

Reference Books:

1. Basic Electrical Engineering, D.C.Kulshreshtha,TataMcGrawHill,2019, First Edition
2. Power System Engineering, P.V.Gupta, M.L.Soni, U.S.Bhatnagar and A. Chakrabarti,

DhanpatRai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition.

Web References:

1. https://www.jntumaterials.co.in/2015/06/jntuk-btech-lab-manuals
2. www.jntumaterials.in

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	20
L2	30	40
L3	40	40
Total (%)	**100**	**100**

Sample Lab Experiments of Various Cognitive Levels:

Experiments

1. Verification of KCL and KVL **COs: CO2**
2. Verification of Superposition theorem **COs: CO2**
3. Measurement of Resistance using Wheatstone bridge **COs: CO2**
4. Magnetization Characteristics of DC shunt Generator **COs: CO2**
5. Measurement of Power and Power factor using Single-phase wattmeter **COs: CO2**
6. Measurement of Earth Resistance using Megger **COs: CO2**
7. Calculation of Electrical Energy for Domestic Premises **COs: CO2**

S. No.	Title	Cognitive Level
1	Verification of KCL and KVL	L1, L2,L3
2	Verification of Superposition theorem	L1, L2,L3
3	Measurement of Resistance using Wheatstone bridge	L2,L3,
4	Magnetization Characteristics of DC shunt Generator	L1, L2,L3
5	Measurement of Power and Power factor using Single-phase wattmeter	L1, L2,L3
6	Measurement of Earth Resistance using Megger	L1,L3
7	Calculation of Electrical Energy for Domestic Premises	L1, L2

Note: Minimum Six Experiments to be performed.

PART B: Electronics Engineering Workshop

Course Objectives:

To impart knowledge on the principles of digital electronics and fundamentals of electron devices & its applications.

List of Experiments:

1. Plot V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias. **COs: CO3**
2. Plot V – I characteristics of Zener Diode and its application as voltage Regulator. **COs: CO3**
3. Implementation of half wave and full wave rectifiers **COs: CO3**
4. Plot Input & Output characteristics of BJT in CE and CB configurations **COs: CO3**
5. Frequency response of CE amplifier. **COs: CO3**
6. Simulation of RC coupled amplifier with the design supplied **COs: CO3**

7. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs. **COs: CO2**
8. Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs. **COs: CO2**

Tools / Equipment Required: DC Power supplies, Multi meters, DC Ammeters, DC Voltmeters, AC Voltmeters, CROs, all the required active devices.

Reference Books:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education, 2009.

Note: Minimum Six Experiments to be performed. All the experiments shall be implemented using bothHardware and Software.

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	20
L2	30	40
L3	40	40
Total (%)	**100**	**100**

Web References:

1. https://www.jntumaterials.co.in/2015/06/jntuk-btech-lab-manuals
2. www.jntumaterials.in

Experiments of Various Cognitive Levels:

S. No.	Title	Cognitive Level
1	Plot V-I characteristics of PN Junction diode A)Forward bias B) Reverse bias.	L1, L2, L3
2	Plot V – I characteristics of Zener Diode and its application as voltage Regulator.	L1, L2, L3
3	Implementation of half wave and full waverectifiers	L2,L3,L4
4	Plot Input & Output characteristics of BJT in CEand CB configurations	L1, L2,L3
5	Frequency response of CE amplifier.	L1, L2,L3
6	Simulation of RC coupled amplifier with the designsupplied	L1,L3,L4
7	Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates	L1, L4
8	Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs.	L1,L3,L4

Note: Minimum Six Experiments to be performed.

Chairperson
Board of Studies (EEE&ECE)

R24ES08 **ENGINEERING WORKSHOP** **0 0 3 1.5**
(Common to all Branches)

Course Objectives:

- Describe how different tools are used in home wiring, tin smiting, blacksmithing, carpentry, and fitting.

Course Code	Course Outcomes	Mapping with Pos					
		PO1	PO2	PO3	PO4	PO6	PO9
R24ES08.1	Identify workshop tools and their operational capabilities. Practice on manufacturing of components using workshop trades including carpentry, fitting, sheet metal	3	2	1	1	1	1
R24ES08.2	Practice on manufacturing of components using workshop trades including foundry and welding.	3	2	1	1	2	3
R24ES08.3	Apply fitting operations in various applications and engineering knowledge for Plumbing, House Wiring Practice, and Making square rod and L-bend from the round rod in black smithy	3	2	1	1	2	3

List of Experiments

1. **Wood Working:** **COs: CO1**
   a) Half – Lap joint
   b) Mortise and Tenon joint
   c) Corner Dovetail joint or Bridle joint
2. **Sheet Metal Working:** **COs: CO1**
   a) Tapered tray
   b) Conical funnel
   c) Elbow pipe
   d) Brazing
3. **Fitting:** **COs: CO1**
   a) V-fit
   b) Dovetail fit
   c) Semi-circular fit
   d) Bicycle tire puncture and change oftwo-wheeler tyre
4. **Foundry Trade:** Preparation of Green Sand Moulds **COs: CO2**
   a) Single piece pattern
   b) Double piece pattern
5. **Welding Shop: Arc welding Practice** **COs: CO2**
   a) Lap joint
   b) Butt joint

6. Electrical Wiring: **COs: CO3**

a) Parallel and series connection
b) Two-way switch connection
c) Tube light connection
d) Soldering of wires

7. Plumbing: **COs: CO3**

a) Prepare Pipe joint with coupling for 1 inch diameter
b) Prepare Pipe joint with coupling for 1.5 inch diameter

8. Black smithy: **COs: CO3**

a) Round rod to Square
b) Round rod to S-Hook

Textbooks:

1. Basic Workshop Technology: Manufacturing Process, Felix W.; Independently Published, 2019. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.
2. A Course in Workshop Technology Vol I. & II, B.S. Raghuwanshi, Dhanpath Rai & Co., 2015 &2017

Reference Books:

1. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14th edition
2. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.
3. Wiring Estimating, Costing and Contracting; Soni P.M. & Upadhyay P.A.; Atul Prakashan 2021-22

Board of Studies: Mechanical Engineering
Approved in BOS No: 01, 31st July, 2024
Approved in ACM No: 01

Sample Experiments

1. Prepare Half – Lap joint
2. Prepare Mortise and Tenon joint
3. Prepare Corner Dovetail joint or Bridle joint
4. Prepare Tapered tray
5. Prepare Conical funnel
6. Prepare Elbow pipe
7. Do Brazing operation
8. Prepare V-fit
9. Prepare Dovetail fit
10. Prepare Semi-circular fit
11. Do Bicycle tire puncture andchange of two-wheeler tyre
12. Prepare Parallel and series
13. Prepare Two-way switch
14. Prepare Tube light
15. Do Soldering of wires
16. Prepare Green Sand Moulds for single piece Pattern

17. Prepare Green Sand Moulds for double piece Patterns
18. Prepare Lap joint using arc welding
19. Prepare Butt joint using arc welding
20. Prepare Pipe joint with coupling for same diameter(10mm)
21. Prepare Pipe joint with coupling for same diameter(12mm)
22. Prepare Round rod to Square rod
23. Prepare Round rod to S-Hook

Chairperson
Board of Studies (ME)

R24MC01 Health and Wellness, Yoga and Sports 0 0 1 0.5
(Common to all Branches)

Course Objectives:

The main objective of introducing this course is to make the students maintain their mental and physical wellness by balancing emotions in their life. It mainly enhances the essential traits required for the development of the personality.

At the end of the course, students will be able:

Course Code	Course Outcomes	Mapping with POs				
		PO3	PO6	PO7	PO9	PO12
R24MC01.1	Understand the importance of yoga and sports for Physical fitness and sound health.	2	1	1	1	1
R24MC01.2	Demonstrate an understanding of health-related fitness components.	1	2	1	1	1
R24MC01.3	Compare and contrast various activities that help enhance their health	2	1	2	2	1
R24MC01.4	Assess current personal fitness levels.		1	1		1
R24MC01.5	Develop Positive Personality	1	1	2	1	1

SYLLABUS

UNIT-I: **3 Hours**

Concept of health and fitness, Nutrition and Balanced diet, basic concept of immunity Relationship between diet and fitness, Globalization and its impact on health, Body Mass Index (BMI) of all age groups.

Activities:

1. Organizing health awareness programmes in community.
2. Preparation of health profile.
3. Preparation of chart for balance diet for all age groups **COs-CO1**

UNIT- II: **3 Hours**

Concept of yoga, need for and importance of yoga, origin and history of yoga in Indian context, classification of yoga, Physiological effects of Asanas- Pranayama and meditation, stress management and yoga, Mental health and yoga practice.

Activities: Yoga practices – Asana, Kriya, Mudra, Bandha, Dhyana, Surya Namaskar. **COs-CO2**

UNIT–III: **3 Hours**

Concept of Sports and fitness, importance, fitness components, history of sports, Ancient and Modern Olympics, Asian games and Commonwealth games.

Activities:

1. Participation in one major game and one individual sport viz., Athletics, Volleyball, Basketball, Handball, Football, Badminton, Kabaddi, Kho-kho, Table tennis, Cricket etc.
2. Practicing general and specific warm up, aerobics
3. Practicing cardio respiratory fitness, treadmill, run test, 9 min walk, skipping and running.

COs-CO3

Board of Studies : BS&H
Approved in BoS No: 01, August, 2024
Approved in ACM No: 01

Text Books:

1. Gordon Edlin, Eric Golanty. Health and Wellness, 14th Edn. Jones & Bartlett Learning, 2022
2. T.K.V.Desikachar. The Heart of Yoga: Developing a Personal Practice
3. Archie J.Bahm. Yoga Sutras of Patanjali, Jain Publishing Company, 1993
4. Wiseman, John Lofty, SAS Survival Handbook: The Ultimate Guide to Surviving Anywhere Third Edition, William Morrow Paperbacks, 2014
5. The Sports Rules Book/ Human Kinetics with Thomas Hanlon. -- 3rd ed. Human Kinetics, Inc.2014

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities of Health/Sports/Yoga.
2. Institutes must provide field/facility and offer the minimum of five choices of as many as Games/Sports.
3. Institutes are required to provide sports instructor / yoga teacher to mentor the students.

Assessment Pattern:

1. Evaluated for a total of 100 marks.
2. A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totaling to 90 marks.
3. A student shall be evaluated by the concerned teacher for 10 marks by conducting viva
4. voce on the subject.

Chairperson
Board of Studies (Mathematics)

24BS04 Differential Equations and Vector Calculus 3 0 0 3
(Common to all Branches)

Course Objectives:

1. To enlighten the learners in the concept of differential equations and multivariable calculus.
2. To furnish the learners with basic concept and techniques at plus two level to lead them in to advanced level by handling various real-world applications.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs			Dok
		PO1	PO2	PO12	
R24BS04.1	Solve the first order differential equations related to various engineering fields.	3	2	1	L1,L2,L3
R24BS04.2	Model engineering problems as higher order differential equations and solve analytically.	3	2	1	L1,L2,L3
R24BS04.3	Identify solution methods for partial differential equations that model physical processes.	3	2	1	L1,L2,L3
R24BS04.4	Interpret the physical meaning of different operators such as gradient, curl and divergence.	3	2	1	L3,L4
R24BS04.5	Estimate the work done against a field, circulation and flux using vector calculus.	3	2	1	L4,L5

SYLLABUS

UNIT- I: Differential equations of first order and first degree **10 Hours**

Formation of differential equations, order, degree, separation of variables (only Review). Linear differential equations-Bernoulli's equations-Exact equations and equations reducible to exact form.

Applications: Newton's Law of cooling – Law of natural growth and decay, Electrical circuits (RL and LC). **COs-CO1**

Self-Learning Topic: Mixed tank problems

UNIT- II: Higher order Linear differential equations with Constant Coefficients **10 Hours**

Definitions, homogenous and non-homogenous, complimentary function, particular integral $\left(e^{ax}, \sin ax, \cos ax, \text{Polynomial in } x, e^{ax}V(x), xV(x)\right)$, general solution, Wronskian, method of variation of parameters. **COs-CO2**

Applications: L-C-R Circuit problems

Self-Learning Topic: Simple Harmonic motion

UNIT–III: Partial Differential Equations **10 Hours**

Introduction and formation of Partial Differential Equations by elimination of arbitrary constants and arbitrary functions, solution of first order linear equations using Lagrange's method. Homogenous Linear Partial differential equations with constant coefficients. **COs-CO3**

Self-Learning Topic: Method of Separation of Variables

UNIT- IV: Vector differentiation **10 Hours**

Vector, Scalar, dot product, cross product, unit vector, equation of a line passing through two points (Review only)

Scalar and vector point functions, vector operator del, del applies to scalar point function-Gradient, del applied to vector point function – Divergence and Curl, Vector Identities **COs-CO4**

Application: Scalar Potential

Self-Learning Topic: Equation of tangent plane and Normal plane.

UNIT-V: Vector integration **10 Hour**

Line integral – circulation – work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof). **COs-CO5**

Self-Learning Topic: Application of above theorems.

Board of Studies: Basic Science and Humanities
Approved in BOS No: 01, 2nd August, 2024
Approved in ACM No: 01

Text Books:

1. B.S.Grewal, Higher Engineering Mathematics, 44/e, Khanna publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2018.

Reference Books:

1. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Jones and Bartlett, 2018.
2. Michael Green berg, Advanced Engineering Mathematics, 9th edition, Pearson edn
3. George B. Thomas, Maurice D. Weir and Joel Hass, Thomas Calculus, 14/e, Pearson Publishers, 2018.
4. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 5/e, Alpha Science
5. International Ltd., 2021 (9th reprint).
6. B.V. Ramana, Higher Engineering Mathematics, McGraw Hill Education, 2017.

Web References:

1. http://onlinecourses.nptel.ac.in
2. https://nptel.ac.in/courses/111105121
3. https://onlinecourses.nptel.ac.in/noc24_ma86/course

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	10
L2	30	10
L3	40	30
L4	--	25
L5	--	25
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

UNIT-I

1. Define Leibnitz's linear differential equation(L1)
2. State Newton's law of cooling(L1)
3. Write differential equation of L-R series circuit (L1)
4. solve the differential equation $\left(1+x^2\right)\frac{dy}{dx}+2xy=4x^2$ (L2)
5. If the temperature of the air is 30^0C and the substance cools from 100^0C to 70^0C in 15 minutes, find when the temperature will be 40^0C (L3)
6. The rate at which bacteria multiply is proportional to the instantaneous number present. If the original number doubles in two hours, then it will triple after ….hours (L3)

UNIT-II

1. Define Wronskian (L1)
2. solve the differential equation $\frac{d^2y}{dx^2}-6\frac{dy}{dx}+13y=8e^{3x}\sin 2x$ (L2)
3. An inductance of 2 henries and a resistance of 20 ohms are connected in series with e.n.f. E volts. If the current is zero when $t=0$. Find the current at the end of 0.01 seconds if E=100 volts. (L3)

UNIT-III

1. State Lagrange's Linear equation (L1)
2. form a partial differential equation by eliminating the arbitrary function φ from $lx+my+nz=\varphi\left(x^2+y^2+z^2\right)$ (L2)
3. solve $\frac{\partial^3 z}{\partial x^3}-2\frac{\partial^3 z}{\partial x^2\partial y}=2e^{3x}+3x^2y$ (L2)
4. Solve $\left(mz-ny\right)\frac{\partial z}{\partial x}+\left(nx-lz\right)\frac{\partial z}{\partial y}=ly-mx$ (L3)

UNIT-IV

1. The temperature of points in space is given by $T\left(x,y,z\right)=x^2+y^2-z.$ A mosquito located at $\left(1,1,2\right)$ desires to fly in such a direction that it will get warm as soon as possible. In what direction should it move? (L3)
2. Show that $\nabla^2\left(r^n\right)=n\left(n+1\right)r^{n-2}$ (L4)

UNIT-V

1. Evaluate $\iiint_v \nabla.\vec{F}dV$, where $\vec{F}=4x\hat{i}-2y^2j+z^2k$ and V is bounded by $x^2+y^2=4, z=0$ and $z=3$ (L4)
2. Evaluate $\int_C\left(3x^2-8y^2\right)dx+\left(4y-6xy\right)dy$ where C is the curve bounded by $y=\sqrt{x}$ and $y=x^2$ (L5)

Chairperson
Board of Studies (Mathematics)

R24BS02 **Engineering Physics** **3 0 0 3**
(Common to all Branches)

Course Objectives:

1. To bridge the gap between the physics in school at 10+2 level and UG level engineering courses.
2. To identify the importance of the optical phenomenon i.e. interference and diffraction related to its engineering applications.
3. To understand the mechanism of emission of light, utilization of lasers as coherent light sources for low and high energy applications.
4. To enlightening the periodic arrangement of atoms in crystalline solids and classify various crystal systems.
5. To explain the significant concepts of dielectric and magnetic materials that leads to potential applications in the emerging micro devices.
6. To enlightenment of the concepts of quantum mechanics and to provide fundamentals of de-Broglie matter waves and the importance of free electron theory for metals.
7. To understand the physics of semiconductors and identify the type of semiconductor using Hall Effect.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with Pos			Dok
		PO1	PO2	PO12	
R24BS02.1	Analyze the intensity variation of light due to interference, diffraction and classify various types of lasers.	3	2	1	L1 ,L2, L3
R24BS02.2	Identify various crystal systems and analyze the crystalline structure.	3	2	1	L1, L2, L3
R24BS02.3	Summarize various types of polarization of dielectrics and classify the magnetic materials.	2	2	1	L2, L3
R24BS02.4	Explain fundamentals of quantum mechanics and apply to one dimensional motion of particles.	3	2	2	L1, L4
R24BS02.5	Outline the properties of charge carriers in semiconductors	3	2	1	L2, L5

SYLLABUS

UNIT-I: Wave Optics and Lasers **14 Hours**

Interference: Introduction - Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) & applications - Colors in thin films- Newton's Rings- Determination of wavelength and refractive index.

Diffraction: Introduction - Fresnel and Fraunhofer diffractions - Fraunhofer diffraction due to single slit- Fraunhofer diffraction due to N-Slits -Diffraction Grating - Dispersive power and resolving power of Grating (Qualitative).

Lasers: Introduction - Characteristics of laser - Spontaneous and Stimulated emissions of radiation - Population inversion - Lasing action - Pumping mechanisms - Ruby laser - He-Ne laser- Applications of lasers. **COs–CO1**

Self-Learning Topics: Interference in thin films due to Transmission of light

UNIT-II: Crystallography and X-ray diffraction **10 Hours**

Crystallography: Space lattice, Basis, Unit Cell and lattice parameters - Bravais Lattices - crystal systems (3D) - coordination number - packing fraction of SC, BCC & FCC - Miller indices - separation between successive (hkl) planes.

X-ray diffraction: Bragg's law - X-ray Diffraction - Crystal structure determination by Laue's and Powder methods. **COs–CO2**

Self-Learning Topics: Effect of crystallite size on diffracted X-Ray intensity

UNIT-III: Magnetic and Dielectric Materials **12 Hours**

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability - Atomic origin of magnetism - Classification of magnetic materials: Dia, para, Ferro, anti-ferro& Ferri magnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials.

Dielectric Materials: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility, Dielectric constant and Displacement Vector - Relation between the electric vectors - Types of polarization- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field - Clausius- Mossotti equation - dielectric loss. **COs–CO3**

Self-Learning Topics: Frequency dependence of polarization.

UNIT-IV: Quantum Mechanics and Free electron theory **12 Hours**

Quantum Mechanics: Dual nature of matter - Heisenberg's Uncertainty Principle - Significance and properties of wave function - Schrodinger's time independent and dependent wave equations - Particle in a one-dimensional infinite potential well.

Free Electron Theory: Classical free electron theory (Qualitative with discussion of merits and demerits) - Quantum free electron theory - electrical conductivity based on quantum free electron theory - Fermi-Dirac distribution - Fermi energy. **COs– CO4**

Self-Learning Topics: Density of states, Origin of energy bands in solids

UNIT-V: Semiconductors **8 Hours**

Semiconductors: Formation of energy bands - classification of crystalline solids - Intrinsic semiconductors: - Fermi level - Extrinsic semiconductors- P-Type semiconductors- N-Type semiconductors- Principle of operation and Characteristics of P-N Junction diode - Drift and diffusion currents - Einstein's equation - Hall Effect and its applications. **COs-CO5**

Self-Learning Topics: Zener diode, Solar cells

Board of Studies : Department of Physics
Approved in BOS No: 01, 5th August, 2024
Approved in ACM No: 01

Textbooks:

1. A Text book of Engineering Physics - M. N. Avadhanulu, P.G. Kshirsagar& TVS Arun Murthy, S. Chand Publications, 11th Edition 2019.
2. Introduction to Quantum Mechanics, David J. Griffiths, Pearson Education India Learning Private Limited (2015).
3. Laser Fundamentals, William T. Silfvast, 2nd edn, Cambridge University press, New York (2004).
4. Introduction to Solid State Physics, 8 th Edition, Charles Kittel, John Wiley & Sons, NJ,

USA (2005).
5. Engineering Physics - D.K. Bhattacharya and Poonam Tandon, Oxford press (2015).
6. Semiconductor Physics and Devices:Basic principle, Donald A. Neamen 4th ed,, McGraw-Hill, New York (2012).

Reference Books:

1. Engineering Physics - B.K. Pandey and S. Chaturvedi, Cengage Learning.
2. The Principles of Quantum Mechanics, P. A. M. Dirac, fourth Edition (Oxford University Press, Oxford, 1958).
3. Physics-Resnick, Halliday, Krane, Fifth edison, Volume-1, Wiley student edition.
4. Engineering Physics - Dr.R. Swapna, Scientific International Publishing House.
5. Concepts of Modern Physics. Arthur Beiser, Tata McGraw-Hill, New Delhi (2010).
6. Engineering Physics" - Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press.
7. Engineering Physics - M.R. Srinivasan, New Age international publishers (2009).

Web References:

1. https://www.ebooksdirectory.com/
2. http://www.sciencedirect.com/Science
3. https://onlinecourses.nptel.ac.in/
4. https://www.link.springer.com/physics/
5. https://www.loc.gov/rr/scitech/selected-internet/physics.html

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	40	20
L2	30	30
L3	30	--
L4	--	30
L5	--	20
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

UNIT-1

1. Define interference? What are the necessary conditions for obtaining interference of light? (L1)
2. Explain interference in thin films due to reflected light. What are the conditions to obtain the maximum and minimum intensities in the reflected light? (L2)
3. Describe the principle and formation of Newton's rings and give a method to determine the radius of nth dark ring, radius of curvature (R) of plano convex lens and radius of nth dark ring. (L1,L3)
4. What is meant by diffraction? Distinguish between Fresnel and Fraunhofer diffraction. (L1)
5. Discuss Fraunhofer diffraction due to single slit and derive an expression for width of the central maxima? (L2,L3)
6. What is meant by stimulated emission. Describe Lasing action. (L1,L2)
7. Describe the construction and working of He-Ne Laser. (L1)

UNIT-2

1. Define the terms space lattice, basis, unit Cell, lattice parameters, bravais Lattice, atomic radius and coordination number. (L1)

2. Illustrate the SC, BCC and FCC crystal structures. (L3).
3. Explain body centered cubic (BCC) and determine the packing fraction of BCC. (L2,L3)
4. Explain body centered cubic (FCC) and determine the packing fraction of FCC. (L2,L3)
5. Classify the seven crystal systems and write the relationship between lattice parameters in various crystal systems. (L2)
6. What are the Miller indices? How are they obtained? (L1)
7. What are the important features of Miller indices? Draw the planes (100), (101) (110) (010) and (111), (123). (L1)
8. State and explain Bragg's law. (L2)
9. Describe the LAUE method for determination of crystal structure. (L2)

.UNIT-3

1. Define the terms magnetic dipole moment and magnetic susceptibility, magnetization, permeability, dielectric flux density and magnetic field intensity. (L1)
2. Summarize various types of polarization of dielectrics. (L2)
3. Show that $\mu r = 1 + \chi$. (L3)
4. Describe the origin of magnetic moment of an atom. (L1)
5. Explain the domain concept of ferromagnetism based on Hysteresis loop (B-H Curve). (L2)
6. Describe soft and hard magnetic materials? (L1)
7. What is meant by internal field or local field or Lorentz field? Derive an expression for internal field. (L1, L3)
8. Derive Clausius-Mosotti relation in dielectrics subjected to static fields. (L3)

UNIT-4

1. Discuss the de-Broglie's hypothesis. Show that $\lambda = h / \sqrt{2mE}$ (L1, L4)
2. Show that the wavelength of an electron accelerated by potential differences $\lambda = \frac{1.227}{\sqrt{V}} nm$. (L3)
3. What are the matter waves? Explain the properties of matter waves. (L1)
4. What is the physical significance of wave function ψ.(L4)
5. Derive the time independent and dependent Schrodinger wave equation. (L4)
6. Describe the particle in 1 dimensional infinite potential box. (L1)
7. Explain Heisenberg uncertainty principle? (L4)
8. Find the energy required to jump an electron from ground state to the second excited state in a metal.(L1),
9. Define the terms (i) mean free path (ii) drift velocity (iii) relaxation time. (L1)
10. What are the success and draw backs of classical free electron theory of metals. (L1)
11. Derive an expression for electrical conductivity on the basis of quantum free electron theory of metals. (L3)
12. What is Fermi level? Explain Fermi-Dirac distribution function (FDD) of the electrons. (L1, L4)

UNIT-5

1. Explain the classification of solids (conductors, semiconductors and insulators (L5).
2. What are the differences between intrinsic and extrinsic semiconductors? (L2)
3. Explain N-Type and P-Type semiconductors. Indicate on an energy level diagram the donor and acceptor level for intrinsic and extrinsic semiconductors. (L5)
4. Explain the characteristics of P-N Junction diode. (L5)

5. Describe the diffusion current and drift current in a semiconductor. (L2)
6. Derive an expression for Einstein's equation by using drift and diffusion currents. (L5)

7. What is Hall Effect? Identify the type of semiconductor using Hall effect and derive an expression for Hall coefficient. (L2, L3).
8. Write the applications of Hall Effect. (L1)

Chairperson
Board of studies (Physics)

R24HS01 COMMUNICATIVE ENGLISH 2 0 0 2

(Common to CSE, CSE-AI & ML, CSD Branches in Semester-I)

(Common to EEE, MECH & ECE in Semester-II)

Course Objectives:

1. To identify the English Communication Skills among the first year B.Tech students and to initiate measures to bridge the gap.
2. To enlighten the students on the necessity of cultivating good language habits through practising LSRW skills.
3 To explain them various topics of grammar and the importance of being grammatically correct in speech and writing.
4 To make them practise Phonetics and impart the nuances of fine speech.
5 To instruct them about the various types of format related to writing letters, paragraph, emails, essays and reports.
6 To make them appreciate English text and deepen their comprehension through reading of textual and non-detailed topics.

At the end of the course, students will be able:

Course Code	Course Outcomes	Mapping with POs			Dok
		PO9	PO10	PO12	
R24HS01.1	To utilize the text, online resources, and other social, and real time situations with an aim to practice Communicative English	1	3	2	L2, L4
R24HS01.2	To apply grammatical knowledge for speaking, and writing purposes	2	3	1	L3, L6
R24HS01.3	To analyze and practice various devices of speech for effective conversation and presentations	2	3	1	L4, L6
R24HS01.4	Appraising the language competence of the learners and suggesting remedial action	2	3	1	L3,L5
R24HS01.5	To make the learners practice writing tasks which are relevant for job training and academic purposes.	1	2	3	L3,L6

SYLLABUS

UNIT-I **12 Hours**

Lesson: HUMAN VALUES: A Power of a Plate of Rice by Ifeoma Okoye (Short story)

Listening: Identifying the topic, the context and specific pieces of information

By listening to short audio texts and answering a series of questions.

Speaking: Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.

Reading: Skimming to get the main idea of a text; scanning to look for specific pieces of information.

Writing: Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences.

Grammar: Parts of Speech, Basic Sentence Structures-forming questions

Vocabulary: Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words. **COs-C01**

Self learning topics : The Great Indian Scientists-Biography of CV Raman

UNIT-II **10 Hours**

Lesson: NATURE: Night of the Scorpion by Nissim Ezekiel (Indian and contemporary)

Listening: Answering a series of questions about main ideas and supporting ideas after listening to audio texts.

Speaking: Discussion in pairs/small groups on specific topics followed by short structure talks.

Reading: Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.

Writing: Structure of a paragraph - Paragraph writing (specific topics)

Grammar: Cohesive devices-linkers, use of articles and zero article prepositions.

Vocabulary: Homonyms, Homophones, Homographs. **COs-C02**

Self learning Topics : Seven Ages of Man by William Shakespeare.

UNIT-III **12 Hours**

Lesson: BIOGRAPHY: Steve Jobs

Listening: Listening for global comprehension and summarizing what is listened to.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed

Reading: Reading a text in detail by making basic inferences-recognizing and interpreting specific context clues; strategies to use text clues for comprehension.

Writing: Summarizing, Note-making, paraphrasing

Grammar: Verbs-tenses; Subject-verb agreement; Compound words, Collocations

Vocabulary: Compound words, Collocations **COs-C03**

Self learning topics: Elon Musk

UNIT-IV **8 Hours**

Lesson: INSPIRATION: The Knowledge Society by APJ Abdul Kalam (Ignited minds)

Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/ patterns / relationships, communicate processes or display complicated data.

Writing: Letter Writing: Official Letters and Resumes

Grammar: Reporting verbs, Direct & Indirect speech, Active & Passive Voice

Vocabulary: Words often confused, Jargons **COs-C04**

Self learning Topics: The writings of Sudha Murthy- "The day I stopped drinking milk"

UNIT-V **10 Hours**

Lesson: MOTIVATION: The Power of Intra personal Communication (An Essay)

Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.

Speaking: Formal Oral Presentation topics from academic contexts

Reading: Reading comprehension.

Writing: Writings structured essays on specific topics.

Grammar: Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject-verb agreement)

Vocabulary: Technical Jargons **COs-C05**

Self learning Topics: Body Language (Allan Pease)

Board of Studies : ENGLISH
Approved in BOS No: 6th August, 2024
Approved in ACM No: 01

Textbooks:

1. Pathfinder: Communicative English for Undergraduate Students, 1stEdition,Orient BlackSwan, 2023 (Units 1,2,3 &5)
2. Empowering English by Cengage Publications, 2023
3. The Great Indian Scientists-Cengage Publications
4. English Essentials- Maruthi Publications.(Unit 4)

Reference Books:

1. P. Elian : A Hand book of English for Engineers and Technologists,
2. Bailey, Stephen. Academic writing: A Handbook for International Students. Routledge, 2014.
3. Murphy Raymond English Grammar in Use, Fourth Edition, Cambridge University Press, 2019.
4. English for Engineers by Shyam Ji Dubey- Vikas Publishing House

Web References:

1. www.bbc.co.uk/learningenglish
2. https://dictionary.cambridge.org/grammar/british-grammar/
3. www.eslpod.com/index.html
4. https://www.learngrammar.net/
5. https://english4today.com/english-grammar-online-with-quizzes/
6. https://www.talkenglish.com/grammar/grammar.aspx
7. https://www.youtube.com/c/DailyVideoVocabulary/videos
8. https://www.youtube.com/channel/UC4cmBAit8i_NJZE8qK8sfpA

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	25	25
L2	25	25
L3	15	15
L4	15	15
L5	10	10
L6	10	10
Total (%)	**100**	**100**

Sample Short and Long Answers questions of various cognitive levels

UNIT-I

1. List the major characters in the story.
2. How did the family financial circumstances affect narrator's behaviour and relationship with her family and students?
3. What are the different types of reading?
4. How to avoid errors in spellings and enlist few steps for vocabulary development?
5. What are the different parts of speech?

UNIT-II

1. Write the summary of the poem Night of the Scorpion?
2. How does the ruler setting serve as a perfect background for the programme?
3. Describe the superstitious beliefs and practices mentioned by writer Nissim Ezekiel in his poem.
4. Write a paragraph on Artificial intelligence
5. Write about Definite and In-definite articles with examples?

UNIT-III

1. How did informal jobs and formal education influence his career?
2. Sketch the biography of Elon Musk.
3. List three steps to effective note making.
4. Can technological advancements address the pressing human problems like climate change and disease prevention?
5. Can you come up with creative ideas to match the technological vision of Elon Musk for our humanity?

UNIT-IV

1. What are the various resources of knowledge that Abdul Kalam points out in the knowledge society?
2. What are three main objectives which need to be realized for India to become a Super Power?
3. How ancient Indian knowledge systems have informed the world over centuries?
4. What does it take according to Dr.Kalam for India to become a Knowledge Society?
5. What message can students import from Knowledge Society?

UNIT-V

1. Write the difference between Inter personal communication and Intra personal communication?
2. Mention the different ways through which Intra personal communication helps to improve every day's life.
3. What do you mean by non-verbal communication? Discuss the various types of non-verbal communication.
4. What is the most important type of non-verbal communication, justify your answer?
5. How to make an effective presentation?

Chairperson
Board of Studies (English)

R24ES01 BASIC CIVIL AND MECHANICAL ENGINEERING 3 0 0 3
(COMMON TO ALL BRANCHES)

Course Objectives:

1. **Understand the Role of Civil Engineers**: Familiarize students with the roles and responsibilities of civil engineers in society and the various sub-disciplines within civil engineering.
2. **Construction Materials**: Provide knowledge about different construction materials such as cement, aggregates, bricks, concrete, steel, soil, stones and their applications in building construction.
3. **Transportation Engineering**: Offer insights into the importance of transportation engineering for national economic development and the fundamentals of highway pavements, harbor, tunnel airport and railway engineering.
4. **Water Resources and Environmental Engineering**: Cover the basics of water sources, water quality specifications, hydrology, rainwater harvesting, and water storage structures, emphasizing their importance in environmental sustainability.
5. **Scope and Importance of Mechanical Engineering**: Familiarize students with the scope and significance of mechanical engineering in various sectors, including energy, manufacturing, automotive, aerospace and marine industries.
6. **Engineering Materials and Manufacturing Processes**: Explain different engineering materials and various manufacturing processes and computational manufacturing.
7. **Thermal Engineering**: Provide an overview of thermal engineering principles, including the working of boilers, IC engines, and power plants, and introduce concepts related to electric and hybrid vehicles.
8. **Mechanical Power Transmission Systems**: Describe different mechanical power transmission systems such as belt drives, chain drives, gear drives, and their applications.
9. **Basics of Robotics**: Introduce the basics of robotics, including joints, links, configurations, and applications, along with advancements in robotics technology.

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO5	PO9	PO12	
R24ES01.1	Understand the role of civil engineers in various disciplines, the scope of each discipline, and the materials used in building construction and principles of surveying.	3	-	1	-	2	1	L1
R24ES01.2	Describe the fundamentals of transportation engineering, water resources, and environmental engineering, including highway pavements, water quality, hydrology, and water storage structures.	3	1	1	1	1	-	L2, L3
R24ES01.3	Understand and apply different manufacturing processes and engineering materials, including	3	2	1	2	2	2	L1

	their applications, and basic mechanical design principles.							
R24ES01.4	Explain the basics of thermal engineering, including working principles of engines, power plants, and related thermal cycles, along with their applications.	3	1	1	2	2	2	L1,L2
R24ES01.5	Describe the working of different mechanical power transmission systems and the basics of robotics and their applications.	3	1	1	2	1	2	L2, L3

SYLLABUS

UNIT I **10 Hours**

Role of Civil Engineers in Society, Various Disciplines of Civil Engineering, Structural Engineering, Geo-technical Engineering, Transportation Engineering, Hydraulics and Water Resources Engineering, Environmental Engineering, Scope of Each Discipline, Building Construction and Planning, Construction Materials Cement, Aggregate, Bricks, Cement Concrete-Steel, soils and stones. Introduction to Prefabricated construction Techniques.

Surveying: Objectives of Surveying, Horizontal Measurements, Angular Measurements, Introduction to Bearings Simple problems on bearings-Contour mapping.

Self-Learning Topic: Advancements in Prefabricated Construction Techniques **COs: CO1**

UNIT II **15 Hours**

Transportation Engineering: Importance of Transportation in Nation's economic development, Types of Highway Pavements, Flexible Pavements and Rigid Pavements, Simple Differences. Basics of Harbor, Tunnel, Airport, and Railway Engineering

Water Resources and Environmental Engineering: Introduction, Sources of water, Quality of water, Specifications, Introduction to Hydrology, Rainwater Harvesting, Water Storage and Conveyance Structures (Simple introduction to Dams and Reservoirs).

Self-Learning Topic: Sustainable Transportation Engineering **COs: CO2**

UNIT-III: **12 Hours**

Introduction to Mechanical Engineering: Role of Mechanical Engineering in Industries and Society Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.

Basic Mechanical Design Principles: Fundamentals of Mechanical Design- Introduction to the design process, understanding design requirements, and conceptual design, Design of Simple Machine Components - Design considerations for basic machine components like shafts, bearings, gears, and fasteners.

Engineering Materials – Metals - Ferrous and Non-ferrous, Ceramics, Composites, Smart materials**.**

Self-Learning Topics: Sustainable Engineering Practices, Advancements in Smart Materials.

COs: CO3

UNIT- IV: **12 Hours**

Thermal Engineering– Working principle of Boilers

Cycles- Otto cycle, Diesel cycle, Refrigeration and air conditioning cycles,

Engines- IC engines, 2-Stroke and 4-Stroke engines, SI/CI Engines,

Power plants – Working principle of Steam, Diesel, Hydro, Nuclear power plants, Introduction to Electric and Hybrid Vehicles.

Self-Learning Topics: Advanced Engine Technologies, Thermodynamics in Renewable Energy Systems. **COs: CO4**

UNIT – V: 12 Hours

Manufacturing Processes: Principles of Casting, Forming, joining processes,

Computational Manufacturing: Introduction to CNC machines, 3D printing, and Smart manufacturing.

Machining – Conventional & Non-Conventional,

Mechanical Power Transmission - Belt Drives, Chain, Rope drives, Gear Drives and their applications.

Introduction to Robotics - Joints & links, configurations, and applications of robotics.

Self-Learning Topics: Additive Manufacturing Technologies, Innovations in Mechanical Power Transmission **COs: CO5**

Text Books:

1. Basic Civil and Mechanical Engineering, by Ommi Srikanth, M. Sreenivasa Reddy S. Chand Publications
2. Internal Combustion Engines by V.Ganesan, By Tata McGraw Hill publications (India) Pvt. Ltd.
3. A Tear book of Theory of Machines by S.S. Rattan, Tata McGraw Hill Publications, (India) Pvt. Ltd.
4. An introduction to Mechanical Engg by Jonathan Wicker and Kemper Lewis, cengage learning India pvt. Ltd.

Reference Books:

1. AppuuKuttan KK, Robotics, I.K. International Publishing House Pvt. Ltd. Volume-I
2. 3D printing & Additive Manufacturing Technology- L. Jyothish Kumar, Pulak M Pandey, Springer publications
3. Thermal Engineering by Mahesh M Rathore Tata Mcgraw Hill publications (India) Pvt. Ltd.
4. G. Shanmugam and M.S.Palanisamy, Basic Civil and the Mechanical Engineering, Tata Mcgraw Hill publications (India) Pvt. Ltd.

Board of Studies: Mechanical Engineering
Approved in BOS No: 01, 31st July, 2024
Approved in ACM No: 01

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	30
L2	30	50
L3	20	20
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

Basic Civil Engineering

L1: Remember

1. List out components of building.
2. Steps in preparation of bricks cement.
3. Explain various requirements of building
4. Write various principles in building planning
5. Write qualities of goods bricks
6. Write uses of concrete
7. What are types in soils.
8. Write about pre-fabricated structures.
9. What are the uses of surveying
10. What are types in surveying
11. Write about closed traverse and open traverse
12. Write about bearings and meridian.
13. What is contour mapping.
14. Write about flexible and rigid pavements.
15. What is runway
16. Write about dams and reservoirs
17. Write the sources of water

1. What are the main roles of mechanical engineering in different industries?
2. Define basic mechanical design principles.
3. List the types of engineering materials covered in this unit.
4. What are the key differences between ferrous and non-ferrous metals?
5. Name three applications of smart materials.
6. What is the working principle of a boiler?
7. Define the Otto cycle and Diesel cycle.
8. What are the key differences between 2-Stroke and 4-Stroke engines?
9. List the types of power plants covered in this unit.
10. Name a major advantage of electric vehicles over conventional vehicles.
11. What are the basic principles of casting in manufacturing processes?
12. Define CNC machining and its basic applications.
13. List the types of mechanical power transmission systems discussed in this unit.
14. What are the key differences between conventional and non-conventional machining?
15. Name the main components of a robotic system.

L2: Understand

1. Explain the process of designing a simple machine component like a shaft.
2. Describe the role of mechanical engineering in the aerospace sector.
3. Compare the properties of ceramics and composites used in engineering.
4. Discuss the importance of understanding material properties in mechanical design.
5. Summarize the technological advancements in smart materials.
6. Explain the basic operation of an IC engine.
7. Describe the differences between refrigeration and air conditioning cycles.
8. Compare the working principles of steam and hydro power plants.
9. Discuss the role of hybrid vehicles in reducing energy consumption.

10. Summarize the working principles of the Diesel cycle and its applications.
11. Explain the process of CNC machining and its advantages.
12. Describe the principles of gear drives and their applications in mechanical systems.

L3: Apply

1. Analyze the role of civil engineering in society.
2. Understanding the various disciplines of civil engineering.
3. Evaluate the use of materials in construction.
4. Create a case study on a recent innovation in civil engineering like prefabricated structures.
5. Apply the principles of the surveying to determine different measurements.
6. Solve problems related to bearings
7. Compare the flexible pavement and rigid pavements.
8. Evaluate the benefits water supply system.
9. Evaluate the benefits of dams.
10. Design a rain water harvesting.
11. Apply the basic mechanical design principles to design a simple gear system.
12. Using the properties of different engineering materials, suggest a suitable material for a specific mechanical component.
13. Design a basic component considering the design requirements and material properties.
14. Analyze how advancements in smart materials can impact the design of mechanical components.
15. Apply knowledge of engineering materials to solve a problem in a real-world mechanical system.
16. Apply the principles of thermal engineering to analyze the efficiency of a steam power plant.
17. Using the Otto cycle, calculate the performance parameters for a given engine setup.
18. Design a basic model of a hybrid vehicle considering its power source and energy efficiency.
19. Apply the knowledge of refrigeration cycles to improve the efficiency of a cooling system.
20. Analyze the impact of different thermal cycles on the performance of an IC engine.
21. Apply the principles of CNC machining to design a simple component.
22. Design a mechanical power transmission system for a specific application, considering the required drives and components.

Chairperson
Board of Studies (ME)

R24EEPC01 ELECTRICAL CIRCUIT ANALYSIS–I 3 0 0 3

Course Objectives:

1. Remembering the basic electrical elements and different fundamental laws
2. To understand the network reduction techniques, transformations, concept of self-inductance and mutual inductance,
3. To Understand phasor diagrams, resonance and network theorems
4. Apply the concepts to obtain various mathematical and graphical representations
5. Analyze nodal and mesh networks, series and parallel circuits

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO 6	PO 8	P0 12	PS02	
R24EEPC01.1	Apply different fundamental laws and network reduction techniques to basic electrical networks.	3	3	2	1	1	1	1	L1,L2
R24EEPC01.2	Understand and apply the concept of self-inductance and mutual inductance to magnetic circuits.	3	3	2	1	1	1	1	L2, L3
R24EEPC01.3	Analyze single phase AC circuits under steady state for different circuit topologies (with R, L and C components).	3	3	2	1	1	1	1	L3, L4
R24EEPC01.4	Understand the concept of Resonance	3	3	2	1	1	1		L4, L5
R24EEPC01.5	Evaluation of Network theorems	3	3	2	1	1	1		L1,L5

SYLLABUS

UNIT I : INTRODUCTION TO ELECTRICAL CIRCUITS 14 Hours

Basic Concepts of passive elements of R, L, C and their V-I relations, Sources (dependent and independent), Kirchoff's laws, Network reduction techniques (series, parallel, series - parallel, star-to-delta and delta-to-star transformation), source transformation technique, nodal analysis and mesh analysis to DC networks with dependent and independent voltage and current sources, node and mesh analysis. Concept of Dual Networks **COs – CO1**

Self-Learning Topics: T and ∏ Networks

UNIT II: MAGNETIC CIRCUITS 10 Hours

Basic definition of MMF, flux and reluctance, analogy between electrical and magnetic circuits, Faraday's laws of electromagnetic induction – concept of self and mutual inductance, Dot convention – coefficient of coupling and composite magnetic circuit, analysis of series and parallel magnetic circuits. **COs – CO2**

Self-Learning Topics Magnetic Materials

UNIT III: SINGLE PHASE CIRCUITS 12 Hours

Characteristics of periodic functions, Average value, R.M.S. value, form factor, representation of a sine function, concept of phasor, phasor diagrams, Steady state analysis of R, L and C circuits to sinusoidal excitations-response of pure resistance, inductance, capacitance, series RL circuit, series RC circuit, series RLC circuit. **COs – CO3**

Self-Learning Topics: Applications of Sinusoidal Signal

UNIT IV: RESONANCE **10 Hours**

Series Resonance: Characteristics of a series resonant circuit, Q-factor, selectivity and bandwidth, expression for half power frequencies; Parallel resonance: Q-factor, selectivity and bandwidth **COs – CO4**

Self-Learning Topics: Applications of Resonance

UNIT V: NETWORK THEOREMS (DC & AC Excitations) **12 Hours**

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem and compensation theorem. **COs – CO5**

Self-Learning Topics: Applications of Network Theorems in Electrical Engineering

Board of Studies : Electrical & Electronics Engineering
Approved in BOS No: 01,1st Aug 2024
Approved in ACM No: 01

Textbooks:

1. Engineering Circuits Analysis, Jack Kemmerly, William Hayt and Steven Durbin, Tata Mc Graw Hill Education, 2005, sixth edition.
2. Network Analysis, M. E. Van Valkenburg, Pearson Education, 2019, Revised Third Edition

Reference Books:

1. Fundamentals of Electrical Circuits, Charles K. Alexander and Mathew N.O. Sadiku, Mc Graw Hill Education (India), 2013, Fifth Edition
2. Electric Circuits (Schaum's outline Series), Mahmood Nahvi, Joseph Edminister, and K. Rao, Mc Graw Hill Education, 2017, Fifth Edition.
3. Electric Circuits, David A. Bell, Oxford University Press, 2009, Seventh Edition.
4. Introductory Circuit Analysis, Robert L Boylestad, Pearson Publications, 2023, Fourteenth Edition.
5. Circuit Theory: Analysis and Synthesis, A. Chakrabarti, Dhanpat Rai & Co., 2018, Seventh Revised Edition.

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc23_ee81/preview
2. https://nptel.ac.in/courses/108104139
3. https://nptel.ac.in/courses/108106172
4. https://nptel.ac.in/courses/117106108

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2 (%)
L1 L2	50	50

L3 L4	30	30
L5	20	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

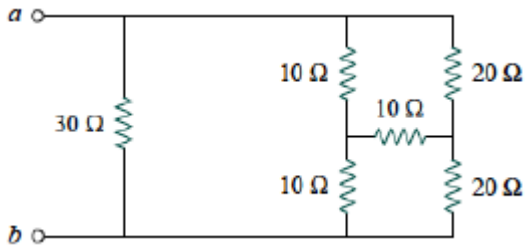
1. Classify the Network elements
2. Define Source Transformation with an example
3. State Kirchoffs law
4. State Faradays Law
5. State Millmans Theorem

L2: Understand

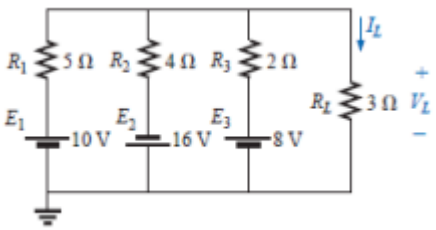
1. Explain the concept of Impedance and Power Factor
2. Explain the Types of sources
3. Explain the coefficient of coupling
4. Explain Quality factor and sensitivity
5. Understand V-I relationships of Passive elements. (L2)
6. Study and understand the concept of duality. (L2)
7. Understand the concept of self and mutual inductance. (L2)

L3: Apply

1. Obtain the equivalent resistance at the terminals a-b Using star delta Transformation



2. The air gap in a magnetic circuit is 1.5 mm long and 2500 mm^2 in cross- sectional area. Calculate (a) The reluctance of the air gap (b) The *mmf* required to set up a flux of 800 μWb in the air gap.
3. Derive the average value for Half wave rectified wave
4. A coil of negligible resistance and inductance 100mH is connected in series with a capacitance of 2 μF and a resistance of 10Ω across a 50V, variable frequency supply. Determine (a) the resonant frequency, (b) the current at resonance, (c) the Q-factor of the circuit.
5. Using Millman's theorem, find the current through the resistor RL of Fig. shown



L4: Analyzing

1. Analyze single phase AC circuits by using mesh and nodal analysis.
2. Analyze series and parallel magnetic circuits.
3. Analyze single phase ac circuits.
4. Analyze series and parallel R, L, C circuits.

L5: Evaluating

1. Determine average and complex power.
2. Determine mesh currents and node voltages
3. Estimate resonance frequency, bandwidth and selectivity of series and parallel resonant circuits.

Chairperson
Board of Studies (EEE)

R24HS02 COMMUNICATIVE ENGLISH LAB 0 0 2 1
(Common to CSE, CSE-AI & ML, CSD Branches in Semester-I)
(Common to EEE, MECH & ECE in Semester-II)

Course Objectives:

The main objective of introducing this course, Communicative English Laboratory, is to expose the students to a variety of self-instructional, learner friendly modes of language learning. Students undergo training in basic communication skills to make them into confident communicators in all situations.

At the end of the course, students will be able:

Course Code	Course Outcomes	Mapping with POs			
		PO9	PO10	PO12	Dok
R24HS02.1	Understand and recognize the various facets of English language ability with a focus on the four basic skills- namely -LSRW abilities.	1	3	2	L1
R24HS02.2	Implement various activities for language learners to practise communication skills.	1	2	3	L2
R24HS02.3	To enhance listening and speaking comprehension, analyze the sounds, stress, rhythm, intonation, and syllable division of English speech.	1	3	2	L3
R24HS02.4	Assess the professionalism of students when taking part in group discussions, debates, JAM sessions, Presentations and Interviews.	3	1	2	L4
R24HS02.5	Equipping oneself with Interview Skills and a range of Soft Skills for life and career.	1	3	2	L5

Board of Studies : BS&H- English

Approved in BOS No: 6th August, 2024

Approved in ACM No: 01

SYLLABUS

Week1:

1. To explain and guide the students in decoding the sounds of English.
2. List all the consonant sounds and vowel sounds in English

Week2:

1. What is a syllable and describe the syllable structure.
2. Define stress, functional stress and various rules of stress.
3. What is connected speech?

Week3:

1. What is Intonation and mention the various pitch movements like rise, fall, fall-rise or rise-fall?
2. What is connected speech?

Week4:

1. To equip students to speak in English language confidently without any inhibitions.
2. Why are majority of the companies conducting JAM session as a preliminary interview?

3. What are the key skills tested in JAM round?

Week5:

1. To help students learn and understand different functions of language like greeting, asking
2. For information, giving information, meetings, requests, exchanging dialogues in formal and informal contexts.
3. Introduce yourself and others, give instructions and directions

Week 6:

1. To help the students understand and work on the digital age connector for personal correspondence, business communication, etc.
2. Write about email etiquette.
3. Draft an email to the HR Manager of Wipro Technologies requesting to consider your application for the post of Software Engineer.

Week 7:

1. To update students about the importance of Resume, the various types and the essentials of an effective resume
2. Draft a resume for a software post in reputed organization.

Week 8:

1. To educate students about the various styles of writing formal letters.
2. What is a cover letter? What are the different types of cover letters?
3. Write a job application letter for any post of your choice in a reputed company?

Week 9:

1. To help students know the importance of an SOP in their professional advancements?
2. What is an SOP and what are the different kinds and parts of an SOP?
3. Prepare an SOP to apply for a Master's Programme in any University of your choice.

Week 10:

1. To educate and guide the students about presentation skills and its importance in the technical evolving world.
2. To inform explain students about the importance of body language in various personal and professional forums
3. To help students to present papers, PPT's in seminars, workshops, conferences, research projects, interviews, etc.

Week 11:

1. To help students to give effective PPT's in various academic and professional platforms.
2. Describe various aspects that make PPT more effective.
3. Make a PPT on any topic of your choice and present it to the class.

Week 12:

1. To foster, creative, critical thinking skills, analytical skills and problem solving skills.
2. Suggest a few tips for preparing a poster.
3. Prepare posters from or outside your curriculum.

List of Activities:

1. Sounds of English (Vowels and Consonants) **COs: CO1,CO2**
2. Neutralization and Accent Rules **COs: CO1,CO2**
3. Improving communication skills /JAM. **COs: CO3,CO4**

4. Letter Writing and E-mail Writing **COs: CO1,CO2**
5. Cover letters and Resume Writing **COs: CO1,CO2**
6. Statement of Purpose. **COs: CO1,CO2**
7. Debates **COs: CO4:CO5**
8. Presentation skills- PPT and Poster **COs: CO4:CO5**
9. Group Discussions , types and practice **COs: CO4,CO5**
10. Interview skills – Mock interviews **COs: CO4,CO5**

Reference Books:

1. Prof. M. Hari Prasad, Prof. Vijaya Babu, Prof. Padmaja Kalapala, Skill Craft – A Communicative English Laboratory Workbook, Maruthi Publications first Edition, 2023
2. Meenakshi Ramana, Sangeeta-Sharma, 4thEdition, Technical Communication, Oxford Press, 2022.
3. Grant Taylor: English Conversation Practice, 1st Edition, Tata ,Mc Graw-Hill Education India, 2001.
4. Hewing,s, Martin, Cambridge Academic English(B2), Cambridge University Press,2012.
5. T. Balasubramanyam, A Textbook of English Phonetics for Indian Students, 3rd Edition, Trinity, 2022.
6. Dr. ShaliniSharma's Body Language Your Success Mantra, S. Chand publications 2010.
7. Sunitha Mishra and C.Murali Krishna's Communication Skills for Engineers Pearson Education Edition 2009.

Suggested software:

- English Wordsworth –Language Lab- Wordsworth Software

Web References for:

Spoken English

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. https://www.britishcouncil.in/english/online
5. http://www.letstalkpodcast.com/
6. . https://www.youtube.com/c/ArnelsEverydayEnglish/featured
7. https://www.youtube.com/c/engvidAdam/featured
8. . https://www.youtube.com/c/EnglishClass101/featured
9. https://www.ted.com/watch/ted-ed
10. http://www.edest.org/

Voice & Accent:

1. https://www.youtube.com/user/letstalkaccent/videos
2. https://www.youtube.com/c/EngLanguageClub/featured
3. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
4. https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp_IA

Chairperson
Board of Studies (English)

R24BS03 **Engineering Physics Lab** **0 0 2 1**
(Common to all Branches)

Course Objectives:

1. To study the concepts of optical phenomenon like interference, diffraction etc.,
2. To recognize the importance of energy gap in the study of conductivity and Hall effect in semiconductors
3. To study the parameters and applications of dielectric and magnetic materials by conducting experiments.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs					Dok
		PO1	P02	P04	PO9	PO12	
R24BS03.1	Demonstrate the modern engineering physics techniques and tools in real times applications in engineering studies.	3	1	2	1	2	L1
R24BS03.2	Develop the laboratory skills in handling of electrical and optical instruments.	2	1	1	2	1	L3
R24BS03.3	Conduct experiment independently and in team to record the measurements	2	1	2	2	1	L2

Board of Studies : Department of Physics
Approved in BOS No: 01, 5th August, 2024
Approved in ACM No: 01

Developing the following programs:

List of Experiments

1. Determination of radius of curvature of a given plano convex lens by Newton's rings.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration.
3. Determination of thickness of thin object by air wedge method.
4. Determination of wavelength of Laser Source by diffraction grating.
5. Determination of rigidity modulus of the material of the given wire using Torsional Pendulum.
6. Magnetic field along the axis of a current carrying circular coil by Stewart & Gee's Method.
7. Determination of dispersive power of the prism.
8. Determination of acceleration due to gravity and radius of Gyration by using Compound Pendulum.
9. Determination of energy gap of a semiconductor using p-n junction diode.
10. Determination of dielectric constant using charging and discharging method.
11. Sonometer: Verification of laws of stretched string.
12. Estimation of Planck's constant using photoelectric effect.
13. Study the variation of B versus H by magnetization of the magnetic material (B-H curve).
14. Determination of frequency of electrically maintained tuning fork by Melde's experiment.
15. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall

effect.

16. Determination of the resistivity of semiconductor by four probe method.
17. Determination of young's modulus for the given material of wooden scale by non- uniform bending (or double cantilever) method.
18. Determination of velocity of sound by Kundt's tube method.

Note: Any **TEN** of the listed experiments are to be conducted. Out of which any **TWO** experiments may be conducted in virtual mode.

Week 1:

1. What is the basic principle of newton's rings experiment?
2. Define Interference phenomena?.
3. Why the rings are circular?
4. What are Newton's Rings?
5. Why it is necessary for the light to fall normally on plano convex lens?
6. What is constructive interference and destructive interference?
7. What is the purpose of glass plate incline at 450 in this experiment?
8. Why the centre of the rings is dark?
9. Which light does u use in this experiment?
10. What will happen if we use White light in this experiment?
11. If u replace yellow light with green light, is there any difference in the formation of rings ?

Week 2:

1. What is diode?
2. What is energy gap?
3. What is valency band?
4. What is conduction band?
5. How many types of solid materials are there and what are those materials?
6. What is a conductor?
7. What is insulator?
8. What are Semi conductors?
9. What are the types of semi conductors are there?
10. What is intrinsic and extrinsic semi conductor?
11. What u meant by Fermi energy level?

Week 3:

1. What is the full form of laser?
2. How laser light is different from the ordinary light?
3. What is population inversion?
4. What is pumping?
5. What is laser?
6. What is meant by the term coherency?
7. What is diffraction?
8. Define Grating
9. What is active medium?
10. What is the action of the optical resonator?

Week 4:

1. What is the magnetic induction formula at a point x, away from the center of the circular

coil?

2. What will be the Magnetic field value at the center of a current-carrying coil?
3. Does earth's horizontal magnetic field value remain the same everywhere or it fluctuates?
4. What is Commutator and what its role in an experiment?
5. What is the relation between Gauss and Tesla?
6. Why do you put apparatus (Wooden Frame along with circular coil) in East-West Direction?
7. What are Tan A and Tan B Positions?
8. What is the unit of magnetic field intensity H?
9. Can you perform the experiment by using the Alternating Current?
10. What are the magnetic elements?

Week 5:

1. What is the purpose of Capacitors ?
2. What the resistor will do ?
3. What is the purpose of Inductors?
4. What is Time constant?
5. What you meant by capacity of a conductor.
6. Define potential.
7. What is capacitance.
8. Define dielectric Constant?
9. What is the significance of finding the dielectric strength of a material?
10. Give some examples of dielectric materials used in electric devices?

Week 6:

1. What is plane transmission diffraction grating?
2. In our experiment, what type of diffraction does occur and how?
3. What is meant by dispersive power of grating?
4. How the commercial gratings can be made?
5. Define grating element
6. Among Prism and grating which gives more intense spectrum and why?
7. Define diffraction grating?
8. What are the essential parts of the spectrometer?
9. Which colour in the spectrum is having more refractive index?
10. How many types of spectra are available?
11. Define grating element.

Week 7:

1. What is the significance of the beam splitter in this experiment?
2. How do you form a wedge shaped air film?
3. Why the fringes are straight?
4. Why the fringes are formed equally spaced?
5. What type of light source is required for this experiment?
6. Why the fringes are formed parallel and why not circular like Newton Ring's experiment?
7. What is the principle involved in this experiment?
8. What is meant by constructive and destructive interference?

Week 8:

1. What is prism?
2. What u meant by Angular Dispersion?

3. Dispersive power of the prism?
4. What is Refractive index?
5. What is Spectrometer?
6. What is the function of Collimator?
7. What u meant by Angle of Prism?
8. What is Dispersion of Light?
9. What is the main optical action of the prism?
10. What type of prism do u use in this experiment?
11. What are the units of Dispersive power?
12. What type of light do u use in this experiment?
13. Which colour in the spectrum is having more refractive index?

Week 9:

1. .Define Rigidity of modulus?
2. Define Moment Of Inertia?
3. What is the meaning in calling this a pendulum?
4. Difference between simple pendulum and torsional pendulum?
5. What is S.H.M ?
6. What is Young's modulus?
7. Define Time Period?
8. Mention the factors on which the rigidity modulus of a material depends?
9. What is meant by mechanical deformation?
10. Define restoring force?
11. Define stress and mention its units?
12. Define strain and mention its units?
13. If we increase the diameter of the wire, what happened to rigidity modulus?
14. Differentiate simple pendulum and torsional pendulum?

Week 10:

1. What does u mean by Frequency?
2. Define Resonance?
3. What u meant by Progressive wave?
4. How many types of progressive waves are there?
5. Difference between transverse wave and longitudinal wave?
6. What u meant by standing wave?
7. In our experiment which type of wave passing along the thread?
8. In our experiment which type of wave passing along the thread?

Week 11:

1. What is the purpose of Capacitors ?
2. What the resistor will do?
3. What is the purpose of Inductors?
4. What is Time constant?
5. What is capacitance?
6. Define potential?
7. What u meant by capacity of a conductor?
8. What is the relation between charge "Q" and capacitor?

References:

1. S. Balasubramanian, M.N.Srinivasan "A Text Book of Practical Physics"-S Chand Publishers, 2017.
2. R.K. Shukla, Anchal Srivastava, Practical Physics, New age international (2011).
3. H.G.Jerrad and D.B. Mc Neil -Theoretical and Experimental Physics.
4. Roman Kezerashvili, Physics laboratory experiments: electricity, magnetism, optics, New York: Gurami Pub., (2003).
5. Y. Aparna and K. Venkateswararao, Engineering Physics–I and II, VGS Techno series.
6. J.R.G. Patnaik, "Physics Laboratory Manual, "Paramount book distributors.
7. S. Panigrahi and B. Mallick, Engineering Practical Physics, Cengage leaning, Delhi, 2015.

Weblinks:

1. https://phet.colorado.edu/en/simulations/filter?subjects=physics&type=html,prototype
2. http:/www./iitk.vlab.co.in

Chairperson
Board of studies (Physics)

R24ES04 **IT Workshop Lab** **0 0 2 1**

(Common to All Branches)

Course Objectives:

1. To assemble and disassemble a computer.
2. To solve hardware and software problems.
3. To learn about Networking of computers and use Internet facility for Browsing and Searching.
4. To develop project documentation using MS word
5. To work with various productivity tools including Excel, PowerPoint.
6. To work with different online repositories such as GITHUB, AI CHATBOT.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs					Dok
		PO1	PO2	PO3	PS01	PS02	
R24ES04.1	Perform Hardware troubleshooting and Perform Hardware troubleshooting	2	3	3	3	2	L2, L3
R24ES04.2	Apply different way of hooking the PC on to the internet from home and Workplace.	3	2	2	2	3	L1, L2 L3
R24ES04.3	Design word documents by learning word processing and Create presentations by using different styles and using AI Tools-Chat GPT and GITHUB	2	3	3	2	3	L2, L3, L4

SYLLABUS

PC Hardware & Software Installation **9 Hours**

Task 1: Identify the peripherals of a computer, components in a CPU and its functions. Draw the Block diagram of the CPU along with the configuration of each peripheral and submit it to your Instructor.

Task 2: Every student should disassemble and assemble the PC back to working condition. Lab Instructors should verify the work and follow it up with a Viva. Also students need to go through the video which shows the process of assembling a PC. A video would be given as part of the course content.

Task 3: Every student should individually install MS windows on the personal computer. Lab Instructor should verify the installation and follow it up with a Viva.

Task 4: Every student should install Linux on the computer. Lab instructor should verify the installation and follow it up with a Viva. **COs-CO1**

Internet &World Wide Web **6 Hours**

Task1: Orientation & Connectivity Boot Camp: Students should get connected to their Local Area Network and access the Internet. In the process they configure the TCP/IP setting. Finally, students Should demonstrate to the instructor, how to access the websites and email. If there is no internet Connectivity preparations need to be made by the instructors to simulate the WWW on the LAN.

Task 2: Web Browsers, Surfing the Web: Students customize their web browsers with the LAN Proxy settings, bookmarks, search toolbars and pop-up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.

Task 3: Search Engines & Netiquette: Students should know what search engines are and how to Use the search engines. A few topics would be given to the students for which they need to search On Google. This should be demonstrated to the instructors by the student. **COs-CO2**

MS WORD **6 Hours**

Task 1: Creating project abstract Features to be covered: -Formatting Styles, Inserting table, Bullets And Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes.

Task 2: Creating a Newsletter: Features to be covered: - Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes, Paragraphs and Mail Merge in word.

EXCEL **6 Hours**

Excel Orientation: The mentor needs to tell the importance of MS office or equivalent (FOSS) tool Excel as a Spreadsheet tool; give the details of the four tasks and features that would be covered in Each. Using Excel – Accessing, overview of toolbars, saving excel files, using help and resources.

Task 1: Creating a Scheduler - Features to be covered: Gridlines, Format Cells, Summation, and auto Fill, Formatting Text**.**

Task 2: Calculating GPA -. Features to be covered: - Cell Referencing, Formulae in excel – Average, std. deviation, Charts, Renaming and Inserting worksheets, hyper linking, Count Function

POWER POINT **6 Hours**

Task 1: Students will be working on basic power point utilities and tools which help them create basic power point presentations. PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows in PowerPoint.

Task 2: Interactive presentations - Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts.

Task 3: Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes etc), and Inserting – Background, textures, Design Templates, Hidden slides.**COs-CO3**

AI TOOLS – Chat GPT **6 Hours**

Task 1: Prompt Engineering: Experiment with different types of prompts to see how the model Responds. Try asking questions, starting conversations, or even providing incomplete sentences to See how the model completes them. Ex: Prompt: "You are a knowledgeable AI. Please answer the following question: What is the capital of France?"

Task 2: Creative Writing: Use the model as a writing assistant. Provide the beginning of a story or a description of a scene, and let the model generate the rest of the content. This can be a fun way to Brainstorm creative ideas Ex: Prompt: "In a world where gravity suddenly stopped working, people started floating upwards. Write a story about how society adapted to this new reality."

Explore – GITHUB **6 Hours**

Task 1: Students should understand GITHUB and should possess accounts in it.

Task 2: Students should explore different repositories available in GITHUB and student should Create his/ her own simple repositories.

Task 3: Students should take simple experiments /presentations and upload them in their GITHUB Account.

Task 4: Students should understand how GITHUB Enterprise Cloud is used and also explore the GIT and GIT HUB resources. **COs-CO3**

Reference Books:

1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream tech, 2003
2. The Complete Computer upgrade and repair book, Cheryl A Schmidt, WILEY Dream tech, 2013, 3rd edition

3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education, 2012, 2nd edition
4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft)
5. IT Essentials PC Hardware and Software Companion Guide, David Anfins on and Ken Quamme. – CISCO Press, Pearson Education, 3rd edition
6. IT Essentials PC Hardware and Software Labs and Study Guide, Patrick Regan– CISCOPress, Pearson Education, 3rd edition
7. "Microsoft Word 2021: A Beginner's Guide"by Steve Lambert.
8. "Excel 2021: A Comprehensive Guide"by Chris Benham.
9. "Microsoft PowerPoint 2021: A Beginner's Guide" by Steve Lambert
10. GITHUB Quick Start Tutorials

WEB REFERENCES:

1. https://en.wikipedia.org/wiki/Main_Page
2. https://edu.gcfglobal.org/en/office2007
3. https://www.w3schools.com

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)
L1	30
L2	20
L3	30
L4	20
Total (%)	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Identify Peripherals of a computer
2. Draw a Block Diagram of the CPU and explain the components along with the functions.
3. Explain the various steps in assembling and dissembling of the CPU.
4. Write the basic utilities used while creating a PowerPoint presentation.

L2: Understand

1. How to install windows operating system.
2. What are search engines and brief the advantages of search engines.
3. Explain the process of creating a project abstract.
4. Explain how to explore GITHUB resources

L3: Apply

1. Explain the process orientation and connectivity boot camp
2. Write the different formulae used while calculating GPA
3. Explain the insertion of various templates while creating power point presentations.
4. Discuss the format for customization your browser for effective searching and online etiquette

L4: Analysing

1. Analyze a structured approach to experiment with prompts.

2. Explore different repositories available in GITHUB.
3. "Imagine a world where every person is born with a unique, magical ability that reflects their deepest desire or fear. Describe a day in the life of a character who discovers that their ability is far more powerful and dangerous than they ever imagined. How does this revelation affect their relationships, their view of themselves, and their place in society?"

Chairperson
Board of Studies (CSE)

R24EEPC02 0 0 3 1.5

Electrical Circuits Lab

Course Objectives:

1. To impart hands on experience in verification of circuit laws and theorems, measurement of circuit parameters, study of circuit characteristics.
2. To determine the self and mutual inductances of a coil
3. To understand the series and parallel resonance

Course Code	Course Outcomes	Mapping with Pos and PSOs							
		PO1	PO2	PO3	PO4	PO6	PO8	PSO 1	PSO 2	DOK
R24EEPC02.1	Apply various theorems to electrical circuits	3	2	2	3	1	-	1	1	L1,L2
R24EEPC02.2	Determination of Two port parameters of a given electric circuits. Determination of self and mutual inductances	2	3	2	1	1	-	1	1	L1,L2
R24EEPC02.3	Determine the parameters of a given coil.	3	2	3	2	1	-	1	1	L1,L2

List of Experiments

1. Verification of Kirchhoff's circuit laws. **CO1**
2. Verification of Superposition theorem. **CO1**
3. Verification of Thevenin's and Norton's theorems. **CO1**
4. Verification of Maximum power transfer theorem. **CO1**
5. Verification of Compensation theorem. **CO2**
6. Verification of Reciprocity and Millman's Theorems. **CO2**
7. Series and parallel resonance. **CO3**
8. Determination of self, mutual inductances and coefficient of coupling **CO2**
9. Determination of Impedance (Z) and Admittance (Y) Parameters for a two port network **CO2**
10. Determination of Transmission and Hybrid parameters **CO3**
11. Determination of Parameters of a choke coil. **CO1**
12. Determination of cold and hot resistance of an electric lamp. **CO1**
13. Measurement of 3-phase power by two wattmeter method for unbalanced loads **CO1**

NOTE: Any 10 experiments are to be conducted

Exercise Problems

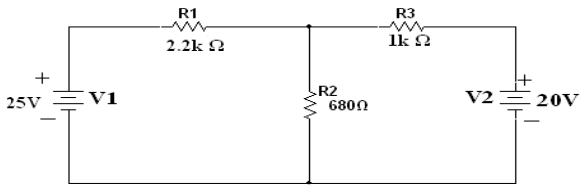
Level: 1

1. An Electric iron is rated 1000W, 240V. Find the current drawn & resistance of the heating element

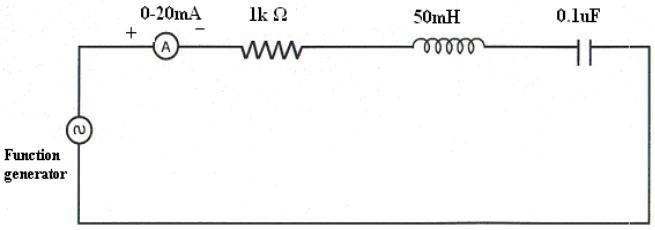
2. State Thevenins theorem.
3. State Norton's theorem
4. State maximum power transfer theorem.
5. Sate superposition theorem.
6. State Norton's theorem and find current using Norton's theorem through a load of 8

Level: 2

1. Determination of self, mutual inductances and coefficient of coupling
2. Determination of Impedance (Z) and Admittance (Y) Parameters for a two port network



3. To find the resonant frequency, quality factor and band width of a given series and parallel resonant circuits



4. Determination of self, mutual inductances and coefficient of coupling
5. Measure the active power for the given star and delta networks

Reference Books:

1. Engineering Circuits Analysis, Jack Kemmerly, William Hayt and Steven Durbin, Tata Mc Graw Hill Education, 2005, sixth edition 2.
2. Network Analysis, M. E. Van Valkenburg, Pearson Education, 2019, Revised Third Edition

Chairperson
Board of Studies (EEE)

Code: R24MC02 NSS /NCC/ SCOUTS & GUIDES / COMMUNITY SERVICE 0 0 1 0.5

(Common to All branches of Engineering)

Course Objectives:

The objective of introducing this course is to impart discipline, character, fraternity, teamwork, social consciousness among the students and engaging them in selfless service.

SYLLABUS

UNIT I: Orientation

General Orientation on NSS/NCC/ Scouts & Guides/ Community Service activities, career guidance.

Activities:

i) Conducting –ice breaking sessions-expectations from the course-knowing personal talents and skills
ii) Conducting orientations programs for the students –future plans-activities-releasing road map etc.
iii) Displaying success stories-motivational biopics- award winning movies on societal issues etc.
iv) Conducting talent show in singing patriotic songs-paintings- any other contribution.

UNIT II: Nature & Care

Activities:

i) Best out of waste competition.
ii) Poster and signs making competition to spread environmental awareness.
iii) Recycling and environmental pollution article writing competition.
iv) Organising Zero-waste day.
v) Digital Environmental awareness activity via various social media platforms.
vi) Virtual demonstration of different eco-friendly approaches for sustainable living.

UNIT III: Community Service

Activities:

i) Conducting One Day Special Camp in a village contacting village-area leaders- Survey in the village, identification of problems- helping them to solve via media- authorities- experts-etc.
ii) Conducting awareness programs on Health-related issues such as General Health, Mental health, Spiritual Health, HIV/AIDS,
iii) Conducting consumer Awareness. Explaining various legal provisions etc.
iv) Women Empowerment Programmes- Sexual Abuse, Adolescent Health and Population Education.
v) Any other programmes in collaboration with local charities, NGOs etc.

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Board of Studies : BS&H (Mathematics)
Approved in BoS No : 01, August, 2024
Approved in ACM No: 01

Reference Books:

1. Nirmalya Kumar Sinha & Surajit Majumder, A Text Book of National Service Scheme Vol;.I, Vidya Kutir Publication, 2021 (ISBN 978-81-952368-8-6)
2. Red Book - National Cadet Corps – Standing Instructions Vol I & II, Directorate General of NCC, Ministry of Defence, New Delhi
3. Davis M. L. and Cornwell D. A., ―Introduction to Environmental Engineering‖, McGraw Hill, New York 4/e 2008
4. Masters G. M., Joseph K. and Nagendran R ―Introduction to Environmental Engineering and Science‖, Pearson Education, New Delhi. 2/e 2007
5. Ram Ahuja. Social Problems in India, Rawat Publications, New Delhi.

Chairperson
Board of Studies (Mathematics)

R24BS10 NUMERICAL METHODS AND TRANSFORM TECHNIQUES 3 0 0 3
(Common to MECH and EEE)

Course Objectives:

1. To elucidate the different numerical methods to solve nonlinear algebraic equations.
2. To disseminate the use of different numerical techniques for carrying out numerical integration.
3. To furnish the learners with basic concepts and techniques at plus two level to lead them into advanced level by handling various real world applications.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs			Dok
		PO1	PO2	PO12	
R24BS10.1	Evaluate the approximate roots of polynomials and transcendental equations by different algorithms. Apply Newton's forward and backward interpolation and Lagrange's formulae for equal and unequal intervals.	2	2	1	L1,L2,L3
R24BS10.2	Apply numerical integral techniques to different Engineering problems. Apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations.	2	2	1	L1,L2,L3
R24BS10.3	Apply the knowledge of Laplace transforms to solve differential equations.	2	2	1	L1,L2,L3
R24BS10.4	Compute the Fourier series of periodic signals.	2	2	1	L3,L4
R24BS10.5	Know and be able to apply integral expressions for the forward and inverse Fourier transforms to a range of non-periodic wave forms.	2	2	1	L4,L5

SYLLABUS

UNIT- I: Iterative Methods **10 hours**

Introduction- Solution of algebraic and transcendental equations: Bisection method-Secant method-Method of false position-Iteration method –Newton-Raphson method.

Interpolation: Newton's forward and backward formulae for interpolation-interpolation with unequal intervals-Lagrange's interpolation formula. **Cos-CO1**

Self-Learning Topic: Gauss's forward and backward interpolation formula

UNIT- II: Numerical Integration, Solution of ordinary differential equation with initial conditions: **10 hours**

Trapezoidal rule-Simson's $1/3^{rd}$ and $3/8^{th}$ rule-Solution of initial value problems by Taylor's series-

Picard's method of successive approximations-Euler's method – Runge-Kutta method (second and fourth order). **Cos-CO2**

Self-Learning Topic: Milne's Predictor and Corrector Method

UNIT- III: Laplace Transforms: 10 hours

Definition of Laplace transform-Laplace transform of standard functions- Properties of Laplace Transforms-Shifting theorems-Transforms of derivatives and integrals-Unit step function-Dirac's delta function-Inverse Laplace transforms-Convolution theorem (without proof)

Applications: Solving ordinary differential equations (initial value problems) and integral differential equation using Laplace transforms. **COs-CO3**

Self-Learning Topic: Solution of simultaneous differential equations by Laplace transforms.

UNIT- IV: Fourier series 10 hours

Introduction- Periodic functions- Fourier series of periodic functions-Dirchlet's conditions –Even and odd functions- Change of intervals-Half-range sine and cosine series. **COs-CO4**

Self-Learning Topic: Applications of Fourier series

UNIT- V: Fourier Transforms: 10 hours

Fourier integrals theorems (without proof)-Fourier sine and cosine integrals-Infinite Fourier transforms-Sine and cosine transforms-Properties-Inverse transforms-Convolution theorem (without proof)-Finite Fourier transforms- Parseval's identity for Fourier transforms(without proof). **COs-CO5**

Self-Learning Topic: Solve Partial differential equation by Fourier transform.

Textbooks:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2017, 44th Edition
2. B.V.Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2018, 10th Edition.
2. M.K.Jain,S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Compuation, New Age International Publication.

Board of Studies : Basic Science and Humanities (Mathematics)
Approved in BOS No: 01, 2nd August, 2024
Approved in ACM No: 01

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	30	10
L2	30	10
L3	40	30
L4	-	25

L5	-	25
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

UNIT 1

1. Find a real root of $xe^x = 3$ using Regula –Falsi method. (L1)
2. Using Newton Raphson method finds a real root of $\cos x = xe^x$ and correct to four decimal places. (L2)
3. Find a real root of the equation $x\log_{10} x = 1.2$ by Regula-Falsi method correct to four decimal Places (L2)
4. If $y(1) = -3, y(3) = 9, y(4) = 30, y(6) = 132$ find the $y(x)$ (L3)

UNIT 2

1. State Simson's 1/3 rule
2. Find $y(0.1)$ and$d\ y(0.2)$ using Picard's method given that $\frac{dy}{dx} = x + y$ given that $y = 1$ when $x = 0$ (L 2)
3.
4. By RK method of second order find $y(0.1)$ and $y(0.2)$ given that $\frac{dy}{dx} = 1 - 2xy^2$, $y(0) = 1$. (L 2)
5. By Taylor's series method find $y(0.2)$ given that $\frac{dy}{dx} = 3x + y^2$, $y(0) = 1$. (L 2)
6. Find $y(0.1)$ given that $\frac{dy}{dx} = x^2 - y^2$, $y(0) = 1$. (L 3)

UNIT 3

1. Define Laplace transform (L1)
2. Find the Laplace transform of $f(t) = \begin{cases} t^2, 0 \le t < 2 \\ t-1, 2 \le t < 3 \\ 7, t \ge 3 \end{cases}$ L2
3. Solve the differential equation $(D^2 + 9)y = \sin t, y(0)1, y'(0) = 0$ L3

UNIT 4

1. Find the Half range cosine series of $f(x) = \begin{cases} 1 & 0 < x < 1 \\ -1 & 1 < x < 2 \end{cases}$ in $[0,2]$ L3
2. Find the Fourier series of $f(x) = \frac{1}{4}(\pi - x)^2$, $0 < x < 2\pi$

   Hence deduce that $\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} \ldots = \frac{\pi^2}{6}$

(L4)

UNIT 5

1. State Parseval's identity L1

2. .Find the Fourier transform of $f(x)$ defined by $f(x)=\begin{cases} x & \text{if } 0<x<1 \\ 1-x & \text{if } 1<x<2 \\ 0 & \text{if } x<2 \end{cases}$

   (L2)

3. Find the Fourier cosine transform of $\frac{1}{1+x^2}$ (L3)

4. If the Fourier sine transform of $f(x)=\frac{1-\cos n\pi}{n^2\pi^2}(0\le x\le \pi)$, find $f(x)$

   (L4)

5. Find the Fourier transform of $f(x)=\begin{cases} 1-x^2, |x|\le 1 \\ 0, \quad |x|>1 \end{cases}$ L4

6. hence evaluate $\int_0^\infty \frac{x\cos x-\sin x}{x^3}\cos\frac{x}{2}dx$ L5

Chairperson
Board of Studies (Mathematics)

R24HS03 Universal Human Values-Understanding Harmony & Human Ethical Conduct

(Common to CSE, CSE (DS), CSE (AI&ML), ECE, EEE, ME) **2 0 0 2**

Course Objectives:

The main objectives of the course are to:

- To enable students to recognize the vital connection between **values and skills**, emphasizing how their integration leads to lasting happiness and prosperity core aspirations shared by all human beings.
- To guide students in developing a **holistic outlook on life and profession** grounded in a deep understanding of human nature and existence. This perspective supports the cultivation of **Universal Human Values** and encourages a natural transition toward **value-based living**.
- To illustrate the practical outcomes of a holistic understanding, particularly in fostering **ethical behavior**, **trust-based and fulfilling relationships**, and **harmonious interaction with nature**.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs & PSOs											DoK
		PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	
R24HS03.1	Develop an understanding of human values.	2	2	-	-	2	3	3	2	2	-	3	L1, L2
R24HS03.2	Achieve harmony within self and body.	2	-	-	-	-	3	3	2	-	-	3	L2, L3
R24HS03.3	Build trustful and respectful relationships.	2	-	-	2	3	2	3	3	3	-	3	L3, L4
R24HS03.4	Understand harmony in nature.	2	2	-	-	-	3	3	2	2	-	3	L4, L5
R24HS03.5	Practice ethical and value-based living.	2	2	-	-	2	2	3	2	2	-	3	L5, L6

SYLLABUS

Unit I: Introduction to Value Education (6 lectures and three tutorials for practice session)

Lecture 1: Introduction to Human Development – Physical, Emotional, and Intellectual Dimensions

Lecture 2: Core Concepts of Value Education in Contemporary Society

Tutorial 1: Practice Session PS1 – Reflective Sharing on Life Values and Personal Experiences

Lecture 3: Self-awareness and Self-exploration: Tools for Inner Clarity

Lecture 4: Aspirations of the Human Being – Joy, Fulfillment, and Meaning

Tutorial 2: Practice Session PS2 – Exploring Self-awareness and Emotional Intelligence

Lecture 5: Challenges to Human Fulfillment in Modern Life

Lecture 6: Mindfulness and Ethical Decision-Making as a Path to Human Aspiration Fulfillment

Tutorial 3: Practice Session PS3 – Identifying Personal Ethical Dilemmas and Responses **CO's CO1**

Self-Learning Concepts: Explore how education influences the development of core human values, the significance of emotional intelligence in personal growth, the role of mindfulness in enhancing self-awareness, the impact of consumerism and modern lifestyle on ethical choices, and reflect on one's own aspirations and value system – all of which build a foundation for inner development.

Unit II: Harmony in the Human Being (6 lectures and three tutorials for practice session)

Lecture 7: Human Being: Alignment of Thoughts, Emotions, and Actions

Lecture 8: Needs and Desires: Distinguishing Between Essentials and Superfluous

Tutorial 4: Practice Session PS4 – Mind Mapping Personal Needs and Desires

Lecture 9: The Role of Body, Mind, and Consciousness in Well-being

Lecture 10: Cultivating Harmony within the Self – Practices and Techniques

Tutorial 5: Practice Session PS5 – Journaling: Tracking Inner Conflicts and Clarity

Lecture 11: Body Awareness and Physical Well-being Practices (Yoga/Meditation)

Lecture 12: Sustainable Self-Regulation and Lifestyle Choices for Health

Tutorial 6: Practice Session PS6 – Wellness and Lifestyle Assessment Activity **CO's-CO2**

Self-Learning Concepts: Understand the benefits of journaling for emotional and mental clarity, examine the relationship between diet, exercise, and mental well-being, explore how to identify and manage sources of stress, study the scientific basis of meditation and mindfulness, and create a personalized routine for achieving physical and emotional balance – fostering harmony within the self.

Unit III: Harmony in the Family and Society (6 lectures and three tutorials for practice session)

Lecture 13: Foundations of Healthy Relationships – Emotional and Ethical Dimensions

Lecture 14: Cultivating Trust and Empathy in Family and Social Contexts

Tutorial 7: Practice Session PS7 – Role-play on Building Trust in Relationships

Lecture 15: Respect and Empathy – Cornerstones of Human Interaction

Tutorial 8: Practice Session PS8 – Group Activity: Expressing Respect in Conversations

Lecture 16: Conflict Resolution and Emotional Safety in Social Interaction

Lecture 17: Principles of Ethical Leadership and Community Engagement

Lecture 18: Global Citizenship and Social Justice in the Modern World

Tutorial 9: Practice Session PS9 – Simulation: Creating a Model Ethical Society **CO's-CO3**

Self-Learning Concepts: Learn how to practice active listening and empathy, recognize and overcome personal biases in relationships, analyze inspiring examples of ethical leadership and community service, understand the concept of emotional safety in interpersonal dynamics, and explore the role of volunteerism in building a responsible and connected society – enhancing harmony in relationships and the social fabric.

Unit IV: Harmony in the Nature/Existence (4 lectures and two tutorials for practice session)

Lecture 19: Ecological Intelligence and Human-Nature Relationship

Lecture 20: Sustainability and Resource Responsibility – A Human Imperative

Tutorial 10: Practice Session PS10 – Case Study: Local Environmental Issue & Action Plan

Lecture 21: Systems Thinking – Viewing Nature as an Interconnected Whole

Lecture 22: Eco-Spirituality and the Harmony of Existence

Tutorial 11: Practice Session PS11 – Nature Walk + Reflection on Human-Nature Coexistence

CO's-CO4

Self-Learning Concepts: Study the principles of minimalism as a lifestyle for environmental consciousness, calculate and reduce your carbon footprint, compare environmental issues in urban and rural areas, explore sustainable agriculture and local food movements, and research the involvement of youth in global climate action – deepening your understanding of harmony with nature.

Unit V: Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and tutorials for practice session)

Lecture 23: Personal Integrity and Professional Ethics – Building the Link

Lecture 24: Ethics in the Digital Age – Responsibility and Cyber Citizenship

Tutorial 12: Practice Session PS12 – Case Analysis: Ethical Dilemma in Technology Use

Lecture 25: Humanistic Leadership and Social Entrepreneurship

Lecture 26: Corporate Social Responsibility and Sustainable Business Models

Tutorial 13: Practice Session PS13 – Designing a Value-based Startup Idea

Lecture 27: Innovation with Purpose: Case Studies in Ethical Innovation

Lecture 28: Life Planning and Career Pathways Anchored in Values

Tutorial 14: Practice Session PS14 – Action Plan: Aligning Career with Core Human Values

CO's-CO5

Self-Learning Concepts: Explore ethical concerns in the digital age such as data privacy and responsible AI use, understand the concept of human-centered design in business, study successful examples of green and socially responsible enterprises, formulate your own personal code of ethics, and analyze real-life ethical dilemmas encountered in the workplace – promoting value-based professionalism and ethical living.

Practice Sessions for UNIT I – Introduction to Value Education

PS1 Sharing about Oneself

PS2 Exploring Human Consciousness

PS3 Exploring Natural Acceptance

Practice Sessions for UNIT II – Harmony in the Human Being

PS4 Exploring the difference between the Needs of the self and body

PS5 Exploring Sources of Imagination in the Self

PS6 Exploring Harmony of self with the body

Practice Sessions for UNIT III – Harmony in the Family and Society

PS7 Exploring the Feeling of Trust

PS8 Exploring the Feeling of Respect

PS9 Exploring Systems to Fulfill Human Goals

Practice Sessions for UNIT IV – Harmony in the Nature (Existence)

PS10 Exploring the Four Orders of Nature

PS11 Exploring Co-existence in Existence

Practice Sessions for UNIT V – Implications of the Holistic Understanding – a Look at Professional Ethics

PS12 Exploring Ethical Human Conduct

PS13 Exploring Humanistic Models in Education

PS14 Exploring Steps of Transition towards Universal Human Order

Board of Studies: Master of Business Administration
Approved in BoS No: 02, 13th May, 2025
Approved in ACM No: 02

Text Book and Teachers Manual

1. **R R Gaur, R Asthana, G P Bagaria**, A Foundation Course in Human Values and Professional
2. Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1 **R R Gaur, R Asthana, G P Bagaria**, Teachers' Manual for A Foundation Course in Human
3. Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2

Reference Books:

1. **JeevanVidya: EkParichaya**, A Nagaraj, JeevanVidyaPrakashan, Amarkantak, 1999.
2. **Human Values, A.N. Tripathi**, New Age Intl. Publishers, New Delhi, 2004.
3. **The Story of Stuff** (Book).
4. **The Story of My Experiments with Truth** - by Mohandas Karamchand Gandhi
5. **Small is Beautiful** - E. F Schumacher.
6. **Slow is Beautiful** - Cecile Andrews
7. **Economy of Permanence** - J C Kumarappa
8. **Bharat Mein Angreji Raj** – PanditSunderlal
9. **Rediscovering India** - by Dharampal
10. **Hind Swaraj or Indian Home Rule** - by Mohandas K. Gandhi
11. **India Wins Freedom** - Maulana Abdul Kalam Azad
12. **Vivekananda** - Romain Rolland (English)
13. **Gandhi** - Romain Rolland (English)

Web References:

1. **https://www.uhv.org.in/uhve**

2. https://fdp-si.aicte-india.org/UHVII.php
3. https://www.aicte-india.org/sites/default/files/Model_Curriculum/Minor%20Degree%20in%20UHV.pdf

Mode of Conduct:

1. Lecture hours are to be used for interactive discussion, where proposals about the topics are to be made and students are to be motivated to reflect, explore, and verify them.
2. Tutorial hours are to be used for practice sessions.
3. While analyzing and discussing the topic, the faculty mentor's role is to point to essential elements to help sort them out from the surface elements. In other words, it allows the students to explore the critical components.
4. In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with oneself and do self-observation, self-reflection, and self-exploration.
5. Scenarios may be used to initiate discussion. The student is encouraged to take up" ordinary" rather than" extraordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentors in a group setting.
6. Tutorials (experiments or practical) are essential for the course. The difference is that the laboratory is part of everyday life; it is helpful in how you behave and work in real life. Worksheets, home assignments, and/or activities are included depending on the nature of the topics.
7. The practice sessions (tutorials) would also support student in performing actions commensurate to their beliefs. It is intended that this would lead to the development of commitment, namely behaving and working based on fundamental human values.
8. It is recommended that this content be placed before the student as it is, in the form of an introductory foundation course, without including anything else or excluding any part of this content. Additional content maybe offered in separate, higher courses. This course is to be taught by faculty from every teaching department, not exclusively by any one department.

Internal Assessment Pattern

Cognitive Level	Internal Assessment # 1 (%)	Internal Assessment # 2 (%)
L1	15	-
L2	34	-
L3	34	15
L4	17	34
L5	-	34
L6	-	17
Total (%)	**100**	**100**

Sample Short and Long Answers to Questions of Various Cognitive Levels

L1: Remember

1. What is meant by Natural Acceptance?
2. Define Right Understanding.
3. List the four orders of nature.
4. What are the basic human aspirations?
5. State the meaning of Sanyam (self-regulation).
6. What is meant by prosperity?
7. Name the two parts of a human being.
8. What is the role of the body according to Value Education?
9. List the feelings essential in human-to-human relationships.
10. What is meant by co-existence?

L2: Understand

1. Explain the relationship between Right Understanding and Relationship.
2. Describe the harmony between the self and the body.
3. Interpret the concept of continuous happiness and prosperity.
4. Discuss the difference between the needs of the self and the body.
5. Explain the meaning of justice in relationships.
6. Describe the importance of self-exploration.
7. Clarify the concept of mutual fulfillment in nature.
8. Discuss how education helps in holistic development.
9. Explain the vision of a universal human order.
10. Describe what is meant by 'respect' as the right evaluation.

L3: Apply

1. Apply the concept of Natural Acceptance in making ethical decisions.
2. Illustrate harmony in the family with an example from your own life.
3. Demonstrate how you can practice self-regulation in your daily routine.
4. Use the idea of mutual fulfillment in a plan for an eco-friendly campus.
5. Apply the idea of Right Understanding to resolve a conflict.
6. Show how holistic development can be integrated into your lifestyle.
7. Implement practices that promote harmony in your social group.
8. Use the concept of the body as an instrument to improve physical health.
9. Plan a group activity that promotes trust and respect.
10. Apply the principles of co-existence in managing natural resources.

L4: Analysing

1. Differentiate between happiness and prosperity with examples.
2. Analyze the role of the self and body in human behavior.
3. Compare trust and respect in family relationships.
4. Examine how lack of Right Understanding leads to disharmony.
5. Distinguish between self-regulation and external regulation.
6. Investigate the root causes of conflict in society.
7. Analyze the systems in nature that demonstrate harmony.
8. Examine how justice arises from mutual fulfillment.

9. Break down the structure of a universal human order.
10. Explore the interconnection between individual values and societal peace.

L5: Evaluating

1. Evaluate the relevance of Value Education in modern society.
2. Assess the impact of materialism on human happiness.
3. Judge the effectiveness of education in achieving holistic development.
4. Critique current societal systems in light of natural co-existence.
5. Appraise the role of mutual trust in building strong relationships.
6. Defend the need for harmony at all levels of human existence.
7. Evaluate the importance of distinguishing between self and body.
8. Justify the inclusion of Value Education in professional courses.
9. Compare the traditional vs. modern views on personal success.
10. Argue whether self-exploration is sufficient for understanding human values.

L6: Create and Develop

1. Design a value-based weekly routine for students.
2. Construct a model society based on mutual trust and justice.
3. Formulate strategies to integrate value education into school curricula.
4. Develop a plan for promoting harmony in a multicultural community.
5. Compose an essay on the role of harmony in personal and professional life.
6. Create a campaign to raise awareness on sustainable coexistence with nature.
7. Design a self-assessment tool for personal value alignment.
8. Develop a short workshop on self-exploration for college students.
9. Write a story that illustrates the principles of Right Understanding.
10. Create a visual mind map connecting harmony at the individual, family, and societal levels.

Chairperson
Board of Studies (MBA)

R24EEPC03 **Electrical Circuit Analysis –II** **3 0 0 3**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To understand three phase circuits
2. To evaluate network parameters of given electrical network
3. To analyze transients in electrical systems
4. To understand the network synthesis concepts
5. To understand the behavior of filters

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO4	PO6	PSO1	PSO2	
R24EEPC03.1	Analyze balanced and unbalanced three-phase systems.	-	3	2	2	1	2	1	L1,L2
R24EEPC03.2	Understand and evaluate parameters of two-port networks.	1	1	-	2	1	2	1	L2, L3
R24EEPC03.3	Determine the transient response of R-L, R-C, and R-L-C circuits for both DC and AC excitations.	-	3	2	2	-	1	1	L3, L4
R24EEPC03.4	Analyze Network Synthesis concepts.	-	3	2	2	1	1	1	L4,L5
R24EEPC03.5	Design and analyze various types of filters	-	3	2	1	1	-	2	L5,L6

SYLLABUS

Unit –I: Analysis of Three Phase Balanced Circuits **14 Hours**

Phase sequence, star and delta connection of sources and loads, relationship between line and phase quantities, analysis of balanced three phase circuits, and measurement of active and reactive power.

Three Phase Unbalanced Circuits

Loop method, Star-Delta transformation technique, measurement of active and reactive power.

Self-Learning Topics: Applications in Electrical Systems **CO's: CO1**

Unit –II: Two Port Networks **10 Hours**

Impedance parameters, Admittance parameters, Hybrid parameters, Transmission (ABCD) parameters, conversion of Parameters from one form to other, Interconnection of Two Port

networks in Series, Parallel and Cascaded configurations- problems, Symmetry and Reciprocity Conditions

Self-Learning Topics: Equivalent Circuits of Two Port Network **CO's: CO2**

Unit –III: Transient Analysis **12 Hours**

Initial conditions -Transient response of R-L, R-C and R-L-C circuits for D.C. and sinusoidal excitations –Solution using differential equation approach and Laplace transform approach.

Self-Learning Topics: Applications of Transients in Electrical Systems **CO's: CO3**

Unit –IV: Network Synthesis **10 Hours**

Driving point impedance and admittance, transfer impedance and admittance network function poles, zeros, Network functions- Hurwitz polynomials, Positive Real Functions Synthesis of LC, RC and function by Foster and Cauer methods.

Self-Learning Topics: Design Networks **CO's: CO4**

Unit –V: Filters **10 Hours**

Classification of filters-Low pass, High pass, Band pass and Band Elimination filters, Design of Constant-k filters -Low pass and High Pass, Design of m derived-Filters - Low pass and High pass.

Self-Learning Topics: Op-Amp Based Filters **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 02, 21st, May, 2025

Approved in ACM No: 02

Text Books:

1. Engineering Circuits Analysis, Jack Kemmerly, William Hayt and Steven Durbin, Tata Mc Graw Hill Education, 2005, sixth edition.
2. Fundamentals of Electrical Circuits, Charles K. Alexander and Mathew N.O. Sadiku, Mc Graw Hill Education (India), 2013, Fifth Edition

Reference Books:

1. Circuit Theory: Analysis and Synthesis, A. Chakrabarti, Dhanpat Rai & Co., 2018, Seventh Revised Edition.
2. Circuits and Networks Analysis and Synthesis, A. Sudhakar, Shyam Mohan S. Palli, 5th Edition, Tata McGraw-Hill, 2017
3. Network Analysis, M. E. Van Valkenburg, Pearson Education, 2019, Revised Third Edition

Web References:

1. https://archive.nptel.ac.in/courses/117/106/117106108/
2. https://archive.nptel.ac.in/courses/108/105/108105159/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What are the standard phase sequence orders?
2. What are the conditions for reciprocity in a two-port network?
3. State the Laplace transform of a unit step function.
4. List the properties of positive real functions.

L2: Understand

1. Illustrate the relationship between current and voltage in a balanced delta-connected load
2. Explain the significance of each parameter in the Z-parameter model.
3. Explain the behavior of capacitors and inductors during the switching process.
4. Explain the significance of Hurwitz polynomials in network synthesis.

L3: Apply

1. Calculate the current in each line of a delta-connected load with given phase impedances.
2. Convert given Z-parameters to h-parameters.
3. Apply Laplace transform to find the complete response of an RLC circuit
4. Use the Foster I method to realize a given LC impedance function.
5. Design a constant-k low-pass filter for a given cutoff frequency and load impedance

L4: Analyzing

1. Compare the current and voltage characteristics of star and delta connections in a tabular form.
2. Identify if a given set of parameters satisfies the condition for reciprocity and symmetry
3. Identify the over damped, under damped, and critically damped cases in an RLC circuit.
4. Compare Foster and Cauer methods of network realization.
5. Compare the characteristics of low-pass, high-pass, and band-pass filters

L5: Evaluating

1. Evaluate the benefits of using a three-phase supply for residential versus industrial setups.
2. Justify the use of hybrid parameters in transistor modeling.
3. Evaluate the performance of various damping conditions in second-order circuits.
4. Determine whether the synthesized network meets design specifications
5. Justify the choice of filter type for specific applications

L6: Create

1. Design a Constant-k low pass filter with a specified cutoff frequency and load impedance. Determine the component values and sketch the frequency response curve.
2. Develop an m-derived high pass filter that addresses the limitations of the Constant-k design near the cutoff frequency.
3. Formulate a band pass filter by cascading appropriate low pass and high pass filter sections.

Chairperson
Board of Studies (EEE)

R24EEPC04 **DC Machines & Transformers** **3 0 0 3**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Understand the characteristics and applications of DC Machines
2. Understand the characteristics and applications of DC Machines
3. Understand the concepts of efficiency and regulation of a transformer by obtaining equivalent circuit.
4. Understand the performance of single-phase transformers.
5. Understand the performance of single-phase transformers.

Course Code	Course Outcomes	Mapping with POs and PSOs						DoK
		PO1	PO2	PO3	PO4	PO6	PSO1	
R24EEPC04.1	Understand the process of voltage build-up in DC generators and characteristics.	3	1	-	2	1	3	L1, L2
R24EEPC04.1	Understand the process of torque production, starting and speed control of DC motors and illustrate their characteristics.	3	1	-	2	1	3	L2, L3
R24EEPC04.1	Obtain the equivalent circuit of single-phase transformer and deter-mine its efficiency & regulation.	-	3	2	3	1	3	L3, L4
R24EEPC04.1	Analyze the performance of Single- Phase Transformers	-	3	2	2	1	3	L4,L5
R24EEPC04.1	Analyse various configurations of three-phase transformers.	-	3	3	2	1	3	L5,L6

SYLLABUS

UNIT – I: Introduction to DC machines **14 Hours**

Introduction to DC machines (Construction and principle of operation of DC machines) – EMF equation for generator –Excitation techniques- Types of DC Machines-shunt, series and Compound – Characteristics of DC generators –applications of DC Generators, Back-EMF and torque equations of DC motor- Characteristics of DC motors - Applications of DC motors – Armature reaction and commutation, voltage regulation, losses-power flow, efficiency calculation.

CO's: CO1

Self-Learning Topics: Principle of Commutation

UNIT – II: Starting, Speed Control and Testing of DC Machines **12 Hours**

Necessity of a starter – starting by 3-point and 4-point starters – speed control by armature voltage and field current control – Testing of DC machines, losses and efficiency, Condition for maximum efficiency, – brake test, Swinburne's test –Hopkinson's test–Field Test – Retardation Test. **CO's: CO2**

Self-Learning Topics: Calculate Losses and Efficiency of DC Machines

UNIT – III: Single-phase Transformers **12 Hours**

Introduction to single-phase Transformers (Construction and principle of operation)–emf equation Ideal Transformer– operation on no-load and on load –lagging, leading and unity power factor loads –phasor diagrams– equivalent circuit –regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – auto transformer –equivalent circuit- all day efficiency, Applications. **CO's: CO3**

Self-Learning Topics: To Draw the Phasor Diagrams at different P.F.

UNIT –IV: Testing of Transformers **12 Hours**

Open-Circuit and Short-Circuit tests, Polarity Test – Sumpner's test – separation of losses— Parallel operation with equal and unequal voltage ratios— equivalent circuit – comparison with two winding transformers. **CO's: CO4**

Self-Learning Topics: Predetermination of Losses, Efficiency and Regulation of a Transformer

UNIT – V: **Three-Phase Transformers:** **12 Hours**

Polyphone connections- Y/Y, Y/Δ, Δ/Y, Δ/Δ, open Δ and Vector groups – third harmonics in phase voltages– Parallel operation–three winding transformers- transients in switching –off load and on load tap changers–Scott connection-Applications. **CO's: CO5**

Self-Learning Topics: transients, star and delta connections

Board of Studies:	Electrical & Electronics Engineering
Approved in BOS No:	02, 21st, May 2025
Approved in ACM No:	02

Text books:

1. Electrical Machinery by Dr. P S Bimbhra, Fully Revised edition, Khanna Publishers, New Delhi, 2021.
2. Performance and analysis of AC machines by M.G. Say, CBS, 2002.

Reference Books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth, McGraw Hill Publications, 5th edition, 2017.

2. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2017
3. Generalized Theory of Electrical Machines by Dr. P S Bimbhra, 7th Edition, Khanna Publishers, 2021.
4. Theory & Performance of Electrical Machines by J.B.Gupta, S.K.Kataria& Sons,2013.
5. Electric Machinery by Fitzgerald, A.E.,Kingsley, Jr.,C.,& Umans, S. D, 7th edition, McGraw-Hill Education, 2014.

Web Resources:

1. nptel.ac.in/courses/108/105/108105112
2. nptel.ac.in/courses/108/105/108105155

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	---
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Describe the functions of individual parts of DC machines.
2. Describe different types of DC generators.
3. Derive the EMF equation of a DC machine.
4. Draw the open circuit and load characteristics of DC generators.
5. Explain armature reaction in DC machines and solutions to overcome its effects.
6. Derive the torque equation of a DC motor.

L2: Understand

1. Why starters are used in DC motors?
2. Explain types of speed control in DC motor.
3. Explain regenerative braking in DC motor.
4. What are the losses associated with DC motor?
5. Select suitable type of DC motor for specific applications.

6. Describe the principle of Swinburn's test for testing of DC motor and perform the calculations.

L3: Apply

1. Derive the EMF equation of single-phase transformer.
2. Derive the condition for maximum efficiency in a transformer.
3. Explain the difference between power transformer and distribution transformer.
4. Explain the current rating and kVA rating of auto transformers.

L4: Analyzing

1. Explain in detail no load and on load tap changing.
2. Draw the various three phase transformer connections.
3. Explain the stabilization by tertiary winding.
4. Draw the equivalent circuit of single-phase transformer referred to primary side.

L5: Evaluating

1. Define voltage regulation in transformers. How is it calculated?.
2. Describe the short-circuit test and how it helps in determining the equivalent circuit parameters of a transformer.
3. Explain the open-circuit test and its purpose in transformer testing.
4. Discuss the efficiency considerations in a Scott-T transformer connection. How does the load sharing between the two transformers affect overall performance?

L6: Create

1. Formulate a strategy to mitigate third harmonic distortions in phase voltages within a power system utilizing three-phase transformers.
2. Propose an implementation plan for integrating on-load tap changers in a substation to regulate voltage levels dynamically. Discuss the control strategies and protection schemes necessary for reliable operation.
3. Develop a use case for employing a Scott connection to supply two-phase equipment from a three-phase power source. Include the design calculations and potential applications in modern industry.

Chairperson
Board of Studies (EEE)

R24EEPC05 **Electro Magnetic Field Theory** **3 0 0 3**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Electric field and potentials due to different configurations of static charges.
2. Behavior of conductors and dielectrics in the presence of external magnetic field, calculate the capacitance of different configurations
3. Magnetic fields produced by currents in different configurations, application of Ampere's law and the Maxwell's second and third equations and to study the magnetic force and torque through Lorentz force equation in magnetic field environment like conductors and other current loops
4. Concept of self and mutual inductances and the energy stored.
5. Time varying and Maxwell's equations in different forms and Maxwell's fourth equation for the induced EMF

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO5	PO6	PSO1	PSO2	
R24EEPC05.1	Determine EFI using Coulomb's and Gauss's law for various electric charge distributions	3	1	1	-	1	1	1	L1,L2
R24EEPC05.2	Calculate the capacitance for different configurations.	-	3	2	2	1	2	1	L2,L3
R24EEPC05.3	Calculate the MFI due to different current configuration using Biot-Savart's law and Ampere's law.	-	3	1	2	1	2	1	L3,L4
R24EEPC05.4	Determine the self inductances of solenoid and Toroid	-	3	2	2	1	1	-	L4,L5
R24EEPC05.5	Calculate induced emf, understand the concepts of displacement current and Poynting vector	-	3	2	2	1	1	1	L5,L6

SYLLABUS

Unit –I: Electrostatic Fields **12 Hours**

Coulomb's law and Electric field intensity (EFI) – EFI due to Continuous charge distributions due to a line and surface charge, Electric flux density, Work done in moving a point charge in an electrostatic field, Electric Potential- properties of potential function, Potential gradient, Gauss's law -Maxwell's first equation. **CO's: CO1**

Self-Learning Topics: work done in moving a point charge in an electrostatic field

Unit –II: Conductor-Dielectrics **14 Hours**

Conductors – Dielectrics and Capacitance Electric dipole – dipole moment – potential and **EFI** due to an electric dipole, Torque on an Electric dipole in an electric field conductors and Insulators – their behaviour in electric field, Ohm's law in Point form- Polarization, boundary conditions between dielectric to dielectrics, conductor to dielectric and conductor to free space.

Laplace's and Poison's equations and solution of Laplace's equation in one variable. Capacitance of parallel plates, spherical and coaxial cables, current density, conduction and convection current densities **CO's: CO2**

Self-Learning Topics: Ohm's law in point form, polarization and bound charges, current density (conduction and convection).

Unit –III: Magneto statics & Ampere's law **14 Hours**

Biot-Savart's law, Magnetic Field Intensity (**MFI**) – MFI due to a straight current carrying filament. Ampere's Law, point form of Ampere's circuital law, Ampere's circuital law and its applications. Maxwell's third equation. Magnetic force, moving charges in a magnetic field – Lorentz force equation, force on a current element in a magnetic field, force on a straight and a long current carrying conductor in a magnetic field. **CO's:CO3**

Self-Learning Topics: Magnetic vector potential, boundary conditions of magnetic fields at material interfaces

Unit –IV: Self and mutual inductance: **10 Hours**

Self and mutual inductance – determination of self-inductance of a solenoid and toroid and mutual inductance between a straight long wire and a square loop wire in the same plane. **CO's: CO4**

Self-Learning Topics: energy stored in magnetic fields, RL and RLC circuit analysis, LC oscillations.

Unit –V: Time Varying Fields **12 Hours**

Faraday's laws of electromagnetic induction – its integral and point forms, Maxwell's fourth equation, modification of Maxwell's equations for time varying fields - displacement current, Poynting theorem and Poynting vector **CO's: CO5**

Self-Learning Topics: skin effect in conductors, electromagnetic radiation from accelerating charges.

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 02, 21st, May 2025

Approved in ACM No: 02

Text books:

1. Elements of Electromagnetic by Matthew N O Sadiku, Oxford Publications, 7th Edition, 2018.

2. Engineering Electromagnetic by William H. Hayt & John. A. Buck Mc. Graw-Hill,9th Editon.2020

Reference Books:

1. Introduction to Electro Dynamics. by D J Griffiths, Prentice-Hall of India Pvt. Ltd,4th Edition, 2020
2. Electromagnetic Field Theory. by Yaduvir Singh, Pearson India, 1st edition, 2011.
3. Fundamentals of Engineering Electromagnetic. by Sunil Bhooshan, Oxford University Press, 2012.

Web References:

1. https://archive.nptel.ac.in/courses/108/106/108106073/
2. https://nptel.ac.in/courses/117103065

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	---
L4	---	50
L5	---	40
L6	---	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. State Coulomb's law of electrostatic field.
2. Define electric field intensity.
3. State and explain the Biot-Savart's law.
4. Define ohm's law in Point form..
5. What is the Faraday's law of induction? What is the significance of the terms transformer e.m.f and generator e.m.f.?

L2: Understand

1. Derive an expression for the Electric field intensity due to a finite length line charge along the Z-axis at an arbitrary point Q(x,y,z)
2. Explain the behavior of conductors in an electric field.
3. Write the similarities between electrostatic field and magnetic field.
4. Show that the field strength at the end of a long solenoid is one-half of that at the Centre.

L3: Apply

1. Derive the expression for the total force experienced by a point charge due to Infinite number to point charges around it.
2. Derive Maxwell's first equation as applied to the electrostatics using Gauss law.
3. Derive the expression for electric potential due to a dipole.
4. Derive the Ohm's law in point form.
5. Obtain the expression for the magnetic field intensity due to infinite length Current carrying conductor.

L4: Analyzing

1. Prove that electric field intensity is equal to the negative gradient of the Potential, i.e., $E = -\nabla V$.
2. Deduce the Biot-Savart's law from Ampere's circuital law.
3. Explain the concept of displacement current and obtain an expression for the Displacement current density.
4. State Pointing theorem and derive the equation.
5. Explain about force on a straight and a long current carrying conductor in a Magnetic field.

L5: Evaluating

1. A parallel plate capacitor consists of two square metal plates with 500mm side and separated by 10 mm. A slab of super (er = 4) 6 mm thick is placed on the lower side of plate and air gap of 4 mm. Calculated 1ha capacitance of capacitor.
2. Show that the field strength at the end of a long solenoid is one-half of that at the centre.
3. A toroid has 600 turns of coil, circular cross section of 6 cm2 and a mean Diameter of 38 cm. The permeability of the toroid is 1000. Calculate the inductance of the coil.
4. Current in a coil is increased from 0 to 10 Amps at a uniform rate is 5 sec. It is found that this coil develops self-induced emf of 100V where as an emf of 20V is reduced in a neighboring coil. Compute self-inductance of the first coil and Mutual inductance between the two coils.
5. A solenoid with 300 turns is 300 mm long and 30 mm in diameter. If the current Flowing through it is 500 mA, find (i) inductance and (ii) energy stored in Solenoid. Assume $\mu r = 1$

L6: Create

1. Develop a computational model to simulate the propagation of an electromagnetic wave in free space, incorporating Maxwell's equations and the Poynting vector.
2. Design an experiment to demonstrate the existence of displacement current and its effects on the surrounding magnetic field.

Chairperson
Board of Studies (EEE)

R24EEPC06 **DC MACHINES & TRANSFORMERS LAB** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To conduct the experiment and plot the characteristics and applications of DC machines.
2. To perform the starting, speed control and testing methods of DC Machines.
3. To determine/Predetermine efficiency and regulation of the transformer through equivalent circuit.

Course code	Course outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO4	PO5	PO11	PSO1	PSO2	
R24EEPC06.1	Apply theoretical concepts in analysing the performance characteristics of DC Machines.	-	3	1	2	1	2	1	L1 L2
R24EEPC06.2	Determine the performance characteristics of DC machines using different testing methods.	-	2	3	2	1	3	1	L2 L3
R24EEPC06.3	Determine the performance parameters of single-phase transformer.	-	2	3	2	1	3	1	L2 L3

Board of Studies : Electrical & Electronics Engineering

Approved in BOS No : 02, 21st, May 2025

Approved in ACM No: 02

List of Experiments

1. Speed control of DC shunt motor by Field Current and Armature Voltage Control CO's: CO1
2. Brake test on DC shunt motor- Determination of performance curves. CO's: CO1
3. Load test on DC shunt generator-Determination of characteristics. CO's: CO1
4. Load test on DC compound generator-Determination of characteristics. CO's: CO1
5. Swinburne's test - Predetermination of efficiencies as DC Generator and Motor. CO's: CO2
6. Hopkinson's test on DC Shunt Machines. CO's: CO2
7. Fields test on DC series machines-Determination of efficiency. CO's: CO2
8. Brake test on DC compound motor-Determination of performance curves. CO's: CO2
9. OC & SC tests on single phase transformer. CO's: CO2
10. Sumpner's test on single phase transformer. CO's: CO3
11. Scott connection of transformers. CO's: CO3

12. Parallel operation of Single-phase Transformers. CO's: CO3
13. Separation of core losses of a single-phase transformer CO's: CO3

Any 10 experiments are to be conducted

Online Learning Resources:

1. https://ems-iitr.vlabs.ac.in/List%20of%20experiments.html

References:

1. Dr. P. S Bimbhra, Electrical Machinery, 7/e, Khanna Publishers,2018.
2. . I.J. Nagarath and D.P. Kothari, Electric Machines,4/e, McGraw Hill, 2010.

L1: Remember

1. Why should the field resistance be kept in the position of minimum resistance?
2. What is the loading arrangement used in a DC motor?
3. What are the mechanical and electrical characteristics of DC shunt motor?

L2: Understand

1. How does the Speed of a DC shunt motor vary with armature voltage and field current?
2. Compare the resistance of armature winding and field winding?
3. What is the speed control of DC Shunt motor in industrial applications?
4. Which of the two speed control methods is better and why?

L3: Apply

1. What is the difference between external and internal characteristics?
2. Write the voltage equation of a separately excited DC generator. State the difference between generated EMF and terminal voltage
3. Why does the terminal voltage decrease as the load current increases?
4. If a DC shunt generator fails to build up voltage, what may be the probable reasons?

Chairperson
Board of Studies (EEE)

R24EEPC07 **Electrical Circuit Simulation Lab** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To measure three phase Active and Reactive power
2. To analyse transient behavior of circuits
3. To analyse electrical circuits using simulation tool

Course code	Course outcomes	Mapping with POs and PSOs									DOK
		PO1	PO2	PO3	PO4	PO6	PO8	PO11	PSO1	PSO2	
R24EEPC07.1	Evaluate the powers in three phase networks	-	3	2	2	1	-	1	2	1	L1, L2
R24EEPC07.2	Analyze the concepts of Transient response and time constants for the given circuits.	-	3	2	3	2	-	1	1	1	L1, L2
R24EEPC07.3	Simulate and analyze electrical circuits using MATLAB/PSPICE tools	-	3	3	3	2	2	1	2	1	L2, L3

Board of Studies : Electrical & Electronics Engineering

Approved in BOS No : 02, 21st, May 2025

Approved in ACM No: 02

List of Experiments: Any 10 experiments are to be conducted

1. Measurement of Active Power and Reactive Power for balanced and Unbalanced loads. CO's: CO1
2. Verification of Kirchhoff's current law and voltage law using simulation tools CO's: CO1
3. Verification of mesh and nodal analysis using simulation tools. CO's: CO1
4. Verification of super position and maximum power transfer theorems using simulation tools. CO's: CO1
5. Verification of Thevenin's and Norton's theorems using simulation tools. CO's: CO2
6. Verification of series and parallel resonance using simulation tools. CO's: CO2
7. Simulation and analysis of transient response of RL, RC circuits. CO's: CO2
8. Simulation and analysis of transient response of RLC circuit. CO's: CO2
9. Verification of Reciprocity and Compensation theorems using simulation tools. CO's: CO2
10. Verification of Millman's Theorems using simulation tools CO's: CO3
11. Design of filters-Low pass filter, High Pass and Band Pass Using simulation tools CO's: CO3
12. Analysis of Three Phase Circuits for Balanced Load Using Simulation. CO's: CO3

13. Analysis of Three Phase Circuits for Unbalanced Load Using Simulation. CO's: CO3

References:

1. Network Analysis - ME Van Valkenburg, Prentice Hall of India, revised 3rd Edition, 2019.
2. Engineering Circuit Analysis by William H. Hayt, Jack Kemmerly, Jamie Phillips,Steven M. Durbin, and 9th Edition 2020.

L1: Remember

1. What instrument is used to measure active power in a balanced three-phase system
2. Draw the Thevenin's equivalent circuit for the above circuit?
3. State Norton's theorem and Norton's current?
4. Draw the Norton's equivalent circuit?

L2: Understand

1. Explain the difference between mesh and nodal analysis.
2. What parameters are measured in simulation to verify nodal analysis?

L3: Apply

1. Simulate the step response of an RC circuit and determine the time constant (τ) from the output waveform.
2. Given an RL circuit, apply a pulse voltage and analyze the inductor current over time. What do you observe?
3. What changes in the transient response if you increase the capacitance in an RC circuit?

Chairperson
Board of Studies (EEE)

R24CSSC04 **COMPUTING SKILLS USING C** **0 0 3 1.5**
(Electrical & Electronics Engineering)

Course Objectives:

- To develop proficiency in using arrays and strings in C, including performing operations such as sorting, searching, insertion, and transformation based on logical conditions.
- To understand and implement linear data structures like stacks, queues, and linked lists using arrays and pointers, and apply them to solve structured programming problems.
- To enhance analytical and problem-solving skills by designing modular functions to handle real-world logical scenarios involving numeric operations, character manipulations, and validations.
- To apply control structures, functions, and user-defined logic in building efficient and modular C programs for various computational tasks.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	Do K
R24CSSC04.1	Understand and implement basic array operations using C and sorting techniques in arrays.	3	2	1	1	2	0	0	0	1	1	1	L1, L2
R24CSSC04.2	Apply searching techniques on arrays and implement stack data structures using arrays.	3	3	2	2	2	0	0	0	1	1	1	L3
R24CSSC04.3	Implement queue data structures using arrays. Develop and manipulate singly linked lists. Implementation of queue, stack, arrays applications.	3	3	3	2	2	0	0	0	2	2	1	L3, L4

Board of Studies: Computer Science and Engineering

Approved in BOS No: 02, 9th May, 2025

Approved in ACM No: 02

Developing the following programs **Arrays with functions** **6 Hours**

In C you can pass single-dimensional arrays in two ways. You can either pass it directly to a function.

Week 1:

1. Write a program in C to read n number of values in an array and display them in reverse order. **CO's-CO1**
2. Write a program in C to find the sum of all elements of the array. **CO's-CO1**

Week 2:

1. Write a program in C to count the total number of duplicate elements in an array. **CO's-CO1**
2. Write a program in C to count the frequency of each element of an array. **CO's-CO1**

Week 3:

1. Write a program in C to separate odd and even integers into separate arrays. **CO's-CO1**

Sorting and Searching **6 Hours**

Week 4:

1. Write a program in C to sort elements of an array in ascending order. **CO's-CO1**
2. Write a program in C to sort the elements of the array in descending order. . **CO's-CO1**

Week 5:

1. Write a program in C to implement Linear Search **CO's-CO2**
2. Write a program in C to implement Binary Search **CO's-CO2**

Week 6:

1. Write a program in C to find the missing number in a given array. **CO's-CO2**

Stacks implementation **6 Hours**

Week 7:

1. Write a C program to check a stack is full or not using an array with push and pop operations. **CO's-CO2**
2. Write a C program to sort a given stack using another stack. **CO's-CO2**

Week 8:

1. Write a C program that reverses a stack using only stack operations push & pop. **CO's-CO2**

Queues implementation **6 Hours**

Week 9:

1. Write a C program to implement a queue using an array. Programs should contain functions for inserting elements into the queue, displaying queue elements, and checking whether the queue is empty or not. **CO's-CO3**
2. Write a C program to implement a queue using an array. Create a function that removes an element from the queue. **CO's-CO3**

Week 10:

1. Write a C program to count the number of elements in a queue. **CO's-CO3**

Linked list implementation **6 Hours**

1. Write a program in C to create and display a Singly Linked List. **CO's-CO3**

Week 11:

1. Write a program in C to create a singly linked list of n nodes and display it in reverse order. **CO's-CO3**
2. Write a program in C to create a singly linked list of n nodes and count the number of nodes. **CO's-CO3**

Problem solving **6 Hours**

Week 12:

1. The function accepts an integers arr of size 'length' as its arguments you are required to return the sum of second largest element from the even positions and second smallest from the odd position of given 'arr' **CO's-CO3**

Assumption:

- All array elements are unique
- Treat the 0th position as even

NOTE

- Return 0 if array is empty
- Return 0, if array length is 3 or less than 3

Example

Input

arr:3 2 1 7 5 4

Output

7

Explanation

- Second largest among even position elements(1 3 5) is 3
- Second smallest among odd position element is 4
- Thus output is 3+4 = 7

Sample Input

arr:1 8 0 2 3 5 6

Sample Output

8

2. The function accepts an integers sum and an integer array arr of size n. Implement the function to find the pair, (arr[j], arr[k]) where j!=k, Such that arr[j] and arr[k] are the least two elements of array (arr[j] + arr[k] <= sum) and return the product of element of this pair **CO's-CO3**

NOTE

- Return -1 if array is empty or if n<2
- Return 0, if no such pairs found
- All computed values lie within integer range

Example

Input

sum:9

size of Arr = 7

Arr:5 2 4 3 9 7 1

Output

2

Explanation

Pair of least two element is (2, 1) 2 + 1 = 3 < 9, Product of (2, 1) 2*1 = 2. Thus, output is 2

Sample Input

sum:4

size of Arr = 6

Arr: 9 8 3 -7 3 9

Sample Output

-21

3. The function accepts string str of size n as an argument. Implement the function which returns 1 if given string str is valid password else 0. **CO's-CO3**

   str is a valid password if it satisfies the below conditions.

- – At least 4 characters
- – At least one numeric digit
- – At Least one Capital Letter
- – Must not have space or slash (/)
- – Starting character must not be a number

Assumption:

Input string will not be empty.

Example:

Input 1: aA1_67

Input2:

a987 abC012

Output1:

1

Output2:

0

Week 13:

1. The function accepts an integer array 'arr', its length and two integer variables 'num' and 'diff'. Implement this function to find and return the number of elements of 'arr' having an absolute difference of less than or equal to 'diff' with 'num'. Note: In case there is no element in 'arr' whose absolute difference with 'num' is less than or equal to 'diff', return -1. **CO's-CO3**

Example:

Input:

- arr: 12 3 14 56 77 13
- num: 13
- diff: 2

Output: 3

Explanation:

Elements of 'arr' having absolute difference of less than or equal to 'diff' i.e. 2 with 'num' i.e. 13 are 12, 13 and 14.

2. The function accepts two integers n, m as arguments Find the sum of all numbers in range from 1 to m(both inclusive) that are not divisible by n. Return difference between sum of integers not divisible by n with sum of numbers divisible by n. C**O's-CO3**

Assumption:

- n>0 and m>0
- Sum lies between integral range

Example

Input
n:4
m:20
Output: 90
Explanation

- Sum of numbers divisible by 4 are 4 + 8 + 12 + 16 + 20 = 60
- Sum of numbers not divisible by 4 are 1 +2 + 3 + 5 + 6 + 7 + 9 + 10 + 11 + 13 + 14 + 15 + 17 + 18 + 19 = 150
- Difference 150 – 60 = 90

Sample Input n:3
m:10
Sample Output: 19

3. Implement the following function

char*MoveHyphen(char str[],int n);
The function accepts a string "str" of length 'n' that contains alphabets and hyphens (-). Implement the function to move all hyphens (-) in the string to the front of the given string. **CO's-CO3**
NOTE: - Return null if str is null.
Example:-

- **Input**:
  - str.Move-Hyphens-to-Front
- **Output:**
  - —MoveHyphenstoFront

Explanation:-
The string "Move-Hyphens -to-front" has 3 hyphens (-), which are moved to the front of the string, this output is "— MoveHyphen"
Sample Input

- Str: String-Compare

Sample Output-

- -StringCompare

Week 14:

4. **Problem Statement**

You are given a function,
Void *ReplaceCharacter(Char str[], int n, char ch1, char ch2);
The function accepts a string 'str' of length n and two characters 'ch1' and 'ch2' as its arguments . Implement the function to modify and return the string ' str' in such a way that all occurrences of 'ch1' in original string are replaced by 'ch2' and all occurrences of 'ch2' in original string are replaced by 'ch1'.
Assumption: String contains only lower-case alphabetical letters.
Note:

- Return null if string is null.
- If both characters are not present in string or both of them are same , then return the string unchanged.

Example:

- **Input:**
  - Str: apples

- ch1:a
- ch2:p

- **Output:**
  - paales

Explanation:

'A' in original string is replaced with 'p' and 'p' in original string is replaced with 'a', thus output is paales.

5. Problem Statement

You are required to implement the following function.

Int Operation Choices(int c, int n, int a , int b)

The function accepts 3 positive integers 'a' , 'b' and 'c ' as its arguments. Implement the function to return.

- (a+ b) , if c=1
- (a – b) , if c=2
- (a * b) , if c=3
- (a / b) , if c =4

Assumption: All operations will result in integer output. **CO's-CO3**

Example:

- **Input**
  - c :1
  - a:12
  - b:16
- **Output:**
  - Since 'c'=1 , (12+16) is performed which is equal to 28 , hence 28 is returned.

Sample Input

c : 2
a : 16
b : 20

Sample Output -4

Text Books:

1. Data structures Using C Second Edition,Reema Thareja.
2. Programming Problem Solving, Reema Thareja..

Reference Books:

1. Lets Us C,Yeswanth Kanethkar.
2. Data Structures,S.Chand And Company Limited,Dr.KV Sambasivarao.

Chairperson
Board of Studies (CSE)

R24HS04 **Logical Reasoning and Corporate Skills** **0 0 2 1**
(Common to all UG programmes)

Course Objectives:

1. **Develop Logical thinking skills:** Students will be able to analyze information, identify patterns, and make informed decisions.
2. **Enhance analytical skills:** Students will be able to break down complex information into its component parts, analyze each part, and draw conclusions.
3. **Understand corporate culture and etiquette:** Students will be able to understand and demonstrate corporate culture and etiquette, including professional behaviour and networking.
4. **Develop effective communication skills:** Students will be able to communicate effectively in a corporate setting, including verbal and written communication.
5. **Develop negotiation and conflict resolution skills:** Students will be able to negotiate effectively and resolve conflicts in a corporate setting.
6. **Improve teamwork and collaboration skills:** Students will be able to work effectively in teams, build strong relationships, and manage conflicts.

At the end of the course, students will be able to:

Course Code	Course Outcome	PO1	PO7	PO9	P011	Dok
R24HS04.1	Use their logical thinking and analytical abilities to solve reasoning questions from number analogy and series and letter and coding and decoding based aptitude questions company specific and other competitive tests.	2	---	---	---	L4,L5
R24HS04.2	Solve questions related to Blood Relations clock and calendar, etc. From company specific and other competitive tests.	1	---	---	---	L4,L5
R24HS04.3	Enforce corporate etiquette, and precise usage of English grammar to enhance their professional communication.	---	2	3	1	L1,L3
R24HS04.4	Master negotiation skills and telephone etiquette with emotional intelligence for corporate interactions.	---	2	3	1	L3
R24HS04.5	Enhance email writing skills by incorporating vocabulary acquired from storytelling, situational dialogues and reading activities by using various digital tools.	2	---	3	1	L2,L3

SYLLABUS

UNIT I **15 Hours**

Number Series, Letter Series, Number analogy, letter analogy, word analogy. Coding Decoding-Letter to letter, letter to digit, letter to number and symbol, Word to word coding, odd man out. Directions-Finding distance, Direction and Shadow based problem, Blood Relations-Mixed Blood Relations, Puzzle-Based Blood Relation, Single-Person Blood Relation, Symbol based Blood Relations.

Self Learning Topic: Number Puzzles

UNIT II **15 Hours**

Clocks–finding Angle, Time, Mirror image, Faulty clock, Calendars – Finding day of the week, Number of odd days, Repetition of same calendar, Seating Arrangement-Circular arrangement, linear arrangement, Order Sequence and Ranking

Self Learning Topic: Arrangement puzzles

UNIT III **10 Hours**

Corporate Etiquette – Work Place Etiquette and Conflict Resolution – Grammar Revision, Leadership and Management skills. Verbal Ability: Prepositions, Articles, tenses and conjunction

Self Learning Topic: Successful Team Leadership

UNIT IV **10 Hours**

EQ – Negotiation Skills – Telephone Etiquette – MNCs Paper Model Introduction, Situational Dialogue Practice – Team Activities Related to Spoken
English Verbal Ability: Fill in the blanks (Based on the given appropriate words)

Self Learning Topic: Group Discussion Skills

UNIT V **10 Hours**

E Mail Writing–Vocabulary, Story Telling Activity, Functional English–IELTS Vocabulary News Paper Reading.
Verbal Ability: Sentence arrangements

Self Learning Topic: Sentence Construction

Board of Studies: MBA
Approved in BOS No: 02, 13th, April, 2025
Approved in ACM No: 02

Text Books:

1. A Modern Approach to Logical Reasoning R.S Aggarwal – S.chand publications.
2. Personality Development and Soft Skills by Barun K.mitra

Reference Books:

1. Shortcuts in Reasoning (Verbal, Non-Verbal, Analytical & Critical) for Competitive Exams Disha's publications
2. Communication by C.S.G Krishnamacharyulu & Lalitha Ramakrishnan–Himalaya publishing house

Web References:

1. https://faceprep.in/ logical reasoning
2. www.sawaal.com
3. http://nptel.ac.in/courses
4. www.prepinsta.com

Model Questions of Logical Reasoning & Corporate Skills

L1: Remember

1. What is the proper way to greet a client or colleague in a professional setting?
2. The book is _____ the table.
3. I'm going _____ the store to buy some milk.
4. If I _____ (know) the answer, I would tell you.
5. By next year, I _____ (study) English for five years.
6. If it _____ (rain), we would have stayed home.
7. I _____ (finish) my homework before I went to bed.

L2: Understand

1. What is your favorite childhood story? Why do you enjoy it?
2. Tell a story about a memorable experience from your life.
3. If you could tell a story to inspire others, what would it be about?
4. Rearrange the following sentences to form a coherent paragraph:
   A. The sun was setting over the ocean.
   B. The sound of the waves was soothing.
   C. We walked along the beach, enjoying the peaceful atmosphere.
   D. The smell of saltwater filled the air.
5. Put the following sentences in the correct order to tell a story:
   A. She packed her bags and said goodbye to her family.
   B. After a few months, she returned home with new experiences and stories.
   C. Emily had always wanted to travel abroad.
   D. She boarded a plane and took off for a new adventure.
6. Rearrange the following sentences to form a logical argument:
   A. Therefore, we should prioritize renewable energy sources.
   B. Fossil fuels are a finite resource and contribute to climate change.
   C. In conclusion, our reliance on fossil fuels is unsustainable.
   D. Renewable energy sources, on the other hand, are sustainable and environmentally friendly.

L3: Apply

1. What qualities do you think are essential for a good leader?
2. How would you motivate a team member who is struggling with their work?
3. Describe a time when you had to make a difficult decision as a leader.
4. The new policy aims to _____ the gap between the rich and the poor.
5. The company's _____ in the market has increased significantly over the past year.
6. The teacher asked the students to _____ their essays before submitting them.
7. The _____ of the new smart phone is its advanced camera system.
8. The company will _____ a new product line next quarter.

9. By the time I arrived, they _____ (eat) dinner.

L4: Analyzing

1. Complete the series: 2, 4, 8, and 16?
2. Find the next number: 1, 2, 4, 7, 11,?
3. Identify the pattern: 3, 6, 9, 12, ?
4. Complete the sequence: 5, 10, 15, 20, ?
5. Determine the next number: 2, 6, 12, 20, ?
6. Identify the pattern: B, D, F, H, ?
7. Complete the sequence: M, O, Q, S, ?
8. Determine the next letter: T, S, R, Q, ?
9. Complete the series: Monday, Tuesday, Wednesday, ?
10. Find the next word: January, February, March, ?
11. Determine the next word: Book, Magazine, Newspaper, ?
12. Find the odd one out: Apple, Banana, Carrot, Mango
13. Identify the odd one out: Football, Basketball, Tennis, Piano
14. Determine the odd one out: Car, Bus, Train, Book
15. Find the odd one out: Red, Blue, Green, Chair
16. Identify the odd one out: Dog, Cat, Elephant, House
17. What is the angle between the hour and minute hands of a clock at 3:15?
18. 1. What is the mirror image of the time 3:45?
19. 2. A person sees their mirror image and notices that their watch shows 9:30. What is the actual time?

L5: Evaluating

1. Five friends - A, B, C, D, and E - are sitting in a row. If A is at one end, B is next to A, and C is in the middle, who is sitting at the other end?
2. Seven people - A, B, C, D, E, F, and G - are sitting in a circle. If A is between B and C, and D is opposite A, who is sitting next to D?
3. If today is Monday, what day of the week will it be 30 days from now?
4. A meeting is scheduled for the 15th of March, which falls on a Wednesday. What day of the week will the 22nd of March be?
5. If you are facing north and turn 90 degrees to your right, which direction are you facing?
6. A person walks 5 km east and then 3 km west. How far is he from his starting point?
7. If you are facing south and walk 2 km, then turn left and walk 1 km, which direction are you facing?
8. A is the brother of B. C is the sister of A. How is B related to C?
9. A woman introduces a man as the son of her brother's father. How is the man related to the woman?
10. A man points to a woman and says, "She is the daughter of my mother's only child." How is the woman related to the man?

R24 MC03 **Environmental Science** **2 0 0 0**

(Common to all branches)

Course Objectives:

1. To make the students to get awareness on environment.
2. To understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life
3. To save earth from the inventions by the engineers.

SYLLABUS

UNIT I **6 Hours**

Multidisciplinary Nature of Environmental Studies: – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources : Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems , Energy resources:

Self-Learning Topics: Food resources, World Food Problems.

UNIT II **7 Hours**

Ecosystems: Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem. b. Aquatic ecosystem

Biodiversity and its Conservation : Introduction ,Definition, Values of biodiversity– India as a mega-diversity nation – Hot-sports of biodiversity – Threats to biodiversity, Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Self-Learning Topics: Desert Ecosystem, Bio-Geographical Classification of India.

UNIT III **6 Hours**

Environmental Pollution: Definition, Cause, effects and control measures of:

a. Air Pollution.
b. Water pollution
c. Soil pollution

Solid Waste Management: Causes**,** effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

Self-Learning Topics : Cause, effects and control measures of :Marine Pollution,Thermal Pollution.

UNIT IV **6 Hours**

Social Issues and the Environment: From Unsustainable to Sustainable development Water conservation, rain water harvesting, – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate Changes: global warming, acid rain, ozone layer depletion. Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Wildlife Protection Act – Forest Conservation Act .

Self-Learning Topics: Water Shed Management, Water (Prevention and control of Pollution) Act

UNIT V **7 Hours**

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programmes. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information

Technology in Environment and human health – Case studies.

Field Work: Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc.

Board of Studies : Basic Science and Humanities Chemistry
Approved in BOS No: 05th, August, 2024
Approved in ACM No: 01

Text Books:

1. Textbook of Environmental Studies for Undergraduate Courses Erach Bharucha for University Grants Commission, Universities Press.
2. Palaniswamy, "Environmental Studies", Pearson education
3. S.Azeem Unnisa, "Environmental Studies" Academic Publishing Company
4. K.Raghavan Nambiar, "Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus", Scitech Publications (India), Pvt. Ltd.

References:

1. Deeksha Dave and E.Sai Baba Reddy, "Textbook of Environmental Science", Cengage Publications.
2. M.Anji Reddy, "Text book of Environmental Sciences and Technology", BS Publication.
3. J.P.Sharma, Comprehensive Environmental studies, Laxmi publications.
4. J. Glynn Henry and Gary W. Heinke, "Environmental Sciences and Engineering", Prentice Hall of India Private limited
5. G.R.Chatwal, "A Text Book of Environmental Studies" Himalaya Publishing House
6. Gilbert M. Masters and Wendell P. Ela, "Introduction to Environmental Engineering and Science, Prentice Hall of India Private limited.

Sample Questions

Unit –I

1. Environmental Science is Multidisciplinary in nature .Justify?
2. Explain the difference between renewable and non-renewable resources.
3. Why forests are considered a critical natural resource?
4. Discuss the positive & negative impacts of Big Dams.
5. Explain the Scope and importance of Environmental Science.
6. Apply the idea of conservation to suggest ways a community can reduce its reliance on fossil fuels.

Unit-II

1. Explain how energy flows through an ecosystem.
2. Describe the role of producers, consumers, and decomposers in an ecosystem
3. Apply the concept of ecological succession to explain how a forest might develop after a wildfire.
4. Explain the Values of Bio-Diversity
5. Evaluate the effectiveness of protected areas in conserving biodiversity.

Unit-III

1. Explain how air pollution can impact human health.
2. Examine how deforestation contributes to both air and water pollution.
3. Explain how agricultural runoff contributes to water pollution.
4. Compare the effects of chemical pollutants versus biological pollutants on freshwater

ecosystems.

5. How can a municipality implement a successful recycling program to reduce the amount of waste sent to landfills?
6. What steps should a local government take to enhance resilience against floods in an urban area?

Unit-IV

1. Describe how sustainable development aims to balance economic growth, environmental protection, and social equity.
2. Explain how a rainwater harvesting system works from collection to storage.
3. How can a government design a resettlement program that minimizes disruption to affected communities?
4. What steps can individuals take to lower their personal contribution to global warming?
5. Discuss (i) Air (Prevention and Control of Pollution) Act (ii) Wildlife Protection Act

Unit-V

1. Explain how rapid population growth can impact natural resources.
2. Examine how population growth trends influence energy consumption and
3. Discuss possible solutions for sustainable energy use.
4. Evaluate the effectiveness of population control measures in addressing environmental issues in a specific country or region.
5. How can healthcare providers ensure that people at high risk for HIV are tested and receive appropriate prevention and care services?
6. Explain the concept of gender equality and its importance in women and child welfare.

7 Discuss the Role of information Technology in Environment and human health

Chairperson
Board of Studies (Chemistry)

R24BS09 COMPLEX VARIABLES AND STATISTICAL METHODS 3 0 0 3

(Common to MECH and EEE)

Course Objectives:

1. To familiarize the complex variables.
2. To familiarize the students with the foundations of probability and statistical methods.
3. To equip the students to solve application problems in their disciplines.

At the end of the course student will be able to:

Course Code	Course Outcomes	Mapping with POs			Dok
		PO1	PO2	PO12	
R24BS09.1	To obtain an analytic function for a given harmonic function using C-R equations.	2	2	1	L1, L2
R24BS09.2	Make use of the Cauchy residue theorem to evaluate certain integrals.	2	2	1	L1,L2
R24BS09.3	Apply the theoretical probability distributions like Binomial, Poisson, and normal in the relevant application areas.	2	2	1	L1,L2,L3
R24BS09.4	Analyze to test various hypotheses included in theory and types of errors for large samples.	2	2	1	L4
R24BS09.5	Apply the different testing tools like t-test, F-test, chi-square test to analyze the relevant real-life problems.	2	2	1	L4,L5

SYLLABUS

UNIT- I: Functions of a complex variable and Complex integration: 10 hours

Introduction – Continuity – Differentiability – Analyticity –Cauchy-Riemann equations in Cartesian and polar coordinates –Harmonic and conjugate harmonic functions – Milne –Thompson method. Complex integration: Line integral– Cauchy's integral theorem–Cauchy's integral formula.

COs-CO1

Self- learning Topics: Evaluating contour integrals, Integration along a smooth path

UNIT- II: Series expansions and Residue Theorem: 10 hours

Radius of convergence –Expansion in Taylor's series, Maclaurin's series and Laurent series. Types of Singularities: Isolated –Essential – Pole of order m –Residues–Residue theorem (without proof) and evaluation of real integrals of the form $\int_{-\infty}^{\infty} f(x)\,dx$, **COs-CO2**

Self- learning Topics: Approximating a function or data using a series of function is a fundamental tool for data analysis.

UNIT- III: Probability and Distributions: 10 hours

Review of probability and Baye's theorem – Random variables – Discrete and Continuous random variables – Distribution functions – Probability mass function, Probability Density function and Cumulative distribution functions – Mathematical Expectation and Variance –Binomial, Poisson,

Uniform and Normal distributions. **COs-CO3**

Self -learning Topics: To understand risk and return on investment.

UNIT-IV: **Sampling Theory:** **10 hours**

Introduction –Population and Samples–Sampling distribution of Means and Variance (definition only) – Central limit theorem (without proof) – Representation of the normal theory distributions– Introduction to t, χ^2 and F-distributions–Point and Interval estimations –Maximum error of estimate. **COs-CO4**

Self- learning Topics: Estimate health outcomes, behaviors and attitudes within a population.

UNIT- V: Tests of Hypothesis: **10 hours**

Introduction – Hypothesis – Null and Alternative Hypothesis – Type I and Type II errors –Level of significance – One tail and two-tail tests – Tests concerning one mean and two means (Large and Small samples)–Tests on proportions. **COs-CO5**

Self- learning Topics: Hypothesis Testing is employed to ensure product quality and process efficiency.

Textbooks:

1. **B.S.Grewal,** Higher Engineering Mathematics, Khanna Publishers, 44thEdition, 2017.
2. **Miller and Freund's,** Probability and Statistics for Engineers, Pearson, 7thedition, 2008.

Approved in BOS No: 01, 02 August, 2024 Mathematics

Approved in ACM No: 01

Internal Assessment Pattern

Cognitive Level	InternalAssessment#1(%)	InternalAssessment#2(%)
L1	30	10
L2	30	10
L3	40	30
L4	-	25
L5	-	25
Total(%)	**100**	**100**

Sample Questions based on cognitive levels

Unit 1

1) Show that $u(x,y)$ is harmonic in some domain and find a harmonic conjugate $v(x,y)$ When $u(x,y)=2x-x^3+3xy^2$. (L1)

2) Show that the function $f(z)=\sqrt{|xy|}$ is not analytic at the origin even though CR equations are satisfied. (L 1, L2)

3) 3) Find the analytic function $f(z)=u+iv$ if $u+v=\dfrac{2\sin 2x}{e^{2y}-e^{-2y}-2\cos 2x}$ (L 1)

4) If $f(z)=\begin{cases}\dfrac{x^3y(y-ix)}{x^6+y^2}, & z\neq 0\\ 0, & z=0\end{cases}$ prove that $\dfrac{f(z)-f(0)}{z}\to 0$ as $z\to 0$ along any radius vector but not as $z\to 0$ along the curve $y=ax^3$. (L1, L2)

Unit 2

Cauchy Integral formula

1) Use Cauchy's integral formula to calculate $\oint_C \dfrac{\sin\pi z+\cos\pi z}{(z-1)(z-2)}dz$ where C is $|z|=4$. (L 3)

2) Evaluate $\int_C \dfrac{\sin^2 z}{\left(z-\frac{\pi}{6}\right)^3}dz$ where C is the circle $|z|=1$. (L 5)

3) Use Cauchy Integral formula to evaluate

4) $\int_C \dfrac{\cos\pi z^2}{(z-1)(z-2)}dz$ Where C is the curve $|z|=3$. (L 3)

Laurent series expansion

1) 1)Expand $f(z)=\dfrac{1}{[(z-1)(z-2)]}$ in the region:

(i) $|z|<1$ (ii) $1<|z|<2$ (iii) $|z|>2$ (L2)

2) Evaluate $\oint_C \dfrac{z-3}{z^2+2z+5}dz$ where C is the circle

(i) $|z|=1$ (ii) $|z+1-i|=2$ (iii) $|z+1+i|=2$ (L2)

Unit 3

1) Define: (i) Binomial (ii) Poisson (iii) Uniform and (iv) Normal distributions. (L1)
2) State and prove Chebyshevs Inequality. (L3)
3) Fit the Poisson distribution for the following data (L3)

X	0	1	2	3	4	5
Y	147	147	74	25	6	1

Unit 4

1) Explain point and interval estimations. (L2)

2) Explain the types of errors in sampling. (L2)
3) A random sample of 125 teachers in a large metropolitan area revealed a mean weekly salary of Rs. 527 with a standard deviation Rs. 45. With what degree of confidence can we assert that the average weekly salary of all teachers in the metropolitan area is between 495 to 532? (L3)

Unit 5

1) Define: t, F and chai square test. (L1)

2) Write the test statistic for (L3)
   (i) The test of significance for single mean for the test of significance for single proportion and difference of means
3) Find the maximum difference that we can expect with probability 0.95 between the means of sample sizes 10 and 12 from normal population if their standard deviations are found to be 2 and 3 respectively. (L5)

Chairperson
Board of Studies (Mathematics)
Chairperson

R24EEPC08 Electric Power Generation, Transmission and Distribution 3 0 0 3

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Analyze different types of power generation methods, including thermal, hydroelectric, nuclear, solar, and wind
2. To Calculate Resistance, Inductance and Capacitance of Transmission Lines.
3. To Find the Regulation and Efficiency of the Transmission Lines
4. To find the Capacitance of Design of Transmission Lines.
5. To study DC and AC Distributions.

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO4	PO6	PSO1	PSO2	
R24EEPC08.1	Illustrate the working principles of various power generating stations.	3	2	1	1	3	2	1	L1, L2,
R24EEPC08.2	Interpret the parameters for various overhead conductor configurations.	-	3	1	2	-	2	2	L2, L3,
R24EEPC08.3	Analyze the performance of short, medium and long transmission line models.	-	3	2	1	1	2	1	L3, L4
R24EEPC08.4	Develop the mechanical design parameters of transmission line. Illustrate the construction and working of cables and insulators.	-	1	3	2	2	3	1	L4, L5
R24EEPC08.5	Compare the operation of AC and DC distribution systems.	-	1	1	2	-	2	1	L5, L6

SYLLABUS

UNIT-I: Power Generating Stations **12 Hours**

Hydel Power Stations- classification-construction and working of hydroelectric power station, thermal power Stations-single line diagram highlighting major components and working, nuclear power stations- nuclear fission and chain reaction-working of nuclear reactors-BWR, PWR

Self-Learning Topics: site selection criteria for power plants, environmental impacts of different power generation methods, safety measures and protocols in nuclear power stations. **CO's: CO1**

UNIT-II: Transmission Line parameters **14 Hours**

Transmission Line Parameters: Transmission line components, GMR and GMD, Numerical problems on resistance, inductance and capacitance for single phase and three phase single circuit symmetrical and asymmetrical configurations (no derivation). **CO's: CO2**

Self-Learning Topics: skin and proximity effects, corona discharge phenomena.

UNIT-III: Transmission Line Performance **14 Hours**

Performance of Short, Medium and Long Transmission Lines: Model description with phasor diagram for Short, Nominal-T, Nominal-π and long transmission lines respectively. ABCD parameter interpretation and calculation of transmission efficiency and voltage regulation, Corona loss and its effects, Ferranti, Skin and Proximity effects, surge impedance loading. **CO's: CO3**

Self-Learning Topics: tuned power lines, constant voltage transmission**.**

UNIT – IV: Underground cables and Mechanical Design of Overhead Lines **14 Hours**

Underground Cables: Construction, Types of Cables, Types of Insulating materials, Calculation of Insulation resistance and stress in insulation, Capacitance of single and 3-core belted cables, Grading of cables -capacitance grading and Inter-sheath grading. Insulators-types-calculation of string efficiency Sag and Tension calculations with equal & unequal heights of towers- effect of wind & ice loading, Grading of Insulators. **CO's: CO4**

Self-Learning Topics: electrical and mechanical fault detection in underground cables.

UNIT–V: DC & AC Distribution Systems **12 Hours**

Distribution System-Components, connection schemes, classification and comparison; Voltage Drop Calculations in DC Distributors for the following cases: Radial DC Distributor fed one end and at both the ends (equal/unequal Voltages) and Ring Main Distributor. Voltage Drop Calculations in AC Distribution System- Distributors for the following cases: Power Factors referred to receiving end voltage and with respect to respective load voltages. **CO's: CO5**

Self-Learning Topics: optimization of voltage profiles using reactive power compensation

Board of Studies:	Electrical & Electronics Engineering
Approved in BOS No:	02, 21st, May 2025
Approved in ACM No:	02

Text books:

1. C.L. Wadhawa, "Generation, Distribution and Utilization of Electric Energy", New Age International (P) Limited, 4th Edition, 2017.
2. C.L. Wadhawa, "Electric Power Systems", New Age International (P) Limited, 7th Edition, 2017.
3. TuranGonen, Electric Power Distribution system, Engineering, McGraw-hill Book Company, 4th edition,2016.

Reference Books:

1. A Chakrabarti, ML Soni, PV Gupta, US Bhatnagar, "A text book on Power System Engineering," Dhanpat Rai & Co., 2008.
2. Hadi Saadat, Power System Analysis, TMH, 3rd edition, 2010.
3. VK Mehta and R Mehta, "Principles of power system," S. Chand, New Delhi, 4th edition, 2005.
4. S.N.Singh, "Electric Power Generation, Transmission and Distribution", PHI, 2nd edition, 2008.

Web Resources:

1. . https://nptel.ac.in/courses/108102047

Internal Assessment Pattern:

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2 (%)
L1	30	---
L2	40	---
L3	30	---
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Illustrate the single line diagram of a power system
2. Define GMD
3. List any two effects of corona
4. Define Skin effect in the long transmission

L2: Understand

1. Classify hydroelectric power plants based on water flow, head, power generated and load
2. Explain any four differences between short and medium transmission line models
3. Outline the construction of an underground cable
4. Summarize any four benefits of bundle Conductors over single conductor.

L3: Apply

1. Develop the model of a Nominal-T transmission line to transfer a power of 100MW for a distance of 80km. Assume any other parameters required.
2. A certain amount of power has to be transmitted from the generating station to a load centre passing through a densely populated urban area extending a distance of 50km. The site engineer has the choice of selecting overhead or underground cables for transmission. Help the engineer choose the type of transmission based on economy, safety and technical superiority.
3. 1000 MW of power has to be transmitted for a distance of 500km over a 400kV double circuit long transmission line. Select a suitable spacing pattern between conductors and calculate the inductance. Justify your selection.
4. Suppose you are a maintenance engineer working at load end and observe the distribution side parameters. At some instant, you observe abnormalities due to light load condition. To solve that issue you have checked with the state load dispatch centre, and figured out that

the voltage at the generating station is less as compared to the voltage at your end. Make use of this information and identify the possible impacts at your end with the help of a suitable phasor diagram. Suggest remedies to overcome this situation and obtain a voltage balance in a system.

L4: Analyzing

1. Compare the AC and DC distribution systems for distribution of power in an urban area.
2. A certain amount of power has to be transmitted over a distance of 100km at 66kV. Develop and compare the T and Pi models and suggest which is more preferable for transmitting the power keeping in view the complexity of solving the network for parameter analysis.
3. Compare the different compounding methods and suggest which is the best method for super thermal power plants employing two stage steam turbines.
4. A cyclone named Titili with wind gusts around 170 km/hr hit the north costal region of Andhra Pradesh. Your locality was within five kilo meters from the epicentre of the cyclone. As a result, transmission lines and towers got damaged. The load end requires 100MVA load at power factor of 0.8 lagging for daily smooth operation. As an electrical engineer, design the conductor configuration based on the following:
    - choice of voltage level
    - choice of conductors
    - Type of circuits
    - spacing of the conductor

L5: Evaluating

1. A 3 phase 100km line has the following constants. Resistance/phase /km =0.153ohm, inductance/phase /km=1.21mH, Capacitance/phase /km= 0.00958μF. If the line supplies a load of 20MW at 0.9 pf lagging at 110kV at the receiving end calculate sending end current, sending end power factor, and regulation and transmission efficiency using nominal T method.
2. A three- phase overhead line has resistance and reactance per phase as 5 ohm and 20ohm respectively. The load at the receiving end is 25MW, 33kV at 0.8pf lagging. By drawing receiving end power circle find the voltage at the sending end.
3. What are the various properties of insulators? Also briefly explain about suspension type and pin type insulators. Draw the schematic diagram.
4. Derive the expression for touch potential and step potential.
5. A 3 phase 4 wire distributor supplies a balanced voltage of 400/230 V to a load consisting of 100A at 0.84 power factor lagging and 60A at unity power factor on phases R, Y, B respectively. The resistance of each core is 0.3Ω. Determine the voltage at the supply end of R-phase relative to the load voltage.

L6: Create

1. Design a radial DC distribution system for a residential area, ensuring voltage drops remain within permissible limits. Specify the conductor sizes, load distribution, and calculate voltage drops at various points.
2. Develop a ring main AC distribution network for an industrial complex with multiple load centers. Incorporate provisions for load balancing and fault tolerance. Provide detailed calculations for voltage drops and power factors.
3. Formulate a method to calculate voltage drops in an AC distributor with loads at different power factors referred to their respective load voltages. Apply this method to a hypothetical distribution system and present your findings.

Chairperson
Board of Studies (EEE)

R24EEPC09 **Induction and Synchronous Machines** **3 0 0 3**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Ability to understand the principle of operation and performance of three-phase induction motor.
2. To provide knowledge on torque vs slip characteristics, Phasor Diagrams and Equivalent Circuits for induction motor and synchronous machines.
3. To discuss the concept of double revolving field theory and torque producing mechanism for single phase induction motor.
4. To discuss the principle of operation, voltage regulation of synchronous Generators.
5. To analyze the construction and performance of synchronous machines and its applications.

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	
R24EEPC09.1	Describe the construction and operation of three-phase induction motor.	3	1	-	2	1	2	2	L1, L2,
R24EEPC09.2	Identify the speed control, testing and performance characteristics of three phase induction motor	-	2	-	2	1	2	2	L2, L3,
R24EEPC09.3	Describe the principle of operation of single-phase induction motors.	3	1	-	2	-	2	3	L3, L4
R24EEPC09.4	Test for Performance and synchronization of synchronous generator	-	3	3	1	2	3	2	L4, L5
R24EEPC09.5	Analyze the performance characteristics of synchronous motor	-	3	2	2	1	2	2	L5, L6

SYLLABUS

UNIT-I: Introduction to 3-Phase Induction Motors **12 Hours**

Introduction, Construction- Stator, Types of rotors, Comparison of rotors, production of rotating magnetic field, principle of operation, Synchronous Speed, Slip, Effect of slip on rotor parameters - rotor emf , rotor frequency, rotor current and power factor at standstill and during running conditions, equivalent circuit , phasor diagram, Losses in an induction motor, Power flow diagram,

Synchronous watt, Relation between rotor input, rotor copper losses and mechanical power developed, Efficiency, Applications. **CO's: CO1**

Self-Learning Topics: design considerations for high-efficiency motors

UNIT-II: Performance of 3-Phase Induction Motors **12 Hours**

Characteristics of **3-phase induction motors:** Torque equation, expressions for maximum torque and starting torque, torque-slip and torque-speed Characteristics, Effect of rotor resistance on T-S Curve.

Testing and starting methods of induction motors: No load & blocked rotor tests, circle diagram –Theory, construction, computation of performance. Starters for induction motors, speed control of induction motor– from stator side, from rotor side, crawling and cogging- Induction Generator.

CO's: CO2

Self-Learning Topics: impact of harmonics and power quality issues on motor performance.

UNIT – III: Single- Phase Motors **12 Hours**

Single phase induction motors: construction, double revolving field theory, Cross field theory , Types of Single phase induction motors : Resistance split phase, capacitor start, capacitor start capacitor run, comparison of Single phase induction motors, Applications.

Single phase Commutator motors: Principle of operation of A.C Series motor, Universal motor, BLDC motor. **CO's: CO3**

Self-Learning Topics: integration of variable frequency drives (VFDs) for speed control

UNIT–IV: Three – Phase Alternators **12 Hours**

Construction, Types of rotors, armature windings, Winding Coefficients, E.M.F equation, Equivalent circuit and phasor diagram, armature reaction and its effects, O.C and S.C tests, voltage regulation by synchronous impedance method, MMF method and Potier triangle method ,two reaction analysis of salient pole machines, Slip test, Applications.

Parallel operation of Alternators: Necessity, Conditions, synchronization methods - two bright and one dark lamp, synchroscope method, parallel operation-with single alternator and infinite bus.

CO's: CO4

Self-Learning Topics: Constructing and interpreting equivalent circuits and phasor diagrams

UNIT–V: Synchronous Motor **12 Hours**

Construction, Magnetic locking, theory of operation, characteristic features of synchronous motor, Behaviour of synchronous motor on loading, Phasor diagram, Effect of varying field current at different loads ,Power transfer stages, Power equations, Solved problems. V and inverted V curves, synchronous condenser, Power factor improvement, solved problems, hunting and its suppression, Applications. **CO's: CO5**

Self-Learning Topics: understanding the construction and magnetic locking principle of synchronous motors

Board of Studies:	Electrical & Electronics Engineering
Approved in BOS No:	02, 21st, May 2025
Approved in ACM No:	02

Text books:

1. Electrical Machinery, Dr. P.S. Bhimbra, Khanna Publishing, New Delhi, Fully Revised Edition, 2021.
2. Electrical Machines by D. P.Kothari, I .J .Nagarth, McGraw Hill Publications, 5th edition, 2017.

Reference Books:

1. Theory & Performance of Electrical Machines by J.B.Gupta, S.K.Kataria & Sons,2013.
2. Electric Machinery, A.E.Fitzgerald, Charles kingsley, Stephen D.Umans, McGraw-Hill, 2020, Seventh edition.
3. Performance and analysis of AC machines by M.G. Say, CBS, 2002.

Web Resources:

1. nptel.ac.in/courses/108/105/108105131
2. https://nptel.ac.in/courses/108106072

Internal Assessment Pattern:

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	---
L4	---	40
L5	---	30
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define the term ‘slip’ in the context of a three-phase induction motor.
2. What is the basic torque equation for a three-phase induction motor?
3. Define armature windings in the context of a synchronous generator.
4. Define the term ‘synchronization’ in the context of synchronous generators.

L2: Understand

1. Describe the effect of rotor EMF at standstill and during running conditions.
2. Explain how the torque-slip curve of a three-phase induction motor varies with rotor speed.
3. Explain how the double revolving field theory helps to understand the operation of a single-phase induction motor.
4. Explain why it is necessary to synchronize a synchronous generator before paralleling it with another generator or an infinite bus.
5. Describe the working principle of a synchronous condenser and its application in improving power factor.

L3: Apply

1. If a motor's stator resistance and rotor resistance are known, calculate the rotor power input using the equivalent circuit model.
2. Given the parameters of a single-phase induction motor, calculate the starting current using the equivalent circuit
3. Draw a phasor diagram for a synchronous generator and explain how it changes with load variations.
4. Demonstrate how to apply the synchronization process for paralleling a synchronous generator to a running infinite bus, considering voltage and phase angle matching.
5. Using the power equation for a synchronous motor, calculate the mechanical power developed by the motor under given conditions.

L4: Analyzing

1. Analyze how the rotor current and power factor change as the motor approaches synchronous speed.
2. Analyze the effect of changing the value of the capacitor on the starting torque of a capacitor-start single-phase induction motor.
3. Given a salient pole synchronous generator, analyze how the two-reaction theory influences the machine's behavior under various load conditions.
4. Design a synchronization system that uses both the synchroscope and the two bright and one dark lamp methods to ensure the safe connection of multiple synchronous generators to an infinite bus.
5. Analyze how different starting methods (e.g., DOL, autotransformer, and damper winding) affect the performance and current drawn during the startup of a synchronous motor.

L5: Evaluating

1. Evaluate the impact of rotor frequency on the overall efficiency of a three-phase induction motor at various operating conditions.
2. Evaluate the effect of using a soft starter versus direct-on-line (DOL) starting for a three-phase induction motor in a high-torque application
3. Evaluate the suitability of a single-phase induction motor for a specific application, considering its speed control, efficiency, and torque characteristics
4. Assess the efficiency of a three-phase alternator when loaded with a three-phase induction motor, considering the impact of power losses and load conditions.
5. Critically assess the performance of a synchronous motor under different excitation conditions (over-excitation, under-excitation, and normal excitation) with respect to power

factor and efficiency

L6: Create

1. Propose a method to start a large synchronous motor that is not inherently self-starting, ensuring minimal impact on the power system.
2. Design a power factor correction scheme using synchronous condensers for a manufacturing facility experiencing low power factor issues.
3. Develop an innovative starting mechanism for a large synchronous motor that minimizes inrush current and mechanical stress during startup.

Chairperson
Board of Studies (EEE)

R24EEPC10 **CONTROL SYSTEMS** **3 0 0 3**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To describe the feedback controls with basic components of control systems.
2. To formulate mathematical models of physical systems and block diagram representation..
3. To analyze stability of the system from transfer function approach.
4. To describe and analyze various time domain and frequency domain tools for analysis and design of linear control system
5. To obtain the mathematical models of physical systems using state space approach and determine the response.

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	
R24EEPC10.1	Able to understand basic components of feedback control systems; formulate mathematical models of physical systems and represent them in block diagrams and signal flow graphs.	3	3	2	3	2	2	1	L1, L2
R24EEPC10.2	Able to understand the time- domain specifications; Analyze first and second order control systems in time domain	3	3	3	1	2	2	3	L2, L3,
R24EEPC10.3	Able to understand the concepts of stability; Analyze stability of the system from transfer functions approach and graphical methods.	3	1	3	1	2	1	3	L3, L4
R24EEPC10.4	Able to understand frequency response analysis and understand compensation techniques	3	1	3	1	2	1	2	L4, L5
R24EEPC10.5	Able to Represent physical systems in state space form and analyze them,	-	3	3	1	1	-	3	L5, L6

SYLLABUS

UNIT I: Mathematical Modelling of Electrical and Mechanical Systems **14 Hours**

Classification of control systems - open loop and closed loop control systems and their differences - Feedback characteristics - transfer function of linear system, Transfer function of Field and armature control DC Motor, translational and rotational mechanical systems- Force-Voltage- Force-Current Analogies- block diagram reduction techniques – representation by signal flow graph –

reduction using Mason's gain formula. **CO's: CO1**

Self-Learning Topics: deriving and analyzing transfer functions for linear systems

UNIT II: Transfer Function of Elements of Control Systems 14 Hours

Transfer Function of DC Servo motor - AC Servo motor- Synchro transmitter and Receiver.

Time Response Analysis: Standard test signals, Time response of first and second order systems, time domain specifications, characteristic Equation, Static error constants, Effects of P, PI, PD and PID controllers. **CO's: CO2**

Self-Learning Topics: deriving transfer functions for DC and AC servo motors, understanding the operation of synchro transmitters and receivers.

UNIT III: Stability and Root-Locus Techniques 14 Hours

Concept of stability: The concept of stability – Routh's stability criterion – qualitative stability and conditional stability

Root Locus Technique: The root locus concept - construction of root loci-effects of adding poles and zeros to G(s)H(s) on the root loci. **CO's: CO3**

Self-Learning Topics: Applying Routh's stability criterion to assess system stability.

UNIT IV: Frequency Response Analysis 14 Hours

Introduction, Frequency domain specifications-Bode plots, Determination of Frequency domain specifications and transfer function from the Bode plot, Phase margin and Gain margin-Stability Analysis from Bode Plots. Polar Plots-Nyquist Plots, Stability Analysis. Concept of Compensation techniques **CO's: CO4**

Self-Learning Topics: constructing and interpreting Bode plots

UNIT V: State Space Analysis of LTI Systems 12 Hours

State Space Analysis of Continuous Systems: Concepts of state, state variables and state model, derivation of state models from transfer function and vice versa - State Transition Matrix, properties of state transition matrix, Eigen Values and Eigen Vectors, controllability, observability. Stability Analysis of Linear Systems . **CO's: CO5**

Self-Learning Topics: understanding the concepts of state, state variables, and state models.

Board of Studies: Electrical & Electronics Engineering
Approved in BOS No: 02, 21st, May 2025
Approved in ACM No: 02

Text books:

1. Modern Control Engineering by Kotsuhiko Ogata, Prentice Hall of India, 5th edition, 2015.
2. Automatic control systems by Benjamin C.Kuo, Prentice Hall of India, 9th Edition, 2014.

Reference Books:

1. Control Systems principles and design by M.Gopal, Tata Mc Graw Hill education Pvt Ltd., 4th Edition.
2. Control Systems Engineering by I.J.Nagarath and M.Gopal, Newage International Publications, 5th Edition.

Web Resources:

1. https://archive.nptel.ac.in/courses/107/106/107106081/
2. https://archive.nptel.ac.in/courses/108/106/108106098/
3. https://nptelvideos.com/video.php?id=1423&c=14

Internal Assessment Pattern:

Cognitive Level	Internal Assessment # 1 (%)	Internal Assessment # 2 (%)
L1	30	---
L2	40	---
L3	30	---
L4	---	50
L5	---	30
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define closed loop control system
2. What are the components of feedback control system?
3. What is an order of a system
4. Define Delay time
5. Define Gain and Phase margin
6. What is the use of lag compensator?
7. What are the main significances of root locus?

L2: Understand

1. Write Masons Gain formula
2. What are the properties of signal flow graphs?
3. Write the force balance equation of ideal dashpot element.
4. How do you find the type of a system?
5. What is the effect of PI controller on the system performance
6. What are the frequency domain specifications?
7. How will you find root locus on real axis?
8. How the roots of characteristic equation are related to stability?

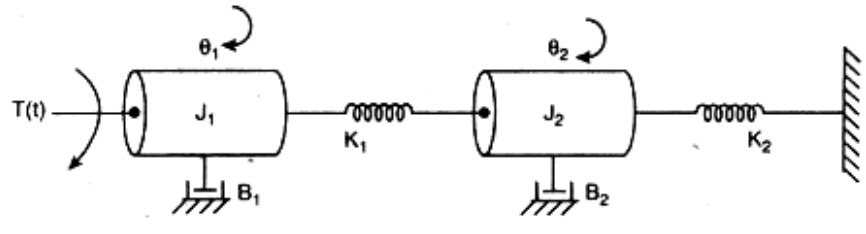
L3: Apply

1. Give some examples of control system

2. What are the two situations in which compensation is required?
3. Define Stability. With an example explain the steps to be followed for Routh - Hurwitz criterion.
4. What are the uses of sampled-data control systems?
5. Give the concept of controllability.

L4: Analyzing

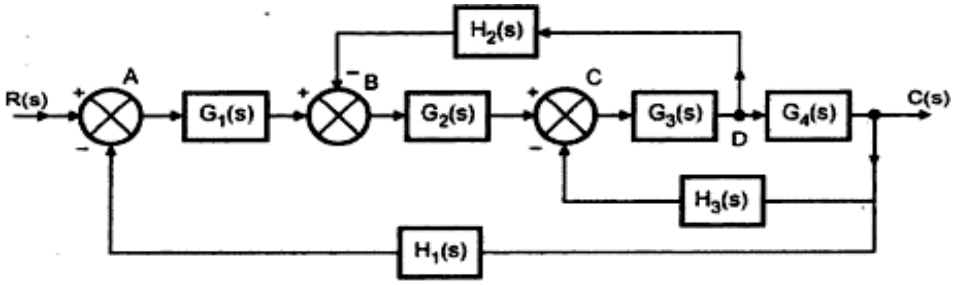
1. Give the comparison between open loop and closed loop system
2. Write the differential equation governing the mechanical rotational system shown in fig below .Draw the Electrical equivalent analogy circuits and derive its transfer function

3. 

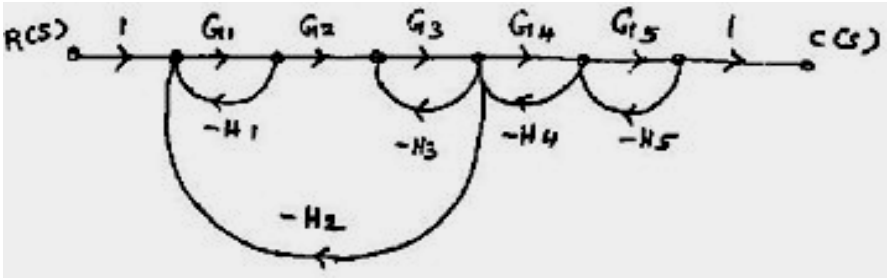
4. Derive the time domain specification of a second order
5. Analyze on Lead, Lag and Lag-Lead compensators with a neat diagram also explain their importance.
6. Draw the State model of a linear single input Single output and obtain its corresponding Equations.

L5: Evaluating

1. Reduce the block diagram shown in figure below and determine the transfer function



2. Obtain the closed loop transfer function of the systems , by using Mason's gain formula.



3. A unity feedback control system is characterized by the following open loop transfer function $G(S) = k / s(s+10)$. Determine the gain K so that the system

will have a damping ration of 0.5 for this value of K. Determine settling time ,peak overshoot and peak time for a unit step input.

4. A discrete time system is described by the difference equation y(k+2)+5y(k+1)+6yk=u(k). Y(0)=y(1)=0. and T=1 sec. determine (i) state model in canonical form. (ii) State transition matrix.

L6: Create

1. Design a state feedback controller that places the closed-loop poles of the given system at desired locations to achieve specified performance criteria.

2. Design a control system for a real-world application (e.g. temperature control in a room) using state-space analysis technique.

3. Develop a state observer for a system where not all states are measurable, ensuring accurate estimation of the unmeasured states.

Chairperson
Board of Studies (EEE)

R24ES10 ANALOG ELECTRONIC CIRCUITS DESIGN 3 0 0 3

(Common to ECE & EEE)

Course Objectives:

- Understand the characteristics of multi stage, differential amplifiers, feedback, power and tuned amplifiers.
- Analyze the performance parameters of various amplifier circuits.
- Analyze different oscillator circuits based on the frequency of operation.
- Study and analyze the various pulse electronic circuits.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes (COs)	Mapping with POs								Do K
		PO1	PO2	PO3	PO4	PO5	PO11	PSO1	PSO2	
R24ES10.1	Understand the characteristics of differential amplifiers, feedback and power amplifiers.	3	3	1	2	-	-	2	1	L1, L2
R24ES10.2	Examine the frequency response of multistage and differential amplifier circuits using BJT & FETs at low and high frequencies.	3	3	1	2	-	-	2	2	L2, L3
R24ES10.3	Investigate different feedback and power amplifier circuits based on the application.	3	3	1	2	-	-	2	2	L3, L4
R24ES10.4	Derive the expressions for frequency of oscillation and condition for oscillation of RC and LC oscillator circuit.	3	2	-	2	1	-	2	2	L4, L5
R24ES10.5	Analyze and design tuned amplifiers, including small signal and large signal amplifiers.	3	3	1	2	-	-	2	-	L3, L6

SYLLABUS

UNIT-I: 16 Hours

Multistage Amplifiers: Classification of amplifiers, distortion in amplifiers, frequency response of an amplifier, step response of an amplifier, methods of coupling, band pass of cascaded stages, Miller's theorem, analysis of n-stages cascaded transistor amplifier, two stage RC coupled amplifier using BJT & FET analysis, Darlington pair amplifier, Boot-strap emitter follower, Cascode amplifier, differential amplifier, Multi stage Amplifiers Using FET, Illustrative Problems.

COs – CO1

Self Learning Topics:

1. Input and Output Impedance: Understanding how multistage amplifiers impact input and output impedance, and how to match impedances for optimal performance.

2. Frequency Response: Studying the frequency response of multistage amplifiers, including the effects of coupling capacitors and bypass capacitors.

UNIT -II **12 Hours**

Feedback Amplifiers:: Classification of basic amplifiers, Feedback concept, types of feedback, feedback topologies, characteristics of negative feedback amplifiers, Effect of Negative feedback upon output and input resistance, generalized analysis of feedback amplifiers, performance comparison of feedback amplifiers, method of analysis of feedback amplifiers. Illustrative Problems. **COs–CO2**

Self Learning Topics:

1. Gain and Bandwidth: Analyzing how feedback affects gain and bandwidth, including the trade-offs between the two.
2. Stability and Oscillation: Understanding how feedback can lead to instability and oscillation, and how to prevent these issues.

UNIT-III **14 Hours**

Oscillators: Oscillator principle, condition for oscillations, types of oscillators, RC-phase shift and Wein bridge oscillators using BJT and FET, generalized analysis of LC oscillators using BJT, Hartley and Colpitt's oscillators using BJT and FET, crystal oscillator, frequency stability of oscillators, Illustrative Problems. **COs–CO3**

Self Learning Topics:

1. Oscillator Circuit Design: Learning how to design oscillator circuits, including selecting components and calculating values.
2. Frequency Stability: Understanding the factors that affect frequency stability, and how to improve it.

UNIT-IV **14 Hours**

Power Amplifiers: Classification of amplifiers, Class A power Amplifiers (Series fed and transformer coupled), harmonic distortions, Class B amplifier, Push-pull amplifier, Complementary symmetry push pull amplifier, Class AB amplifier, Class-C amplifier, thermal stability and heat sink, distortion in power amplifiers. **COs–CO4**

Self Learning Topics:

1. Power Amplifier Efficiency: Understanding the factors that affect power amplifier efficiency, and how to improve it.
2. Distortion and Linearity: Studying the causes of distortion in power amplifiers, and how to minimize it.

UNIT-V **14 Hours**

Tuned Amplifiers: Introduction, Q-Factor, small signal tuned amplifiers, effect of cascading single tuned and doubled tuned amplifiers on band width, stagger tuned amplifiers, comparison of tuned amplifiers, large signal tuned amplifiers, stability of tuned amplifiers. **COs–CO5**

Self Learning Topics:

1. Noise and Interference: Understanding how to minimize noise and interference in tuned amplifiers, including techniques like noise matching and shielding.
2. Modern Tuned Amplifier Designs: Studying modern designs and techniques for tuned amplifiers, including the use of active devices and feedback.

Board of Studies: Electronics and Communication Engineering
Approved in BOS No: 02,30th May, 2025

Approved in ACM No: 02

Text Books:

1. Electronic Devices and Circuits - J.Millman, C.C. Halkias & S.Jit, TMH, 4thEdition, 2015.
2. Pulse and Digital Circuits- A.Anand Kumar, PHI Learning Private Limited, 2012.

References:

1. Integrated Electronics- Jacob Millman, C. Halkies&C.D.Parikh, TMH, 2nd Edition, 2010.
2. Electronic Devices and Circuits- S.Salivahanan & N.Suressh Kumar,TMH,3rd Edition,
3. 2012.
4. Electronic Devices and Circuits – A.K.Maini & V.Agarawal, Wiley India Pvt.Ltd., First Edition, 2009.

Internal Assessment Pattern

Cognitive Level	Internal Assessment # 1 (%)	Internal Assessment # 2 (%)
L1	30	--
L2	40	--
L3	30	30
L4	--	40
L5	--	30
Total (%)	100	100

Questions on Various Cognitive Levels

L1: Remember

1. What is a multistage amplifier, and why is it used?
2. What are the benefits and drawbacks of using feedback in amplifiers?
3. What are the conditions required for sustained oscillation in an oscillator?
4. Do power amplifiers differ from voltage amplifiers?
5. What are the different classes of power amplifiers (e.g., Class A, Class B, Class AB)?
6. What is the purpose of tuning in amplifiers, and how is it achieved?
7. What are the applications of tuned amplifiers in electronic systems?

L2: Understand

1. How do you calculate the overall gain of a multistage amplifier?
2. What is the effect of cascading multiple amplifier stages on the bandwidth and gain of the overall amplifier?
3. What is the difference between voltage feedback and current feedback in amplifiers?
4. How do you design a feedback amplifier to achieve a specific gain and stability?
5. How do you design an oscillator to produce a specific frequency and amplitude?
6. What are the factors that affect the stability and accuracy of an oscillator?
7. How do you calculate the efficiency of a power amplifier?
8. What are the differences between Class A, Class B, and Class AB power amplifiers?
9. What is the effect of Q-factor on the selectivity and bandwidth of a tuned amplifier?
10. How do you use tuned amplifiers in radio frequency (RF) applications?

L3: Apply

1. How do you analyze the noise performance of a multistage amplifier, and what are the techniques to minimize noise?

2. How do you design a multistage amplifier for high-frequency applications, considering factors like parasitic capacitances and inductances?
3. Apply the stability of a feedback amplifier using techniques like Nyquist plots and Bode plots?
4. Apply the feedback concepts and design a feedback amplifier with a specific gain-bandwidth product and stability margin?
5. Describe the design procedure of phase-locked loop (PLL) oscillator, and what are its applications?
6. What are the effects of phase noise and jitter on oscillator performance, and how can they be minimized?
7. Write the principle of oscillator design an oscillator for high-frequency applications, such as microwave or millimeter-wave frequencies?
8. What are the effects of thermal management and heat sinking on power amplifier performance and reliability?
9. Explain the concepts of power amplifiers and apply these concepts for linearity and low distortion, using techniques like linearization and predistortion?
10. How do you use tuned amplifiers in applications like radio frequency identification (RFID) or wireless communication systems?

L4: Analysing

1. How can you optimize the noise figure and gain of a multistage amplifier using advanced techniques like noise matching and gain shaping?
2. Analyse the multistage amplifiers and design for high-speed applications, such as fiber-optic communication systems or high-speed data acquisition?
3. Analyze the stability and robustness of a feedback amplifier using advanced techniques like μ-analysis or singular value decomposition?
4. How do you design a feedback amplifier with optimal performance and robustness using advanced control theory techniques?
5. How do you design an ultra-low-phase-noise oscillator using advanced techniques like crystal oscillators or optoelectronic oscillators?
6. Explain the design Procedure of an oscillator for extreme environments, such as high-temperature or high-radiation applications?
7. How do you design a high-power amplifier for applications like radar or microwave heating, considering factors like thermal management and electrical breakdown?
8. What are the effects of load mismatch and VSWR on power amplifier performance, and how can they be mitigated?
9. Analyse design a tunable filter or amplifier using advanced techniques like varactor diodes or MEMS devices?
10. What are the effects of component aging and drift on tuned amplifier performance, and how can they be compensated?

L5 Evaluating:

1. What are the fundamental limits on the noise figure and gain of multistage amplifiers, and how can they be approached?
2. What are the implications of emerging technologies like graphene or nanotubes on the design and performance of multistage amplifiers?

3. Evaluate and analyze the stability and performance of feedback amplifiers with nonlinear and time-varying components using advanced mathematical tools like Lyapunov theory?
4. What is the trade-offs between feedback and feed forward control in amplifiers, and how can they be optimized?
5. What are the fundamental limits on the phase noise and stability of oscillators, and how can they be approached?
6. How can you design an oscillator with optimal performance and minimal power consumption using advanced techniques like injection locking or frequency division?
7. What is the trade-offs between different power amplifier architectures, such as Doherty or Chireix, and how can they be optimized?
8. Evaluate power amplifier for emerging applications like 5G or IoT, requiring high efficiency and linearity?
9. What are the implications of emerging technologies like met materials or graphene on the design and performance of tuned amplifiers?
10. Evaluate and design a tuned amplifier for applications like spectrum sensing or cognitive radio, requiring high selectivity and adaptability?

Chairperson
Board of Studies (ECE)

R24ES13 **Design Thinking & Innovation** **0 1 2 2**

(Common to All Branches)

Course Objectives:

1. The objective of this course is to familiarize students with design thinking process as a tool for breakthrough innovation.
2. It aims to equip students with design thinking skills and ignite the minds to create innovative ideas, develop solutions for real-time problems.

Course Code	Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO9	PO10	PO11	PSO1	PSO2	DOK
R24ES13.1	Define the concepts related to design thinking. Explain the fundamentals of Design Thinking and innovation	3	3	2	2	2	-	1	2	2	2	L1, L2
R24ES13.2	Apply the design thinking techniques for solving problems in various sectors.	3	3	3	2	3	-	1	2	3	3	L3
R24ES13.3	Analyse to work in a multidisciplinary environment	3	3	3	2	3	-	-	2	3	3	L4
R24ES13.4	Evaluate the value of creativity	3	2	3	2	3	1	1	3	3	3	L5
R24ES13.5	Formulate specific problem statements of real time issues	3	2	3	2	3	1	1	3	3	3	L3, L6

SYLLABUS

UNIT-I **10 Hours**

Introduction to Design Thinking: Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry. **CO's: CO1**

UNIT-II **10 Hours**

Design Thinking Process: Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development

Activity: Every student presents their idea in three minutes, every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development. **CO's: CO2**

UNIT-III **10 Hours**

Innovation: Art of innovation, Difference between innovation and creativity, role of creativity and

innovation in organizations- Creativity to Innovation- Teams for innovation- Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation. **CO's: CO3**

UNIT IV **10 Hours**

Product Design: Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications- Innovation towards product design- Case studies.

Activity: Importance of modeling, how to set specifications, Explaining their own product design.

CO's: CO4

UNIT V **10 Hours**

Design Thinking in Business Processes: Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs- Design thinking for Startups- Defining and testing Business Models and Business Cases- Developing & testing prototypes.

Activity: How to market our own product, about maintenance, Reliability and plan for startup.

CO's: CO5

Board of Studies: Mechanical Engineering

Approved in BOS No: 02,13th May, 2025

Approved in ACM No: 02

Text Books:

1. Tim Brown,Change by design, Harper Bollins (2009)
2. Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons..

Reference Books:

1. David Lee, Design Thinking in the Classroom, Ulysses press
2. Shrutin N Shetty, Design the Future, Norton Press
3. William Lidwell, Universal Principles of Design- Kritinaholden, Jill Butter.
4. Chesbrough. H, The Era of Open Innovation – 2013

Online Learning Resources:

- https://nptel.ac.in/courses/110/106/110106124/
- https://nptel.ac.in/courses/109/104/109104109/
- https://swayam.gov.in/nd1_noc19_mg60/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)

L1	10	--
L2	30	--
L3	30	20
L4	30	30
L5	--	30
L6	--	20
Total (%)	**100**	**100**

Chairperson
Board of Studies (ME)

R24EEPC11 **Control Systems Lab** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To impart hands on experience to understand the performance of basic control system components such as magnetic amplifiers, D.C. servo motors, A.C. Servo motors and Synchros.
2. To understand time and frequency responses of control system with and without controllers and compensators.
3. To know the different logic gates and Boolean expressions using PLC

Course Code	Course Outcomes	Mapping with POs and PSOs								DoK
		PO1	PO2	PO3	PO5	PO6	PO9	PO11	PSO1	PSO2	
R24EEPC11.1	Analyze the time response of system (first order and second order system).	-	3	2	2	1	1	1	3	1	L1 L2
R24EEPC11.2	Analyze PID controllers and compensators	-	3	2	3	1	2	2	3	1	L1 L2
R24EEPC11.3	Determine the transfer function of D.C Motor	-	2	3	2	1	1	1	3	1	L2 L3

Board of Studies : Electrical & Electronics Engineering

Approved in BOS No : 02, 21st, May 2025

Approved in ACM No: 02

List of Experiments

(Any 10 of the following experiments are to be conducted)

1. Analysis of First order system in time domain (For Step, Ramp Inputs) COs: CO1
2. Analysis of Second order system in time domain (For Step, Ramp Inputs) COs: CO1
3. Effect of P, PD, PI, PID Controller on a second order systems COs: CO1
4. Lag Compensation - Magnitude and phase plot. COs: CO1
5. Lead Compensation - Magnitude and phase plot COs: CO2
6. Transfer function of DC Motor COs: CO2
7. Stability analysis of Linear Time Invariant system using Root Locus Technique (MAT LAB) COs: CO2
8. Stability analysis of Linear Time Invariant system using Bode Plot Technique (MAT LAB)

COs: CO2

9. Stability analysis of Linear Time Invariant system using Nyquist Plot Technique (MAT LAB) COs: CO2
10. Kalman's test of controllability and Observability using MATLAB COs: CO3
11. Characteristics of AC Servomotor COs: CO3
12. State space model for classical transfer function using MATLAB COs: CO3
13. Characteristics of Magnetic Amplifiers COs: CO3
14. Implementation of different logic gates using PLC COs: CO3
15. Characteristics of synchro transmitter and receiver COs: CO3
16. Temperature Control using PID COs: CO3

Hardware Requirements:

Control System Kits

Software Requirements:

MATLAB simulation software tool, Computer Systems with required specifications

SAMPLE QUESTIONS

L1-Remember

1. What is a time constant?
2. Define rise time and settling time.
3. Define each type of controller.
4. What is a compensator?
5. What is a transfer function?
6. What is the Nyquist criterion?
7. Define controllability and observability.
8. What is the state variable form of a system?

L2 -Understand

1. Explain the difference between under damped and over damped systems.
2. How does a PID controller improve system performance compared to a P controller?
3. Differentiate between lead and lag compensators.
4. Explain the relationship between input voltage and speed of the motor.
5. Why is stability analysis important in control systems?
6. What is the significance of state-space representation in control?
7. Explain how transfer functions can be converted to state-space.

L3-Apply

1. Calculate damping ratio from a given response curve.

2. Tune a PID controller for a given system.
3. Use MATLAB to convert a second-order system into state-space.
4. Sketch the Bode plot of a lead compensator.
5. Derive the transfer function from experimental data.

Chairperson
Board of Studies (EEE)

R24EEPC12 **Induction and Synchronous Machines Lab** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Speed control methods of three-phase induction motors.
2. Performance characteristics of three-phase and single-phase induction motors
3. Voltage regulation calculations of three–phase alternator by various methods.

Course Code	Course Outcomes	Mapping with POs and PSOs									DOK
		PO1	PO2	PO3	PO4	PO5	PO9	PO11	PSO1	PSO2	
R24EEPC12.1	Assess the performance of single phase and three phase induction motors	2	2	2	3	2	2	2	3	2	L2, L3
R24EEPC12.2	Control the speed of three phase induction motor	2	2	1	3	1	3	2	3	3	L1, L2,
R24EEPC12.3	Predetermine the regulation of three–phase alternator by various methods	2	2	2	3	2	2	2	3	3	L2, L3

Board of Studies : Electrical & Electronics Engineering

Approved in BOS No : 02, 21st, May 2025

Approved in ACM No: 02

List of Experiments

1. Brake test on three phase induction motor. COs: CO1
2. Circle Diagram of three phase induction motor. COs: CO1
3. Speed control of three phase induction motor by V/f method. COs: CO1
4. No-load & Blocked Rotor tests of single-phase induction motor. COs: CO1
5. Power factor improvement of single-phase induction motor by using capacitors. COs: CO1
6. Brake test on single phase induction motor. COs: CO2
7. Load test on Universal Motor. COs: CO2
8. Brake test on A.C Series motor. COs: CO2
9. Regulation of a three -phase alternator by synchronous impedance. COs: CO2
10. Regulation of a three -phase alternator by MMF method. COs: CO2
11. Regulation of three-phase alternator by Potier triangle method. COs: CO3
12. V and Inverted V curves of a three-phase synchronous motor. COs: CO3
13. Determination of Xd, Xq & Regulation of a salient pole synchronous generator. COs: CO3
14. Determination of efficiency of three phase alternator by loading with three phase induction motor. COs: CO3

NOTE: Any 10 experiments are to be conducted.

SAMPLE QUESTIONS

L1-Remember:

Brake Test on Three-Phase Induction Motor

Problem:

A 10 HP, 415 V, 50 Hz, 4-pole, three-phase induction motor is running at 1440 RPM. During the brake test, the mechanical power required to brake the motor at full load is 700 W. The slip at full load is 0.04.

Calculate:

a. The full load torque of the motor.

b. The efficiency of the motor at full load.

c. The mechanical losses of the motor at full load.

No-load & Blocked Rotor tests of Three-Phase Induction Motor

Problem:

A three-phase induction motor has the following no-load and full-load parameters:

- No-load current = 15 A, power factor = 0.2, voltage = 415 V.
- Full-load current = 35 A, power factor = 0.8, voltage = 415 V.

  Task:

  Plot the circle diagram for the induction motor.

  Hint: Use the given parameters to determine the no-load and full-load power components and draw the corresponding circle diagram.

L2 –Understand:

Speed Control of Three-Phase Induction Motor by V/f Method

Problem:

A three-phase induction motor operates at a base speed of 1440 RPM at a rated voltage of 415 V.

Calculate:

a. The frequency required to run the motor at 1200 RPM using the V/f control method.

b. The new voltage required for the motor to operate at the reduced speed.

No-load & Blocked Rotor tests of Single-Phase Induction Motor

Problem:

The following parameters are given for a single-phase induction motor:

- Rated voltage = 230 V
- Rated current = 4 A
- Power factor = 0.85

- Input power = 900 W

Task:

Draw the equivalent circuit of a single-phase induction motor and calculate:

a. The resistance and reactance of the motor.

b. The efficiency of the motor.

L3-Apply:

Power Factor Improvement of Single-Phase Induction Motor by Using Capacitors

Problem:

A 2 HP, 230 V, 50 Hz single-phase induction motor operates at a power factor of 0.6. The current drawn by the motor is 8 A.

Calculate:

a. The apparent power drawn by the motor.

b. The reactive power required to improve the power factor to 0.9.

c. The value of the capacitor needed to improve the power factor.

Load Test on Single-Phase Induction Motor

Problem:

A 1 HP, 230 V, single-phase induction motor is tested under load conditions. The input power to the motor at full load is 750 W, and the output power is 600 W.

Calculate:

a. The efficiency of the motor.

b. The losses in the motor.

Regulation of a Three-Phase Alternator by Synchronous Impedance Method

Problem:

A 3-phase alternator has the following parameters:

- Rated voltage = 11 kV
- Rated current = 150 A
- Synchronous reactance = 10 Ω
- Resistance = 0.5 Ω

The alternator is operating at a lagging power factor of 0.85 with a load current of 130 A.

Calculate:

a. The synchronous impedance (Z_s)

b. The voltage regulation of the alternator.

Regulation of a Three-Phase Alternator by MMF Method

Problem:

A 3-phase alternator has a synchronous reactance of 12 Ω and a resistance of 0.5 Ω. The rated

output voltage is 415 V, and the load current is 120 A at a power factor of 0.8 lagging.

Calculate:

a. The voltage regulation using the MMF method.

Chairperson
Board of Studies (EEE)

R24CSSC05 **Python Programming** **0 0 3 1.5**

(Common to EEE)

Course Objectives:

- Introduce core-programming concepts of Python programming language.
- Demonstrate about Python data structures like Lists, Tuples, Sets and dictionaries
- Implement Functions, Modules and Regular Expressions in Python Programming and to create practical and contemporary applications using these

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs			
		PO1	PO2	PO3	Dok
R24CSSC01.1	Introduce core-programming concepts of Python programming language.	3	3	3	L1
R24CSSC01.2	Develop, run and manipulate Python programs using Functions, Core data structures like Lists, Dictionaries, and use of Strings Handling methods	3	3	3	L2
R24CSSC01.3	Demonstrate about Python data structures like Tuples, Sets and dictionaries	3	3	3	L2
R24CSSC01.4	Develop, run and manipulate Python programs using File Operations and concepts of object-oriented programming	3	3	3	L3
R24CSSC01.5	Understand Data Science, Numpy, Pandas and working with XML, JSON and other file formats.	3	3	3	L3

Board of Studies : Computer Science and Engineering
Approved in BOS No: 02, 9th May, 2025
Approved in ACM No: 02

Developing the following programs:

UNIT-I: **CO's:CO1**

History of Python Programming Language, Thrust Areas of Python, Installing Anaconda Python Distribution, Installing and Using Jupyter Notebook, Features, Limitations, advantages, and applications of python.

Parts of Python Programming Language: Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and associativity, Data Types, Indentation, Comments, Reading Input, Print Output, Type Conversions, the type () Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: if statement, if-else statement, if...elif…else, Nested if statement, while Loop, for Loop, continue and break Statements, Catching Exceptions Using try and except Statement.

Sample Experiments:

1. Write a program to find the largest element among three Numbers.
2. Write a Program to display all prime numbers within an interval
3. Write a program to swap two numbers without using a temporary variable.
4. Demonstrate the following Operators in Python with suitable examples.
    i. Arithmetic Operators
    ii. Relational Operators
    iii. Assignment Operators
    iv. Logical Operators
    v. Bit wise Operators
    vi. Ternary Operator
    vii. Membership Operators
    viii. Identity Operators
5. Write a program to add and multiply complex numbers
6. Write a program to print multiplication table of a given number.
7. Write how to Handle specific exceptions – like division of a number by zero

UNIT-II: **CO's:CO2**

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the function, return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments, Lambda Functions: Syntax and usage of lambda functions..

Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings, Regular Expressions (Regex)

Lists: Creating Lists, Basic List Operations, Indexing and Slicing in Lists, Built-In Functions Used on Lists, List Methods, del Statement.

Sample Experiments:

1. Write a Python program to square each element in a list using a lambda function.
2. Write a program to define a function with multiple return values.
3. Write a program to define a function using default arguments.
4. Write a program to find the length of the string without using any library functions.
5. Write a program to check if the substring is present in a given string or not.

6. Write a program to perform the given operations on a list:
    i. Addition
    ii. Insertion
    iii. Slicing
7. Write a program to perform any 5 built-in functions by taking any list.

UNIT-III: CO's:CO3

Dictionaries: Creating Dictionary, Accessing and Modifying key:value Pairs in Dictionaries, Built-In Functions Used on Dictionaries, Dictionary Methods, del Statement. Tuples and Sets: Creating Tuples, Basic Tuple Operations, tuple() Function, Indexing and Slicing in Tuples, Built-In Functions Used on Tuples, Relation between Tuples and Lists, Relation between Tuples and Dictionaries, Using zip() Function, Sets, Set Methods, Frozenset, Defaultdict and OrderedDict (from collections).

Sample Experiments:

1. Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples.
2. Write a program to count the number of vowels in a string (No control flow allowed).
3. Write a program to check if a given key exists in a dictionary or not.
4. Write a program to add a new key-value pair to an existing dictionary.
5. Write a program to sum all the items in a given dictionary.
6. Write a program using defaultdict to count the frequency of each fruit in the given list:['apple', 'banana', 'apple', 'orange', 'banana', 'apple']

UNIT-IV: CO's:CO4

Files: Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, Pickle Module, Reading and Writing CSV Files, Python os and os.path Modules.

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, Constructor Method, Classes with Multiple Objects, Class Attributes Vs Data Attributes, Encapsulation, Inheritance, Polymorphism.

Sample Experiments:

1. Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered.
2. Python program to print each line of a file in reverse order.
3. Python program to compute the number of characters, words and lines in a file.
4. Write a program to create, display, append, insert and reverse the order of the items in the array.

5. Write a program to add, transpose and multiply two matrices.
6. Write a Python program to create a class that represents a shape. Include methods to calculate its area and perimeter. Implement subclasses for different shapes like circle, triangle, and square.

UNIT-V: **CO's:CO5**

Introduction to Data Science: Functional Programming, JSON and XML in Python, NumPy with Python, Pandas.

Board of Studies: Computer Science and Engineering

Approved in BoS No: 02,--April, 2025

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Sample Experiments:

1. Python program to check whether a JSON string contains complex object or not.
2. Python Program to demonstrate NumPy arrays creation using array () function.
3. Python program to demonstrate use of ndim, shape, size, dtype.
4. Python program to demonstrate basic slicing, integer and Boolean indexing.
5. Python program to find min, max, sum, cumulative sum of array
6. Create a dictionary with at least five keys and each key represent value as a list where this list contains at least ten values and convert this dictionary as a pandas data frame and explore the data through the data frame as follows:
    a) Apply head () function to the pandas data frame
    b) Perform various data selection operations on Data Frame
7. Select any two columns from the above data frame, and observe the change in one attribute with respect to other attribute with scatter and plot operations in matplotlib

Reference Books:

1. Gowri shankar S, Veena A., Introduction to Python Programming, CRC Press.
2. Python Programming, S Sridhar, J Indumathi, V M Hariharan, 2nd Edition, Pearson, 2024
3. Introduction to Programming Using Python, Y. Daniel Liang, Pearson

Online Learning Resources Links:

1. https://www.coursera.org/learn/python-for-applied-data-science-ai
2. https://www.coursera.org/learn/python?specialization=python#syllabus

Web References:

1. https://www.geeksforgeeks.org/python-programming-language-tutorial/
2. https://www.python.org/about/gettingstarted/
3. https://www.w3schools.com/python/

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define identifiers and give two examples.
2. List any three features of Python.
3. What is the use of the type() function.
4. Define a function. What is a lambda function?
5. What are default and keyword arguments?
6. List any four string methods in Python.
7. Define a dictionary. How is it different from a list?
8. What is a frozenset?
9. What is the syntax of zip()?
10. What is a constructor in Python?
11. List any three file handling functions.
12. Define encapsulation.
13. What is a NumPy array?
14. Define a DataFrame in pandas.
15. Mention any two data visualization functions from matplotlib.

L2: Understand

1. Explain the significance of indentation in Python.
2. Differentiate between is and == with examples.
3. Explain the flow of execution for the if...elif...else structure.
4. Differentiate between *args and **kwargs.
5. Explain string slicing and joining with examples.
6. Explain the scope and lifetime of a variable in Python
7. Explain the relation between tuples and dictionaries.
8. Describe the purpose of defaultdict and OrderedDict.
9. Differentiate between class and object.
10. Explain the difference between class attributes and instance attributes.
11. Explain the difference between .ndim, .shape, and .size in NumPy.
12. Describe the process of reading JSON data in Python.

L3: Apply

1. Write a Python program to swap two variables without a temporary variable.
2. Write a program to print the largest of three numbers using conditional statements.
3. Write a Python program using a lambda function to square each element of a list.
4. Write a function that returns both sum and product of two numbers.

5. Write a program to check if a substring exists in a string.
6. Write a program to count vowels in a string using only string and set operations.
7. Write a program to check if a given key exists in a dictionary.
8. Write a program to concatenate two tuples.
9. Write a Python program to read from a file and print its contents in reverse line order.
10. Write a class representing a rectangle with methods to calculate area and perimeter.
11. Write a Python program to create a NumPy array and perform slicing.
12. Create a dictionary with lists and convert it into a pandas DataFrame.

L4: Analysing

1. Compare the use of for and while loops with scenarios.
2. Analyze how operator precedence affects the outcome of expressions in Python.
3. Analyze how positional arguments differ from keyword arguments in function calls.
4. Compare string formatting methods: %, .format(), and f-strings.
5. Compare the use of sets and dictionaries in Python.
6. Analyze the output when applying slicing on a tuple with an example.
7. Compare inheritance and polymorphism with suitable class examples.
8. Analyze the structure and behavior of a file object during read and write operations.
9. Analyze how data is structured differently in NumPy and pandas.
10. Compare JSON and XML data formats with Python parsing tools.

L5: Evaluating

1. Evaluate the use of dynamic typing in Python. What are its pros and cons?
2. Assess the effectiveness of Anaconda and Jupyter Notebook for beginner programmers
3. Evaluate the usefulness of using regular expressions for string validation.
4. Justify the use of built-in functions over writing manual logic
5. Evaluate the use of immutable data types (tuples, frozensets) in large applications.
6. Assess the performance difference between regular dict and defaultdict when counting frequencies.
7. Evaluate the usefulness of OOP in Python compared to procedural programming.
8. Judge whether using binary files or text files is better for storing structured data.
9. Evaluate the benefits of using pandas over lists/dictionaries for data manipulation.
10. Assess the effectiveness of functional programming in handling large-scale data pipelines.

Chairperson
Board of Studies (CSE)

R24HS05 Numerical Ability & Professional Communication skills 0 0 2 1
(Common to all UG Programmes)

Course Objectives:

1. **Develop problem-solving skills**: Students will be able to apply numerical concepts and techniques to solve problems in various contexts.
2. **Enhance data analysis skills**: Students will be able to collect, analyze, and interpret numerical data to inform decision-making.
3. **Develop effective communication skills**: Students will be able to communicate effectively in various professional settings, including verbal and non-verbal communication.
4. **Improve presentation skills**: Students will be able to deliver clear, concise, and engaging presentations to different audiences.
5. **Enhance writing skills**: Students will be able to write clear, concise, and well-structured professional documents, such as reports, emails, and memos.
6. **Develop interpersonal skills**: Students will be able to build and maintain effective relationships with colleagues, clients, and stakeholders.

At the end of the course, students will be able to:

Course Code	Course Outcomes	PO1	PO7	PO9	P011	Dok
R24HS05.1	Use their logical thinking and analytical abilities to solve Quantitative aptitude questions from company specific and other competitive tests..	2	---	---	---	L4
R24HS05.2	Solve questions related to time and distance and time and work etc. from company specific and other competitive tests.	1	---	---	---	L5
R24HS05.3	Comprehend the essentiality of LSRW skills in paper presentations, seminars, workshops, conferences etc. with teams and to solve different types of questions based on vocabulary, structure, grammar and verbal reasoning.	2	2	3	1	L1, L2
R24HS05.4	Attain the knowledge of soft skills in various conditions, Solve questions based on sentence completion and fill in the blanks	---	1	3	---	L2, L3
R24HS05.5	Explore diverse fields through English , To solve different types of questions based on vocabulary, structure, grammar and verbal reasoning	---	---	3	---	L4

SYLLABUS

UNIT-I: Numerical computation **15 Hours**

Application based on Numbers –Classification of Number System, Prime and Composite, Even and Odd Numbers, Divisibility Rule, BODMAS Rule, Unit digit, fractions, LCM &HCF**.** Percentages and its Applications, Profit Loss and Discount, Simple interest and Compound interest. Averages, Ratio Proportion, Application of Ratios**,** Partnerships, Shares and dividends.

Self Learning Topic: Problems on Ages

UNIT-II: Numerical Estimation **15 Hours**

Time and work, Application of Time-work (pipes and cisterns) , Time and Distance, circular Tracking, concept of Boats & steams. Mixtures and allegations, application of percentage and Ratios and Averages in Mixtures

Self Learning Topic: Problems on Trains

UNIT-III **5 Hours**

Abstract Preparation – Noticing Key Words –Literature Survey – Using Academic Verbs Verbal Ability: Sentence correction, Resume Writing and Cover letter

Self Learning Topic: Project Report

UNIT-IV **5 Hours**

Organizational Skills – Time Management – IELTS Test Papers Exercises Verbal Ability: sentence completion

Self Learning Topic: Jumbled Sentences

UNIT-V **5 Hours**

Analogy, origin of Words, Idioms and phrases, MNC's question papers Verbal Ability: Error Identification

Self Learning Topic: Speaking and writing diction (Choice of Words)

Board of Studies: MBA
Approved in BOS No: 02, 13th May, 2025
Approved in ACM No: 02

Text Books:

1. Quantitative Aptitude for competitive examinations by R.S.Agrawal - S.Chand publications.
2. Business Communication by C.S.G Krishnamacharyulu & Lalitha Ramakrishna – Himalaya publishing house

Reference Books:

1. Numerical Aptitude and Reasoning Ability tests in Competitive exams by Prof.A.Balasubramanian.
2. Numerical Ability and Mathematical Aptitude by Dr.A.B.Rao
3. Communication skills and soft skills by E.Suresh Kumar , p.sreehari & j.savithri

Web References:

1. https://faceprep.in/ logical reasoning

2. www.sawaal.com
3. http://nptel.ac.in/courses
4. www.prepinsta.com

Model Questions from Numerical Ability

1. What is the unit digit of 2^10?
2. Find the unit digit of 17^5.
3. What is the unit digit of 3 × 7 × 9 × 11?
4. Determine the unit digit of 123^4.
5. Find the unit digit of 2^20 + 3^15.
6. Is 432 divisible by 3?
7. Check if 756 is divisible by 9.
8. Determine if 1240 is divisible by 8.
9. Is 531 divisible by 11?
10. Check if 2700 is divisible by 15.
11. Simplify: 2 × 3 + 12 ÷ 4 - 5
12. Evaluate: 18 - 3 × 2 + 12 ÷ 4
13. Simplify: 9 + 8 ÷ 2 × 3 - 1
14. Evaluate: 15 - 2 × 3 + 8 ÷ 2
15. Simplify: 24 ÷ 4 × 2 + 10 – 3
16. Find the HCF of 12 and 18.
17. Determine the HCF of 24 and 30.
18. The HCF of two numbers is 6 and their LCM is 72. What are the two numbers?
19. The LCM of two numbers is 120 and their HCF is 10. If one of the numbers is 24, what is the other number?
20. A shirt is marked at $80 and sold at a 20% discount. What is the selling price?
21. A student scored 75% marks in an exam. If the total marks were 200, how many marks did the student score?
22. A number is increased by 25% and then decreased by 10%. What is the net percentage change?
23. A book is bought for $50 and sold for $60. What is the profit percentage?
24. A shopkeeper sells an item at a 15% loss. If the cost price is $100, what is the selling price?
25. A person buys a product for $80 and sells it for $100. What is the profit percentage?
26. Find the simple interest on $1000 at 5% per annum for 2 years.
27. A sum of money amounts to $1200 in 3 years at 8% per annum simple interest. What is the principal amount?
28. What is the rate of interest if a sum of $500 amounts to $600 in 4 years at simple interest?

Model Questions from professional communication skills

1. You're working with a team member who has a different work style. How would you adapt your communication approach?
2. A client is unhappy with the project's progress. How would you handle the situation?
3. You're part of a team, and there's a conflict between two members. How would you facilitate a resolution?
4. How would you use body language to convey confidence during a presentation?
5. You're in a virtual meeting, and your internet connection is unstable. How would you

handle the situation?

6. You're meeting a client for the first time. What nonverbal cues would you use to build rapport?
7. You're presenting a project update to a client. How would you structure your presentation to ensure effective communication?
8. A colleague is not meeting their deadlines, affecting the team's project timeline. How would you approach the conversation?
9. You're in a meeting, and a team member is dominating the discussion. How would you politely intervene?
10. You're tasked with writing a report on a project's progress. How would you structure the report?

Chairperson
Board of Studies (MBA)

R24ES14 MICROPROCESSORS AND MICROCONTROLLER 3 0 0 3

(Common to ECE and EEE)

Course Objectives:

1. To impart knowledge of the architecture and functioning of 8086 microprocessor and 8051 microcontrollers.
2. To familiarize students with assembly language programming concepts and their practical implementation.
3. To understand memory interfacing and peripheral device interfacing with 8086 and 8051.
4. To develop the ability to interface microcontrollers with external hardware components and sensors.
5. To provide hands-on experience for designing embedded systems using 8051.

Course Outcomes:

After completion of the course, the student will be able to:

Mapping with POs and PSOs															Dok
Course Code	**Course Outcomes (COs)**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	
R24ES14.1	Understand the internal architecture and operations of 8086 microprocessor and write assembly language programs.	3	2	1	-	1	-	-	-	-	-	1	3	1	L1, L2
R24ES14.2	Analyze and design memory and peripheral interfacing techniques for microprocessors and microcontrollers.	3	3	2	1	1	-	-	-	-	-	1	3	2	L3, L4
R24ES14.3	Develop embedded applications using 8051 microcontroller and its instruction set.	3	2	3	1	2	-	-	-	-	1	2	2	3	L2, L3
R24ES14.4	Interface 8051 with external peripherals such as LCDs, motors, keypads, ADCs/DACs, and sensors.	3	2	3	1	2	-	-	-	-	1	2	2	3	L4, L5
R24ES14.5	Design simple embedded systems integrating sensors and actuators using the 8051 microcontrollers.	3	3	3	2	2	-	-	-	-	2	2	3	3	L4, L5

SYLLABUS

UNIT-I: 8086 Microprocessors **14 Hours**

Introduction to microcomputer, evolution of processors and semiconductor memories (RAM,

ROM, EPROM, EEPROM), Architecture of 8086 microprocessor, register organization of 8086, Pipelining concept, Memory segmentation, Addressing Modes. **COs-CO1**

Self learning topics: Pin diagram of 8086 microprocessor

UNIT-II: Assembly Language Programming **14 Hours**

Instruction Set and Programming: Instruction set of 8086 microprocessors: Data transfer instructions, Arithmetic instructions, Logical Instructions, String instructions, Stack related instructions, Branching instructions, Assembler directives. Data transfer instructions of 8086 microprocessor. **COs–CO2**

Self learning topics: Assembly Language Programming Development Tools

UNIT-III: 8086 Operational Modes and Memory Interfacing: **14 Hours**

Minimum and Maximum mode operations of 8086 with timing diagrams, Procedures and macros, Stack Structure of 8086, Interfacing of 8255 Programmable Peripheral Interface with 8086 microprocessors. Dynamic RAM, Direct memory access. **CO's–CO3**

Self learning topics: Static RAM Interfacing

UNIT-IV **14Hours**

Comparison between microprocessor and microcontroller, 8051 family microcontroller, RAM architecture of 8051, Pin description of 8051 microcontroller, Addressing Modes, Instruction set of 8051: Data transfer instructions, Arithmetic instructions, Logical Instructions, Stack related instructions, Branching instructions. Timers, Interrupts, Universal Asynchronous Receiver Transmitter (UART). **CO's-CO4**

Self learning topics: External memory interfacing with 8051 microcontroller, various constituents of hex file

UNIT-V **14 Hours**

Interfacing 8051 with Peripherals:

Interfacing 8051 with: Matrix Keypad, Seven-segment displays, Stepper motor, Analog-to-Digital Converter (ADC 0804) and Digital-to-Analog Converter (DAC 0808)

Sensor and Relay Interfacing with 8051:

Interfacing of temperature sensor LM35 with 8051, Relay interfacing with 8051, Case studies and practical applications using 8051. **CO's–CO5**

Self learning topics: L293D Motor Driver, LCD

Board of Studies: Electronics and Communication Engineering
Approved in BOS No: 03, 27th May, 2026
Approved in ACM No: 03

Text Books:

1. K. Ray and K. M. Bhurchandi is titled "Advanced Microprocessors and Peripherals: Architecture, Programming and Interfacing".

2. Kenneth J. Ayala – The 8051 Microcontroller: Architecture, Programming & Applications
3. Douglas V. Hall – Microprocessors and Interfacing

Reference Books:

1. Muhammad Ali Mazidi, Janice Mazidi – The 8051 Microcontroller and Embedded Systems
2. N. Senthil Kumar, M. Saravanan, S. Jeevananthan – Microprocessors and Microcontrollers

Web References:

1. https://onlinecourses.nptel.ac.in/noc20_ee11/preview
2. https://electronicsmind.com/architecture-of-8086-microprocessor/
3. https://www.tutorialspoint.com/article/difference-between-microprocessor-and-microcontroller
4. https://www.scribd.com/doc/74666075/8051-hard-lab4

Cognitive Level	InternalAssessment#1(%)	InternalAssessment#2(%)
L1	30	--
L2	30	--
L3	30	30
L4	10	40
L5	--	30
Total(%)	100	100

Sample Short and Long Answers questions of Various Cognitive

Levels L1: Remembering

1. Define a microcomputer.
2. List types of instructions in 8086.
3. Define minimum and maximum mode.
4. Define microcontroller.
5. List peripherals interfaced with 8051.

L2: Understanding

1. Describe the architecture of 8086 with BIU and EU.
2. Describe string instructions.
3. Describe SRAM interfacing.
4. Explain RAM architecture of 8051
5. Describe DAC operation.

L3: Applying

1. Show how memory is divided using segmentation
2. Write an ALP to add two numbers.
3. Write macro and procedure examples.
4. Write UART communication program.
5. Design stepper motor control.

L4: Analyzing

1. Analyze limitations of segmentation.
2. Differentiate CALL and JMP instructions.
3. Analyze DMA data transfer process.
4. Differentiate instruction types.
5. Justify use of ADC/DAC in systems.

L5: Evaluating

1. Assess advantages of 8086 over earlier processors.
2. Evaluate different branching techniques.
3. Evaluate role of 8255 in systems.
4. Evaluate microcontroller advantages over microprocessor.
5. Evaluate different peripherals.

Chairperson
Board of Studies (ECE)

R24EEPC13 **Power Electronics** **3 0 0 3**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To understand the construction, operation, characteristics, triggering, and protection of power semiconductor devices such as SCR, MOSFET, and IGBT.
2. To analyze the operation and performance of single-phase and three-phase AC–DC converters under different load conditions.
3. To study the principles and applications of AC–AC converters and cycloconverters for power control applications.
4. To understand the operation, analysis, and control techniques of DC–DC converters operating in CCM and DCM modes.
5. To analyze the operation and modulation techniques of DC–AC converters and inverters for single-phase and three-phase applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC13.1	Explain the operation, characteristics, triggering methods, and protection circuits of SCR, Power MOSFET, and IGBT used in power electronic applications.	3	2	1	1	2	1	-	-	-	-	1	3	1	L1, L2
R24EEPC13.2	Analyze the performance of single-phase controlled rectifiers and converters with different types of loads under continuous and discontinuous conduction modes.	3	3	2	2	3	1	-	-	-	-	1	3	2	L3, L4
R24EEPC13.3	Evaluate the operation and output	3	3	2	2	3	2	-	-	1	-	2	3	3	L4,

	characteristics of three-phase AC–DC converters and AC–AC converters for industrial power control applications.														L5
R24EEPC13.4	Analyze the operation of DC–DC converters such as Buck, Boost, and Buck-Boost converters and determine their performance parameters in CCM and DCM modes	3	3	2	3	3	2	-	-	1	-	2	3	3	L4, L5
R24EEPC13.5	Analyze single-phase and three-phase DC–AC converters, PWM techniques, and inverter operation for various load conditions and applications.	3	3	3	3	3	2	1	-	1	1	2	3	3	L3, L4

SYLLABUS

Unit –I: Power Semi- Conductor Devices **12 Hours**

Silicon controlled rectifier(SCR) – Two transistor analogy -Static and Dynamic characteristics – Turn on and Turn off Methods - Triggering Methods (R, RC and UJT) – Snubber circuit design.

Study of MOSFET and IGBT Characteristics from Manufacturer Datasheets, Static and Dynamic Characteristics of Power MOSFET and Power IGBT-Numerical problems.

Self-Learning Topics: Evolution of Power Semiconductor Devices and Their Applications, Constructional Features of SCR, Power MOSFET, and IGBT. **CO's: CO1**

Unit –II: Single-Phase AC-DC Converters **12 Hours**

Single-phase half-wave controlled rectifiers - R and RL loads with and without freewheeling diode -Single-phase fully controlled mid-point and bridge converter with R load, RL load and RLE load-Continuous and Discontinuous conduction - Effect of source inductance in Single-phase fully controlled bridge rectifier – Expression for output voltages – Single-phase Semi-Converter with R load-RL load and RLE load – Continuous and Discontinuous conduction - Dual converter and its mode of operation, Applications - Numerical Problems.

Self-Learning Topics: Speed control of DC motors using single-phase controlled rectifiers, Modern applications of thyristor converters in industrial drive systems. **CO's: CO2**

Unit –III: Three-phase AC-DC Converters & AC–AC Converters 15 Hours

Three-phase half-wave Rectifier with R and RL load - Three-phase fully controlled rectifier with R and RL load - Three-phase semi converter with R and RL load - Expression for Output Voltage - Numerical Problems. Single-phase AC-AC power control by phase control with R and RL loads- Expression for rms output voltage– Single-phase step down and step up Cycloconverter – Applications- Numerical Problems.

Self-Learning Topics: Converter-fed DC motor drives in industrial applications, Modern variable-speed drive systems using power electronic converters. **CO's: CO3**

Unit –IV: DC–DC Converters 14 Hours

Operation of Basic Chopper –Analysis of Buck, Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) - Output voltage equations using volt-sec balance in CCM & DCM–Expressions for output voltage ripple and inductor current ripple–control techniques –Introduction to PWM control – Applications-Numerical Problems.

Self-Learning Topics: Buck converter for low-speed traction control, Boost converter for voltage boosting from battery packs. **CO's: CO4**

Unit –V: DC–AC Converters 12 Hours

Introduction-Single-phase half-bridge and full-bridge inverters with R and RL loads –Phase Displacement Control –PWM with bipolar voltage switching, PWM with unipolar voltage switching- Three-phase square wave inverters 120^0 conduction and 180^0 conduction modes of operation - Sinusoidal Pulse Width Modulation - Current Source Inverter (CSI) – Applications-Numerical Problems.

Self-Learning Topics: PWM techniques for AC motor speed control. **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 3

Approved in ACM No: 03

Text Books:

1. Power Electronics: Converters, Applications and Design by Ned Mohan, Tore M Undeland, William P Robbins, John Wiley & Sons, 2002.
2. Power Electronics: Circuits, Devices and Applications– by M.H.Rashid, Prentice Hall of India, 2nd edition, 2017.

3. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited, India, 2009.

Reference Books:

1. Elements of Power Electronics–Philip T. Krein. Oxford University Press; Second edition, 2014.
2. Power Electronics–by P.S. Bhimbra, Khanna Publishers.
3. Thyristorised Power Controllers – by G. K. Dubey, S. R. Doradla, A. Joshi and R. M. K.Sinha, New Age International (P) Limited Publishers, 1996.
4. Power Electronics by Daniel W.Hart, McGraw Hill, 2011.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_ee97
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee37

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. List the terminals of an SCR
2. Define controlled rectifier.
3. What is phase control in AC voltage controllers?
4. Define duty cycle.
5. What is PWM?

L2: Understand

1. Differentiate static and dynamic characteristics of SCR.

2. Explain the operation of single-phase half-wave rectifier with R load.
3. Explain the operation of three-phase fully controlled bridge rectifier with waveforms.
4. Explain the operation of Buck, Boost, and Buck-Boost converters.
5. Explain PWM techniques used in inverters.

L3: Apply

1. Determine switching losses in MOSFET and IGBT for given operating conditions.
2. Derive the expression for average output voltage of single-phase full converter.
3. Determine RMS output voltage for AC voltage controller
4. Determine inductor current ripple in Boost converter.
5. Derive expressions for output voltage of square-wave inverter.

L4: Analyzing

1. Compare SCR, MOSFET, and IGBT with respect to ratings, switching speed, losses, and applications.
2. Analyze the effect of source inductance on converter performance.
3. Analyze the effect of RL load on AC voltage controller operation.
4. Compare various chopper configurations and applications.
5. Compare VSI and CSI based on operation and applications.

L5: Evaluating

1. Assess the importance of snubber circuits in SCR-based converters.
2. Evaluate various power factor improvement techniques in controlled rectifiers.
3. Evaluate harmonic performance of three-phase rectifiers.
4. Evaluate the importance of PWM techniques in DC–DC converters.

L6: Create

1. Develop a protection scheme for SCR against overvoltage and over current conditions.
2. Design a single-phase PWM rectifier for improved input current waveform.
3. Develop a PWM control strategy for DC–DC converters.

Chairperson
Board of Studies (EEE)

R24EEPC14 **Renewable Energy Systems** **3 0 0 3**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Understand the concepts, availability, prospects, and significance of conventional and non-conventional energy sources, along with energy sustainability and energy policies.
2. Explain the operating principles, characteristics, design aspects, and performance evaluation of solar photovoltaic systems, including MPPT techniques and economic considerations.
3. Analyze the principles, components, performance characteristics, and environmental impacts of wind energy conversion systems for effective utilization of wind resources.
4. Examine the construction, working mechanisms, electrochemical processes, types, and applications of fuel cells and their role in renewable energy integration.
5. Evaluate the operating principles, advantages, limitations, and applications of emerging renewable energy technologies such as geothermal energy, hydrogen energy, MHD power generation, OTEC, tidal energy, and wave energy systems for sustainable energy development.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC14.1	Explain energy sources, sustainability indices, and energy availability concepts	3	2	1	-	-	3	-	-	-	-	2	-	3	L1,L2
R24EEPC14.2	Analyze PV cell characteristics and solar PV system design	3	3	2	2	3	1	-	-	-	1	1	2	3	L3, L4
R24EEPC14.3	Analyze wind energy conversion systems and their performance	3	3	2	2	2	2	-	-	-	1	1	2	3	L3, L4
R24EEPC14.4	Examine fuel cell operation, types, and applications	3	3	2	2	1	2	-	-	-	-	1	2	3	L4,L5

R24EEPC14.5	Evaluate geothermal, hydrogen, MHD, OTEC, tidal, and wave energy systems	3	3	2	1	1	3	-	-	-	-	2	1	3	L5,L6

SYLLABUS

UNIT I: Energy Sources & Availability **12 Hours**

Conventional, non-conventional sources of energy, prospects, perspectives, & advantages. Introduction to different types of non conventional source of energy: solar, wind, biomass, Ocean Thermal Energy Conversion (OTEC), geothermal, hydrogen energy, fuel cells, MHD, thermionic power conversion, thermoelectric power conversion

Self-Learning Topics: Energy sustainability indices energy policies and trends- Energy Availability in India. **CO's: CO1**

UNIT II: Solar Energy Systems **12 Hours**

Solar cell - equivalent circuit - characteristics of PV cell - PV array design - PV System components - Sizing and economics - Peak power operation - Fill Factor- MPPT (P&O only)

Self-Learning Topics: Floating solar systems - Building integrated photovoltaics (BIPV) - Advanced MPPT techniques. **CO's: CO2**

UNIT III: Wind Energy Systems **12 Hours**

Wind power sources - wind characteristics - site selection - Criterion, momentum theory, WECS and its types - Components of wind energy systems - performance and limitations - classification of wind energy Turbines - Aerodynamic forces acting on blades - applications and environmental impacts.

Self-Learning Topics: Offshore wind energy systems **CO's: CO3**

UNIT IV: Fuel cell **14 Hours**

Fuel cell definition - Basic principle of operation - Construction and components (anode, cathode, electrolyte) - Working mechanism of hydrogen fuel cell - Electrochemical reactions at anode and cathode - Overall cell reaction and energy conversion process-List types of fuel cells-Efficiency and operating parameters - Advantages and limitations-Applications - Role of fuel cells in renewable energy integration.

Self-Learning Topics: Hydrogen production techniques - Fuel cell stack design - Hybrid fuel cell systems - Recent advancements in hydrogen energy systems. **CO's: CO4**

UNIT V: Geothermal Energy **12 Hours**

Origin and types: Hydrothermal, Geo-pressurized & Petro thermal, advantages and disadvantages of geothermal energy. Hydrogen energy: Magneto Hydro Dynamic (MHD) power conversion: Principle, types, closed & open cycle sys materials. Ocean Thermal Energy Conversion (OTEC). Tidal energy, Wave energy.

Self-Learning Topics: Global distribution and potential of geothermal energy resources, Recent developments in geothermal power generation technologies. **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. G.D. Rai, Non-Conventional energy sources, 6th Edition, Khanna Publishers, 2011.
2. Renewable Energy in Power Systems by Leon Freris and David Infield, John Wiley & Sons,Ltd.

Reference Books:

1. John Twidell & Toney Weir - Renewable Energy Sources, E & F.N. Spon
2. G.S. Sawhney, Non-Conventional Energy Sources, 1st Edition, Prentice India Pvt. Ltd, 2012.
3. G.N. Tiwari and M.K. Ghosal, Renewable Energy Resources: Basic Principles and Applications, 1st Edition, Alpha Science International Ltd, 2004.
4. Chetan Singh Solanki, Fundamentals, Technologies & Applications, Solar Photovoltaic, PHI Publishers, 2019, 3rd Edition.

Web References:

1. https://nptel.ac.in/courses/108/105/108105058/
2. https://nptel.ac.in
3. https://swayam.gov.in

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	

L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What are renewable energy sources?
2. Define solar constant.
3. State Betz limit.
4. List different types of hydro turbines.

L2: Understand

1. Explain the need for renewable energy sources.
2. Describe the working of a solar PV cell.
3. Explain the principle of wind energy conversion.
4. Summarize the concept of fuel cells.

L3: Apply

1. Calculate the power output of a wind turbine for given wind conditions.
2. Determine the efficiency of a solar PV system.
3. Apply MPPT (P&O method) for solar energy systems.
4. Illustrate the working of a fuel cell with a suitable example.

L4: Analyze

1. Analyze the performance of solar PV systems under varying conditions.
2. Compare different types of wind turbines based on efficiency and applications.
3. Examine biomass energy conversion techniques.
4. Analyze V–I characteristics of fuel cells.

L5: Evaluate

1. Evaluate the advantages and limitations of renewable energy sources.
2. Justify the use of wind energy for power generation.

3. Assess feasibility of geothermal energy.
4. Evaluate fuel cells compared to conventional batteries.

L6: Create

1. Design a solar PV system for a residential application.
2. Develop a hybrid renewable energy system.
3. Propose an energy management strategy using renewable sources.
4. Design a fuel cell-based power system for practical applications.

Chairperson
Board of Studies (EEE)

R24EEPE01 **Electrical Machine Design** **3 0 0 3**

(Professional Elective-I)

Course Objectives:

The main objectives of the course are to

1. To introduce the fundamental principles and modern trends of electrical machine design.
2. To analyze thermal, mechanical, and material considerations in the design of electrical machines.
3. To understand the selection and role of magnetic, electric, and insulating materials for optimal performance.
4. To design transformers, DC machines, induction motors, and synchronous machines based on output equations.
5. To apply Computer-Aided Design (CAD) tools for optimizing electrical machine design parameters.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE01.1	Analyse design factors, material properties, modern trends, and thermal and cooling aspects in electrical machine design.	2	2	-	2	1	2	-	-	-	-	2	2	2	L2, L3
R24EEPE01.2	Design transformers based on output equations, core dimensions, winding parameters, and cooling requirements.	2	2	3	2	2	1	-	-	-	-	1	3	1	L3, L4
R24EEPE01.3	Design DC machines by estimating armature slots, conductor dimensions, field systems, interpoles, and	2	2	3	2	2	1	-	-	-	-	1	3	1	L3, L4

	brush gear.														
R24EEPE01.4	Design induction motors by estimating main dimensions, stator and rotor slots, bars, end rings, and no-load current.	2	2	3	2	2	2	-	-	-	-	1	2	2	L4, L5
R24EEPE01.5	Design synchronous machines and apply CAD tools for optimising turbo-alternator and salient-pole designs.	2	2	3	2	3	2	-	-	-	-	2	3	2	L5, L6

SYLLABUS

Unit –I: Fundamental Aspects of Electrical Machine Design **12 Hours**

Design of machines – Design factors – Limitation in design – Modern trends in electrical machine design – Types of magnetic materials: silicon steel, CRGO, amorphous alloys – Types of electric materials: conductors and resistivity – Types of insulating materials and insulation classes: A, B, E, F, Hnote IEC basis. – Modes of heat dissipation: conduction, convection, radiation – Thermal model of machines – Cooling of rotating machines – Methods of cooling: self-cooled, force-cooled, water-cooled – Enclosure types and duty cycles – Design for efficiency and sustainability.

Self-Learning Topics: Green Machine Design: Energy-Efficient and Eco-Friendly Electrical Machines

CO's: CO1

Unit –II: Design of Transformers **14 Hours**

Transformer construction and windings – Output equation – EMF per turn – Design of main dimensions: core area and window area – Design of core: core type and shell type – Choice of flux density – Determination of number of turns and length of mean turn – Resistance and leakage reactance calculation – Magnetizing current and no-load current calculation – Cooling: ONAN, ONAF, OFAF – Computer-aided design aspects for transformers.

Self-Learning Topics: Dry-Type and Cast Resin Transformer Design for Indoor Applications

CO's: CO2

Unit –III: Design of DC Machines **10 Hours**

Output equation – Selection of specific magnetic and electric loadings – Separation of D and L using

aspect ratio – Estimation of number of conductors – Design of armature slots and conductor dimensions – Choice of number of poles – Calculation of length of air gap – Design of field systems: shunt, series, and compound field windings – Design of interpoles – Commutator and brush design – Design optimization using computer programs.

Self-Learning Topics: Permanent Magnet DC Machines: Design Considerations and Applications

CO's: CO3

Unit –IV: Design of Induction Motors **10 Hours**

Output equation and specific loadings – Design of main dimensions: bore diameter and core length – Choice of average flux density and ampere conductors per metre – Design of stator slots: open, semi-closed, and closed slots – Design of stator winding – Design of rotor slots – Design of rotor bars: cross-section, resistance, and reactance – Design of end rings – Design of wound rotor – Calculation of no-load current: magnetising and loss components – Estimation of performance: efficiency and power factor

Self-Learning Topics: Design of Energy-Efficient IE3 and IE4 Class Induction Motors **CO's: CO4**

Unit –V: Design of Synchronous Machines **10 Hours**

Types of construction: salient pole and cylindrical rotor – Output equation – Main dimensions – Short circuit ratio and its effects on machine performance – Design of rotor: salient pole and round rotor – Design of field winding – Design of turbo-alternators – Temperature rise and its effects – Introduction to Computer Aided Design (CAD) tools for synchronous machine design

Self-Learning Topics: Design of Permanent Magnet Synchronous Generators for Wind Energy Applications **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. A.K. Sawhney, "A Course in Electrical Machines Design", Dhanpath Rai& Co., 6th edition, 2010.
2. A.K. Sawhney and Puneet Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai Publications, 2019.

Reference Books:

1. A.E. Clayton and N.N. Hancock, "The Performance and Design of Direct Current Machines", CBS Publishers, 3rd edition, 2004.

2. M.G. Say, "Performance and Design of A.C. Machines", ELBS and Pitman & Sons, 4th edition, 2013.
3. S.K. Sen, "Principles of Electrical Machine Design with Computer Programmes", Oxford and IBH Company Pvt. Ltd., 2nd edition, 2006.
4. K.M. Vishnu Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 1st edition, 2008.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_ee50
2. https://nptel.ac.in/courses/108106023

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. List the fundamental design factors influencing electrical machine performance.
2. Classify insulating materials according to their thermal class.
3. State the output equation for a transformer.
4. Define short circuit ratio and its significance in synchronous machine design.

L2: Understand

1. Explain the significance of specific magnetic and electric loadings in DC machine design.
2. Describe the modes of heat dissipation in rotating electrical machines.
3. Explain the role of core type and shell type construction in transformer design.

4. Discuss the effect of air gap length on the performance of induction motors.

L3: Apply

1. Compute the main dimensions of a single-phase transformer for given kVA and voltage ratings.
2. Estimate the number of armature conductors and slots for a DC generator with specified ratings.
3. Design the stator of an induction motor for given power, voltage, and frequency specifications.
4. Calculate the number of cooling tubes required for a transformer tank.
5. Determine the main dimensions of a salient pole synchronous generator for given output requirements.

L4: Analyze

1. Analyze the effect of choice of flux density on core weight and efficiency of a transformer.
2. Examine the trade-off between number of poles and machine dimensions in DC machine design.
3. Compare open and closed slot designs for induction motor rotors in terms of performance.
4. Analyze the impact of short circuit ratio on voltage regulation of synchronous machines.

L5: Evaluate

1. Evaluate the effect of insulation class on power density and temperature rating of an electrical machine.
2. Justify the selection of CRGO material over hot-rolled silicon steel for transformer core design.
3. Assess the advantages of CAD tools over manual design procedures for electrical machine optimization.

L6: Create

1. Design a complete three-phase distribution transformer specifying core, winding, cooling system, and tank dimensions for given kVA and voltage ratings.
2. Develop a complete design procedure for a squirrel cage induction motor, computing all main dimensions, stator and rotor parameters, and estimated performance.
3. Create a design report for a salient pole synchronous generator including rotor design, field winding, and damper winding for specified output and performance requirements.

Chairperson
Board of Studies (EEE)

R24EEPE02 **Advanced Control Systems** **3 0 0 3**
(Professional Elective-I)

Course Objectives:

The main objectives of the course are to

1. To understand controllability, observability, and duality in state-space analysis of continuous-time systems.
2. To design state feedback controllers and observers using pole placement and Ackermann's formula.
3. To analyse the stability of nonlinear systems using phase-plane analysis and describing functions.
4. To apply Lyapunov's direct method for stability analysis of linear and nonlinear autonomous systems.
5. To formulate and solve optimal control problems including minimum time, energy, and state regulator problems.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PS O2	
R24EEPE02.1	Explain and test controllability, observability, and the principle of duality in continuous-time state-space systems.	3	2	-	2	1	-	-	-	-	-	1	3	1	L1, L2
R24EEPE02.2	Design state feedback controllers and observers using pole placement and Ackermann's formula for continuous-time systems.	2	2	3	2	2	-	-	-	-	-	1	3	1	L3, L4
R24EEPE02.3	Analyse stability of nonlinear systems using phase-plane analysis, isocline method, and describing functions.	2	3	-	2	2	-	-	-	-	-	2	3	1	L4, L5
R24EEPE02.4	Apply Lyapunov's direct method to	3	2	-	2	1	-	-	-	-	-	1	3	1	L3,L 4

	determine stability of linear and nonlinear continuous-time autonomous systems.														
R24EEPE02.5	Formulate and solve optimal control problems including minimum time, minimum energy, and LQR state regulator problems.	2	3	3	2	2	1	-	-	-	-	2	3	2	L5, L6

SYLLABUS

Unit –I: Controllability, Observability and Pole Placement **14 Hours**

General concepts of controllability and observability – Tests for controllability and observability for continuous-time systems: Kalman's rank test, Gilbert's test – Principle of duality – Effect of state feedback on controllability and observability – Design of state feedback control through pole placement using Ackermann's formula – Full-order Luenberger observer design – Reduced-order observer design – Separation principle.

Self-Learning Topics: Observer-Based Control Applications in Robotics and Aerospace Systems

CO's: CO1, CO2

Unit –II: Nonlinear Systems Analysis **10 Hours**

Introduction to nonlinear systems – Types of nonlinearities: saturation, dead zone, backlash, relay – Phase plane analysis – Singular points and their classification – Construction of phase trajectories: analytical method and isocline method – Describing function method – Describing functions of on-off nonlinearity, on-off nonlinearity with hysteresis, relay with dead zone, and saturation – Limit cycles and their stability using describing functions.

Self-Learning Topics: Nonlinear Control Applications in Power Electronics and Electric Drives

CO's: CO3

Unit –III: Stability Analysis by Lyapunov Method **10 Hours**

Stability in the sense of Lyapunov – Definitions: stable, asymptotically stable, uniformly stable – Lyapunov's stability theorem and instability theorem – Direct method of Lyapunov for linear and nonlinear continuous-time autonomous systems – Construction of Lyapunov functions: variable gradient method,

Self-Learning Topics: Lyapunov Stability Analysis in Power System Transient Stability **CO's: CO4**

Unit –IV: Calculus of Variations and Optimal Control Formulation 10 Hours

Minimisation of functionals – Euler-Lagrange equation – Functionals of single and multiple functions – Constrained minimisation with equality constraints – Pontryagin's Minimum Principle – Control variable inequality constraints – Mixed control and state variable inequality constraints.

Self-Learning Topics: Applications of Variational Methods in Trajectory Optimisation **CO's: CO5**

Unit –V: Optimal Control Problems 12 Hours

Necessary conditions for optimal control – Formulation of the optimal control problem – Minimum time problem – Minimum energy problem – Minimum fuel problem – Linear Quadratic Regulator (LQR): state regulator problem – Output regulator problem –Introduction to Model Predictive Control (MPC) – Applications of optimal control in power systems and industrial automation.

Self-Learning Topics: Reinforcement Learning-Based Optimal Control for Autonomous Systems

CO's: CO5

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Modern Control Engineering – K. Ogata, Prentice Hall of India, 5th edition, 2010.
2. Automatic Control Systems – B.C. Kuo, Prentice Hall Publication, 8th Edition.

Reference Books:

1. Modern Control System Theory – M. Gopal, New Age International Publishers, 2nd edition, 1996.
3. Optimal Control Theory: An Introduction – Donald E. Kirk, Dover Publications.
4. Control Systems Engineering – I.J. Nagrath and M. Gopal, New Age International (P) Ltd., 5th Edition.
5. Nonlinear Control Engineering – D.P. Atherton, Van Nostrand Reinhold, 2nd Edition.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_ee90
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_ee33

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---

L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. State Kalman's rank condition for controllability of a linear time-invariant system.
2. Define asymptotic stability in the sense of Lyapunov.
3. List the types of nonlinearities encountered in control systems.
4. State Pontryagin's Minimum Principle.

L2: Understand

1. Explain the principle of duality between controllability and observability.
2. Describe the construction of phase trajectories using the isocline method.
3. Explain the concept of a Lyapunov function and its role in stability analysis.
4. Discuss the physical interpretation of the minimum energy optimal control problem.

L3: Apply

1. Apply Ackermann's formula to design a state feedback controller for specified pole locations.
2. Construct the phase portrait of a second-order nonlinear system and identify singular points.
3. Determine the Lyapunov function for a given linear system using Krasovskii's method.
4. Solve a minimum time optimal control problem for a double-integrator system.
5. Design a full-order Luenberger observer for a given state-space system.

L4: Analyse

1. Analyse the effect of state feedback on controllability and observability of a system.
2. Investigate the existence and stability of limit cycles in a nonlinear system using describing functions.
3. Compare the performance of full-order and reduced-order observers for a given system.
4. Analyse the steady-state solution of the matrix Riccati equation for the LQR problem.

L5: Evaluate

1. Evaluate the performance of a pole placement controller against an LQR controller for a given plant.
2. Justify the use of describing function analysis as an approximate tool for nonlinear system stability.
3. Assess the applicability of Lyapunov's direct method versus linearisation for stability determination.

L6: Create

1. Design a complete state feedback control system with a reduced-order observer for a third-order plant and verify the design via simulation.
2. Formulate and solve an LQR optimal control problem for a DC motor speed regulation system selecting appropriate Q and R matrices.
3. Develop a Lyapunov-based stability analysis for a nonlinear system and construct a control law that guarantees asymptotic stability.

Chairperson
Board of Studies (EEE)

R24EEPE03 **AI Techniques in Electrical Engineering** **3 0 0 3**

(Professional Elective-I)

Course Objectives:

The main objectives of the course are to

1. Understand the fundamentals of Artificial Intelligence techniques in Electrical Engineering.
2. Analyze various Artificial Neural Network architectures and learning methods.
3. Understand fuzzy logic concepts and genetic algorithms.
4. Apply AI techniques to solve electrical engineering problems.
5. Develop intelligent models for optimization and control applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE03.1	Understand the concepts and architectures of Artificial Intelligence techniques.	3	2	1	1	2	-	-	-	-	-	2	1	1	L1,L2
R24EEPE03.2	Analyze feed forward and feedback neural networks and their learning algorithms.	3	3	2	3	3	1	-	-	1	-	2	3	2	L3,L4
R24EEPE03.3	Analyze fuzzy set theory and fuzzy inference systems for engineering applications.	3	3	2	2	3	1	-	-	1	-	2	2	3	L3,L4
R24EEPE03.4	Examine the concepts and operators of Genetic Algorithms for optimization problems.	3	3	2	3	3	1	-	-	1	1	3	2	2	L2,L3
R24EEPE03.5	Apply ANN,	3	3	3	3	3	2	-	1	1	1	3	3	3	L3,L4

	Fuzzy Logic and GA techniques to Electrical Engineering applications.														

SYLLABUS

Unit – I: Fundamentals of Artificial Intelligence and Neural Networks 12 Hours

Introduction to Artificial Intelligence, Biological neuron and organization of brain, Artificial neuron models, Characteristics of ANN, McCulloch-Pitts Model, Types of activation functions, ANN architectures, Learning processes – Supervised, Unsupervised and Reinforcement learning.

Self-Learning Topics: Applications of AI in Smart Electrical Systems **CO's: CO1**

Unit – II: ANN Paradigms and Learning Algorithms 12 Hours

Perceptron model and limitations, Multilayer perceptron, Back propagation algorithm with example problems, Radial Basis Function Network, Hopfield Network, Feed forward and feedback neural networks.

Self-Learning Topics: Deep Learning Concepts in Electrical Engineering **CO's: CO2**

Unit – III: Fuzzy Logic and Fuzzy Systems 12 Hours

Classical sets and operations, Introduction to fuzzy sets, Membership functions, Fuzzy versus crisp sets, Fuzzy set operations and properties, Fuzzy relations, Fuzzy inference systems, Defuzzification methods.

Self-Learning Topics: Fuzzy Controllers in Industrial Applications **CO's: CO3**

Unit – IV: Genetic Algorithms and Optimization Techniques 14 Hours

Introduction to Genetic Algorithms, Fitness function, Reproduction operators, Crossover techniques – single point, two point, multipoint and uniform crossover, Mutation operator, Generational cycle, Convergence of Genetic Algorithms.

Self-Learning Topics: Optimization Techniques in Power Systems **CO's: CO4**

Unit – V: Applications of AI Techniques in Electrical Engineering 12 Hours

Applications of ANN, Fuzzy Logic and GA in Load flow studies, Economic load dispatch, Load frequency control, Small signal stability, Speed control of DC and AC motors, Intelligent control systems.

Self-Learning Topics: AI based Smart Grid Technologies **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No : 03,

Approved in ACM No : 03

Text Books:

1. Neural Networks, Fuzzy Logic, Genetic Algorithm - Synthesis and Applications, PHI, Second Edition, 2017.
2. Soft Computing Techniques, Wiley Publications, Third Edition, 2018.

Reference Books:

1. Introduction to Artificial Neural Systems, Jaico Publishing House, First Edition, 1994.
2. Optimization for Engineering Design – Algorithms and Examples, PHI, Second Edition, 2012.
3. Soft Computing and Intelligent Systems Design, Prentice Hall, First Edition, 2009.

Web References:

1. NPTEL – Artificial Intelligence and Soft Computing: https://nptel.ac.in/courses/106105173
2. NPTEL – Neural Networks and Applications: https://archive.nptel.ac.in/courses/117/105/117105084

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	---
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Artificial Intelligence.
2. List the types of neuron activation functions.
3. State the properties of fuzzy sets.

4. Define crossover operation in Genetic Algorithms.

L2: Understand

1. Explain the working of McCulloch-Pitts neuron model.
2. Illustrate supervised and unsupervised learning methods.
3. Explain the significance of membership functions in fuzzy logic.
4. Explain the role of fitness function in Genetic Algorithms.

L3: Apply

1. Apply back propagation algorithm for a simple ANN problem.
2. Develop a fuzzy rule base for temperature control application.
3. Apply Genetic Algorithm steps to solve an optimization problem.
4. Use ANN techniques for load forecasting applications.

L4: Analyze

1. Compare feed forward and feedback neural networks.
2. Analyze the advantages of fuzzy sets over classical sets.
3. Compare various crossover techniques in Genetic Algorithms.
4. Analyze AI based control methods for electrical drives.

L5: Evaluate

1. Evaluate the performance of ANN models in electrical engineering applications.
2. Justify the use of fuzzy logic controllers in industrial automation.
3. Evaluate the effectiveness of Genetic Algorithms in optimization problems.
4. Assess AI techniques for smart grid applications.

L6: Create

1. Design a simple ANN model for electrical load prediction.
2. Develop a fuzzy logic controller for speed control of DC motor.
3. Formulate a Genetic Algorithm for economic load dispatch problem.
4. Create an AI based intelligent control system for power system stability.

Chairperson
Board of Studies (EEE)

R24EEPE04 **Utilization of Electrical Energy** **3 0 0 3**
(Professional Elective-I)

Course Objectives:

The main objectives of the course is to

1. To understand the fundamentals of electric drives and selection of motors for various applications.
2. To study illumination concepts, lighting systems, and their practical applications.
3. To learn principles and methods of electric heating and their industrial uses.
4. To understand electric welding techniques and their applications.
5. To analyze electric traction systems and performance characteristics.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE04.1	Understand energy scenario and environmental impacts	3	2	1	1	1	3	1	-	1	-	2	1	3	L1,L2
R24EEPE04.2	Learn illumination concepts and lighting systems.	3	2	2	1	2	3	-	-	1	1	2	1	3	L2, L3
R24EEPE04.3	Understand electric heating methods and applications.	3	2	2	1	2	2	-	-	1	1	2	2	2	L3, L4
R24EEPE04.4	Learn electric welding techniques and uses.	3	2	2	1	2	2	1	-	1	1	2	2	2	L4,L5
R24EEPE04.5	Analyze electric traction systems and performance.	3	3	2	2	3	3	-	-	1	1	2	3	3	L5,L6

SYLLABUS

UNIT-I: Electric Drives: **12 Hours**

Electric Drive, Advantages of electric drives, Characteristics of different mechanical loads, Parts of electric drives electric motors, close loop of electric drive system, Types of motors used in electric drive pulley drives etc., Examples of selection of motors for different types of domestic loads,

Selection of drive for applications such as general workshop, textile mill, paper mill, steel mill, printing press, crane and lift etc.

Self-Learning Topics: Electric vehicles (EVs) - BLDC and PMSM motors - Basic motor control methods. **CO's: CO1**

UNIT-II: Illumination **14 Hours**

Nature of light, Definition: Luminous flux, solid angle, luminous intensity, illumination, luminous efficiency, depreciation factor, coefficient of utilization, space to height ratio, reflection factor, glare, shadow, lux, Laws of illumination, Different type of lamps, construction and working of incandescent and discharge lamps - their characteristics, fittings required for filament lamp, mercury vapour lamp, fluorescent lamp, metal halide lamp, neon lamp, Main requirements of proper lighting; absence of glare, contrast and shadow, General ideas about street lighting, flood lighting, monument lighting and decorative lighting, light characteristics etc.

Self-Learning Topics: Energy efficient lighting systems - LED drivers and controls -Recent trends in lighting technology. **CO's: CO2**

UNIT- III-Electric Heating: **12 Hours**

Advantages of electrical heating, Heating methods: Resistance heating – direct and indirect resistance heating, properties of resistance heating elements, domestic water heaters and other heating appliances and thermostat control circuit, Induction heating; principle of core type and coreless induction furnace, Electric arc heating; direct and indirect arc heating, construction, working and applications of arc furnace

Self-Learning Topics: Temperature control methods - Energy efficiency in heating systems- Recent advancements in electric heating. **CO's: CO3**

UNIT -IV Electric Welding **12 Hours**

Advantages of electric welding, Welding method, Principles of resistance welding, types, Principle of arc production, electric arc welding, characteristics of arc; carbon arc, metal arc, hydrogen arc welding method of and their applications.

Self-Learning Topics: Automation in welding - Recent advancements welding -Electric welding power usage **CO's: CO4**

UNIT - V: Electric Traction **12 Hours**

Electric traction and track electrification, Special features of traction motor, methods of electric braking- plugging, rheostatic braking and regenerative braking. Mechanics of train movement. Speed-time curves for different services -trapezoidal and quadrilateral speed time curves, tractive effort, power, specific energy consumption for a given run, dead weight, adhesive weight, braking retardation, and coefficient of adhesion.

Self-Learning Topics: Traction system protection - Recent advancements in electric traction systems. **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. "Utilization of electrical energy" by E.O.Taylor.
2. "Electrical Drives: Concept and applications" by VedamSubrahmanyam" THM.

Reference Books:

1. "Art and Science of Utilisation of Electrical Energy" by H.Pratab, DhanpatRai& Co.

Online Learning Resources:

1. https://archive.nptel.ac.in/courses/108/104/108104140
2. https://nptel.ac.in/courses/108105060

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define electric drive.
2. What is illumination?
3. List types of electric heating.
4. What is electric welding?
5. Define electric traction.

L2: Understand

1. Explain the selection of motors for different applications.
2. Describe basic laws of illumination.

3. Explain the principle of electric heating.
4. Describe different welding methods.
5. Explain the need for electric traction systems.

L3: Apply

1. Select a suitable motor for a conveyor system and justify.
2. Calculate illumination level for a given area.
3. Apply electric heating method for industrial use.
4. Choose a welding method for a specific application.
5. Apply traction system concepts to railway operation.

L4: Analyze

1. Analyze different types of electric drives and their applications.
2. Compare various lighting systems and their efficiency.
3. Analyze different electric heating methods with advantages and limitations.
4. Compare welding techniques based on applications.
5. Analyze performance characteristics of electric traction systems.

L5: Evaluate

1. Evaluate the best motor for industrial applications with justification.
2. Assess energy-efficient lighting systems for modern use.
3. Evaluate the effectiveness of electric heating in industries.
4. Justify selection of a welding method for heavy engineering works.
5. Evaluate different traction systems based on performance and cost.

L6: Create

1. Design an electric drive system for an industrial application with proper motor selection.
2. Develop an energy-efficient lighting scheme for a commercial building.
3. Propose an electric heating system for a specific industrial process.
4. Design a suitable welding setup for heavy fabrication work.
5. Develop an electric traction system for modern railway applications.

Chairperson
Board of Studies (EEE)

R24EEOE01 **Industrial Automation** **3 0 0 3**
(Open Elective-I)

Course Objectives:

The main objectives of the course is to

1. To understand the fundamentals of industrial automation systems.
2. To study PLC architecture and programming concepts.
3. To understand SCADA and DCS systems used in industries.
4. To analyze industrial sensors, actuators, and control devices.
5. To understand robotics, industrial communication, and Industry 4.0 concepts.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE01.1	Understand industrial automation concepts and applications.	3	2	1	–	1	2	1	–	1	–	2	1	2	L1,L2
R24EEOE01.2	Analyze PLC hardware and develop ladder logic programs.	3	3	2	2	3	–	–	1	1	1	2	3	2	L2, L3
R24EEOE01.3	Understand SCADA and DCS systems for process control applications.	3	2	2	2	3	1	–	1	1	1	2	2	2	L3, L4
R24EEOE01.4	Analyze industrial sensors, actuators, and communication systems.	3	3	2	2	3	1	–	1	1	–	2	3	2	L4,L5
R24EEOE01.5	Design and evaluate automation systems using robotics and Industry 4.0 technologies.	3	3	3	2	3	2	1	2	2	2	3	3	3	L5,L6

SYLLABUS

Unit – I: Introduction to Industrial Automation **12 Hours**

Introduction to automation, need for automation, types of automation, advantages and disadvantages of automation, industrial control systems, open-loop and closed-loop systems, automation hierarchy, applications of industrial automation.

Self-Learning Topics: Industrial Automation in Smart Manufacturing **CO's: CO1**

Unit – II: Programmable Logic Controllers (PLC) **14 Hours**

PLC architecture, input/output modules, memory organization, PLC operation, ladder logic programming, timers, counters, internal relays, PLC troubleshooting, applications of PLC in industries.

Self-Learning Topics: Advanced PLC Programming Techniques **CO's: CO2**

Unit – III: SCADA and DCS Systems **12 Hours**

Introduction to SCADA, SCADA architecture, Human Machine Interface (HMI), Remote Terminal Unit (RTU), communication protocols, introduction to Distributed Control Systems (DCS), comparison between PLC, SCADA, and DCS.

Self-Learning Topics: Cloud-Based SCADA Systems **CO's: CO3**

Unit – IV: Industrial Sensors and Communication **12 Hours**

Industrial sensors and transducers, temperature sensors, pressure sensors, proximity sensors, actuators, servo motors, industrial communication systems, Modbus, Profibus, CAN protocol, industrial networking.

Self-Learning Topics: Wireless Industrial Communication **CO's: CO4**

Unit – V: Robotics and Industry 4.0 **10 Hours**

Introduction to robotics, robot configuration, robot applications in industries, Industrial Internet of Things (IoT), cyber physical systems, smart factories, Industry 4.0 concepts and applications.

Self-Learning Topics: Artificial Intelligence in Industrial Automation **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Stenerson Jon, "Industrial Automation and Process Control", Pearson Education, 2015.
2. Frank D. Petruzella, "Programmable Logic Controllers", McGraw Hill Education, 2017.
3. Krishna Kant, "Computer-Based Industrial Control", PHI Learning, 2018.

Reference Books:

1. Bolton W., "Programmable Logic Controllers", Newnes Publications, 2015.
2. Mikell P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 2019.
3. Webb John W., "Process Control Instrumentation Technology", Pearson Education, 2016.

Web References:

1. https://nptel.ac.in/courses/108105088
2. https://nptel.ac.in/courses/108104100

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	---
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Industrial Automation.
2. What is PLC?
3. Expand SCADA and DCS.
4. List the types of industrial sensors.
5. Define Industry 4.0.

L2: Understand

1. Explain the need for industrial automation.
2. Illustrate the architecture of PLC.
3. Explain the functions of SCADA systems.
4. Explain the role of sensors in automation systems.

5. Explain the concept of smart factories.

L3: Apply

1. Develop a ladder logic program for motor control.
2. Apply SCADA concepts in process monitoring.
3. Demonstrate the working of proximity sensors.
4. Use communication protocols in industrial networking.
5. Implement automation using PLC and sensors.

L4: Analyze

1. Compare PLC and DCS systems.
2. Analyze the performance of different industrial sensors.
3. Compare wired and wireless industrial communication systems.
4. Analyze robotic applications in manufacturing industries.
5. Compare traditional manufacturing with Industry 4.0.

L5: Evaluate

1. Evaluate the advantages of automation in industries.
2. Justify the use of PLCs in process industries.
3. Evaluate SCADA systems for large-scale industrial control.
4. Determine the suitability of communication protocols for automation.
5. Evaluate the impact of Industry 4.0 on manufacturing systems.

L6: Create

1. Design a PLC-based traffic light control system.
2. Develop an industrial automation system for conveyor belt operation.
3. Formulate a smart factory model using IoT concepts.
4. Design a robotic automation system for material handling.
5. Create an automation system integrating PLC, SCADA, and sensors.

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Board of Studies (EEE)

24EEOE02 **Electrical Design, Estimation & Costing** **3 0 0 3**
(Open Elective-I)

Course Objectives:

The main objectives of the course is to

1. To understand the fundamentals of electrical wiring systems and estimation.
2. To learn the preparation of electrical layouts and wiring diagrams.
3. To estimate materials and costs for domestic and industrial installations.
4. To understand the design aspects of electrical installations.
5. To develop knowledge on tendering, costing, and electrical safety regulations.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE02.1	Understand electrical wiring systems and installation methods.	3	1	1	-	1	1	-	-	-	-	1	1	1	L1,L2
R24EEOE02.2	Prepare electrical layouts and estimate materials for installations.	3	2	2	1	2	1	-	-	1	1	1	2	2	L2,L3
R24EEOE02.3	Analyze domestic and industrial electrical installation requirements.	3	3	2	2	2	2	-	-	1	-	1	2	2	L3,L4
R24EEOE02.4	Analyze costing, tendering, and safety aspects in electrical systems.	3	3	2	1	2	3	2	-	1	2	1	1	2	L4,L5
R24EEOE02.5	Design electrical systems and prepare detailed estimation reports.	3	3	3	3	3	2	1	1	2	3	2	3	3	L5,L6

SYLLABUS

Unit – I: Electrical Wiring Systems **12 Hours**

Introduction to electrical wiring, types of wiring systems, wiring accessories, symbols used in electrical installations, domestic wiring systems, selection of wires and cables, earthing methods and safety precautions.

Self-Learning Topics: Modern Electrical Wiring Practices **CO's: CO1**

Unit – II: Estimation of Domestic Electrical Installations **14 Hours**

Estimation of residential electrical installations, connected load calculation, preparation of wiring diagrams, selection of rating of main switch, distribution board, and protective devices, preparation of material schedule and cost estimation.

Self-Learning Topics: Energy Efficient Residential Installations **CO's: CO2**

Unit – III: Estimation of Industrial Electrical Installations **12 Hours**

Electrical installation for small industries, estimation of power wiring, motor installation, cable sizing, selection of switchgear and protection equipment, industrial load calculations.

Self-Learning Topics: Industrial Energy Management Systems **CO's: CO3**

Unit – IV: Design and Costing **12 Hours**

Design considerations for electrical installations, illumination design, estimation of street lighting systems, preparation of detailed estimates, costing methods, tender specifications, and electrical contracts.

Self-Learning Topics: Computer-Aided Electrical Design Tools **CO's: CO4**

Unit – V: Safety Regulations and Electrical Standards **10 Hours**

Electrical safety regulations, Indian Electricity Rules, IE standards, testing of electrical installations, maintenance of electrical systems, energy conservation techniques.

Self-Learning Topics: Smart Electrical Installations and Safety Systems **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. J.B. Gupta, "Electrical Design, Estimating and Costing", S.K. Kataria & Sons, 2019.
2. K.B. Raina and S.K. Bhattacharya, "Electrical Design Estimating and Costing", New Age International Publishers, 2017.

3. Uppal S.L., “Electrical Wiring Estimating and Costing”, Khanna Publishers, 2018.

Reference Books:

1. M.V. Deshpande, “Electrical Power System Design”, Tata McGraw Hill, 2016.
2. S. Singh and R.D. Singh, “Electrical Estimating and Costing”, Dhanpat Rai Publications, 2015.
3. B.L. Theraja, “Electrical Technology”, S. Chand Publications, 2019.

Web References:

1. https://nptel.ac.in/courses/108105053
2. https://nptel.ac.in/courses/108106165

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	---
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define electrical estimation.
2. What is meant by earthing?
3. List the types of wiring systems.
4. Define connected load.
5. State the purpose of a distribution board.

L2: Understand

1. Explain the need for electrical estimation.
2. Illustrate the layout of domestic wiring.
3. Explain the function of protective devices.

4. Explain the importance of earthing in installations.
5. Explain the significance of tender specifications.

L3: Apply

1. Calculate the connected load for a residential building.
2. Prepare a material estimate for domestic wiring.
3. Select suitable cables for an industrial motor installation.
4. Apply illumination design concepts for street lighting.
5. Estimate the cost of a small industrial installation.

L4: Analyze

1. Compare conduit wiring and casing-capping wiring.
2. Analyze the factors affecting electrical installation cost.
3. Compare domestic and industrial wiring systems.
4. Analyze the safety measures used in electrical installations.
5. Compare different earthing methods.

L5: Evaluate

1. Evaluate the advantages of conduit wiring systems.
2. Justify the selection of protective devices in installations.
3. Evaluate the effectiveness of energy-efficient electrical systems.
4. Determine the suitability of various wiring methods.
5. Evaluate the impact of safety standards on electrical installations.

L6: Create

1. Design a complete electrical layout for a residential building.
2. Develop an estimation report for a small industrial installation.
3. Formulate a street lighting system for a rural area.
4. Design an illumination system for a commercial building.
5. Create a detailed cost estimation for electrical wiring installation.

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Board of Studies (EEE)

R24EEOE03 **Concepts of Renewable Energy Sources** **3 0 0 3**
(Open Elective-I)

Course Objectives:

The main objectives of the course are to

1. To understand the global and Indian renewable energy scenario, energy resources, and sustainability concepts.
2. To analyze the principles, characteristics, and power electronics interfaces of solar photovoltaic systems.
3. To understand the working principles, types, and power systems of wind energy conversion systems.
4. To evaluate small hydro, biomass, geothermal, and tidal energy systems and their applications.
5. To understand hybrid renewable energy systems, energy storage, and grid integration of renewables.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE03.1	Explain the global and Indian renewable energy scenario, energy resource assessment, and sustainability of renewable energy sources.	2	2	-	1	1	3	1	-	1	-	2	1	3	L1, L2
R24EEOE03.2	Analyse the working principle, I-V characteristics, MPPT, and grid-connected and off-grid solar PV system configurations.	2	3	2	2	2	2	-	-	-	-	2	2	3	L3, L4
R24EEOE03.3	Evaluate wind turbine types, wind energy resource assessment,	2	3	2	2	2	2	-	-	-	-	2	2	3	L3, L4

	and power electronics interfaces for PMSG and DFIG generators.														
R24EEOE03.4	Analyse small hydro, biomass, geothermal, and tidal/wave energy systems and evaluate their suitability for specific applications.	2	3	-	2	1	3	-	-	-	-	2	1	3	L2, L4
R24EEOE03.5	Evaluate hybrid renewable energy systems, energy storage technologies, and grid integration challenges for high renewable penetration.	2	3	3	2	2	3	-	-	-	1	3	2	3	L5, L6

SYLLABUS

Unit I – Solar Energy 12 Hours

Introduction, renewable sources prospects, solar radiation at Earth surface, equivalent circuit of PV cell, I-V and P-V characteristics, flat plate and concentrating collectors, solar energy storage, solar pond, solar water heating, solar greenhouse

Self-Learning Topics: Agri-Voltaics: Dual Land Use for Solar Energy Generation and Agriculture

CO's: CO1

Unit II – Wind Energy 12 Hours

Basic principles of wind energy conversion, nature of wind, power in wind, wind energy conversion, site selection considerations, basic components of WECS, classification, applications

Self-Learning Topics: Floating Solar PV Systems: Technology, Advantages, and Projects in India

CO's: CO2

Unit III – Biomass, Hydel and Geothermal Energy 12 Hours

Biomass conversion, photosynthesis, bio digestion; Hydro: classification (large/small/micro); Geo-thermal: sources, applications, operational and environmental problems

Self-Learning Topics: Airborne Wind Energy Systems: Tapping High Altitude Wind Using Kite-Based Generators **O's: CO3**

Unit IV – Energy from Oceans, Waves and Tides **12 Hours**

OTEC methods, prospects of OTEC in India; Wave energy conversion devices; Tidal energy: basic principle, components

Self-Learning Topics: Green Hydrogen Production from Biomass Gasification: Technology and Economic Prospects **CO's: CO4**

Unit V – Chemical Energy Sources **12 Hours**

Fuel cells: equivalent circuit, operation, types, applications; Hydrogen energy: production, storage, applications; MHD power generation: principle, types

Self-Learning Topics: Power-to-X: Green Hydrogen, Synthetic Fuels, and Chemicals from Renewable Energy **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Renewable Energy Sources and Emerging Technologies – D.P. Kothari, K.C. Singal, RakeshRanjan, PHI Learning, 3rd Edition, 2017.
2. Non-Conventional Energy Resources – S.K. Sharma, PHI Learning, 2nd Edition, 2018.

Reference Books:

1. Renewable Energy – Godfrey Boyle, Oxford University Press, 2nd Edition, 2004.
2. Wind Energy Explained: Theory, Design and Application – J.F. Manwell, J.G. McGowan, A.L. Rogers, Wiley, 2nd Edition, 2009.
3. Solar Engineering of Thermal Processes – J.A. Duffie and W.A. Beckman, Wiley, 4th Edition, 2013.
4. Power Electronics for Renewable Energy Systems – Ahmed Al-Durra, S.M. Muyeen, Syed Masoud Barakati, IET, 2015.

Web References:

1. https://nptel.ac.in/courses/112106318
2. https://mnre.gov.in

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. State the Betz limit for wind turbines and explain its physical significance.
2. List the types of solar cells and classify them based on the material used.
3. Define Global Horizontal Irradiance (GHI) and distinguish it from Direct Normal Irradiance (DNI).
4. List the types of geothermal power plants and state the resource conditions suitable for each.

L2: Understand

1. Explain the photovoltaic effect and describe the I-V and P-V characteristics of a solar cell.
2. Describe the Weibull distribution for wind speed and explain how it is used in wind resource assessment.
3. Explain the operating principle of a Doubly Fed Induction Generator (DFIG) for wind energy conversion.
4. Discuss the anaerobic digestion process for biogas production and describe the composition and uses of biogas.

L3: Apply

1. Calculate the power output of a solar PV array for given irradiance, temperature, and module efficiency.
2. Design a 5 kWp off-grid solar PV system with battery storage for a rural household with given daily energy demand.
3. Compute the annual energy yield of a wind turbine using its power curve and a given Weibull

wind speed distribution.

4. Determine the pelton turbine specifications for a micro hydro plant given the head and flow rate.
5. Size the battery storage for a hybrid solar-wind system using HOMER methodology for a given load profile.

L4: Analyze

1. Analyze the effect of partial shading on the I-V characteristic of a solar PV array and evaluate the role of bypass diodes.
2. Compare DFIG and full converter PMSG wind turbine systems in terms of power quality, cost, and grid compatibility.
3. Examine the grid integration challenges posed by high solar PV penetration and analyse mitigation strategies.
4. Evaluate the environmental impact of a 100 MW solar PV plant using lifecycle assessment methodology.

L5: Evaluate

1. Evaluate the techno-economic viability of a 1 MW solar power plant in a given location considering capital cost, O&M, generation, and feed-in tariff.
2. Justify the selection of pumped hydro storage over battery storage for seasonal energy storage in a grid with high renewable penetration.
3. Assess the potential and limitations of tidal energy in India and compare it with offshore wind energy.

L6: Create

1. Design a complete grid-connected solar PV plant of 10 MW specifying module type, string and array configuration, inverter selection, transformer rating, grid interconnection, and annual energy yield.
2. Develop a hybrid solar-wind-battery microgrid for an island community of 200 households using HOMER simulation, specifying all component ratings, control strategy, and cost of energy.
3. Formulate a renewable energy integration plan for a state to achieve 50% renewable energy share specifying the technology mix, grid flexibility requirements, storage needs, transmission upgrades, and policy framework.

Chairperson
Board of Studies (EEE)

R24EEOE04 **Basics of Control System** **3 0 0 3**
(Open Elective-I)

Course Objectives:

The main objectives of the course is to

1. To understand the basic concepts and components of control systems.
2. To study mathematical modeling of physical systems.
3. To analyze time response and stability of control systems.
4. To understand frequency response characteristics and controllers.
5. To develop the ability to design and analyze basic control systems.

Course Outcomes:
At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE04.1	Understand the fundamentals and classifications of control systems.	3	2	1	1	1	-	-	-	-	-	1	2	1	L1,L2
R24EEOE04.2	Analyze mathematical models and transfer functions of systems.	3	3	1	2	2	-	-	-	-	-	1	3	1	L2, L3
R24EEOE04.3	Analyze time response characteristics of first and second order systems.	3	3	2	2	2	-	-	-	-	-	1	3	2	L3, L4
R24EEOE04.4	Analyze stability and frequency response of control systems.	3	3	2	3	3	1	-	-	1	-	2	3	2	L4,L5
R24EEOE04.5	Design and evaluate controllers for control system applications.	3	3	3	3	3	2	1	1	1	1	2	3	3	L5,L6

SYLLABUS

Unit – I: Introduction to Control Systems **12 Hours**

Basic concepts of control systems, open-loop and closed-loop systems, examples of control systems, components of control systems, transfer function, block diagram representation, signal flow graphs.

Self-Learning Topics: Applications of Control Systems in Industries CO's: CO1

Unit – II: Mathematical Modeling of Systems **14 Hours**

Mathematical modeling of electrical and mechanical systems, transfer functions, force-voltage and force-current analogy, block diagram reduction techniques, Mason's gain formula.

Self-Learning Topics: Modeling of Electromechanical Systems
CO's: CO2

Unit – III: Time Response Analysis **12 Hours**

Standard test signals, transient and steady-state response, time response of first-order and second-order systems, performance specifications, steady-state error and error constants.

Self-Learning Topics: Control System Simulation Using Software Tools **CO's: CO3**

Unit – IV: Stability and Frequency Response Analysis **12 Hours**

Concept of stability, Routh-Hurwitz stability criterion, root locus technique, frequency response analysis, Bode plots, polar plots, Nyquist stability criterion.

Self-Learning Topics: Applications of Frequency Response Methods **CO's: CO4**

Unit – V: Controllers and Compensation Techniques **12 Hours**

Introduction to controllers, P, PI, PD, and PID controllers, compensation techniques, lead compensation, lag compensation, applications of controllers in industrial systems.

Self-Learning Topics: Digital Control Systems **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. I.J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International Publishers, 2018.
2. Katsuhiko Ogata, "Modern Control Engineering", Pearson Education, 2019.
3. Benjamin C. Kuo, "Automatic Control Systems", Wiley India, 2017.

Reference Books:

1. Norman S. Nise, "Control Systems Engineering", Wiley Publications, 2016.
2. A. Anand Kumar, "Control Systems", PHI Learning, 2015.
3. Richard C. Dorf and Robert H. Bishop, "Modern Control Systems", Pearson Education, 2018.

Web References:

1. https://nptel.ac.in/courses/108106098
2. https://nptel.ac.in/courses/108102044

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	---
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define control system.
2. What is a transfer function?
3. Define steady-state error.
4. What is a PID controller?
5. State the condition for system stability.

L2: Understand

1. Explain the difference between open-loop and closed-loop systems.
2. Illustrate block diagram representation of control systems.
3. Explain the significance of transfer functions.
4. Explain the importance of stability analysis.

5. Explain the working of PID controllers.

L3: Apply

1. Determine the transfer function of a given system.
2. Apply Mason's gain formula to calculate system gain.
3. Calculate steady-state error for a control system.
4. Draw the root locus for a given transfer function.
5. Design a PI controller for a control system.

L4: Analyze

1. Compare open-loop and closed-loop control systems.
2. Analyze the time response of first-order and second-order systems.
3. Compare Routh-Hurwitz and root locus methods.
4. Analyze Bode plot characteristics of a control system.
5. Compare different controller types.

L5: Evaluate

1. Evaluate the advantages of feedback control systems.
2. Justify the use of PID controllers in industries.
3. Evaluate the stability of a given control system.
4. Determine the effectiveness of compensation techniques.
5. Evaluate the performance specifications of second-order systems.

L6: Create

1. Design a closed-loop control system for motor speed control.
2. Develop a PID controller for temperature control applications.
3. Formulate a transfer function model for an electromechanical system.
4. Design a lead compensator for improving system stability.
5. Create a block diagram model for an industrial automation system.

Chairperson
Board of Studies (EEE)

R24EEOE05 **Fundamentals of Power Systems** **3 0 0 3**

(Open Elective-I)

Course Objectives:

The main objectives of the course are to

1. To understand the sources of electrical energy and the working principles of major power plants.
2. To study the parameters and performance of transmission lines and the basics of distribution systems.
3. To understand types of faults, protective devices, and methods of neutral grounding.
4. To analyze load curves, load factors, tariff structures, and the cost of electrical energy.
5. To understand power factor improvement techniques and methods of voltage control.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE05.1	Explain the working principle and schematic of thermal, hydro, nuclear, and gas power plants and compare them.	2	2	-	1	-	3	1	-	1	-	2	2	2	L1, L2
R24EEOE05.2	Describe transmission line conductor types, line parameters, performance of short lines, and basics of distribution systems and substations.	3	2	-	2	1	1	-	-	-	-	1	3	1	L2, L3
R24EEOE05.3	Identify types of faults and explain the operation of fuses, circuit breakers, relays, lightning arresters, and neutral grounding methods.	2	2	-	2	1	3	2	-	-	-	2	3	1	L1, L2

R24EEOE05.4	Define load curves, load factor, demand factor, utilization factor, and solve numerical problems on types of tariffs and cost of electrical energy.	2	3	-	2	1	2	-	-	-	2	2	2	2	L3, L4
R24EEOE05.5	Explain causes and effects of low power factor solve capacitor compensation problems, and describe voltage regulating devices.	2	2	3	2	2	2	-	-	-	1	2	3	2	L3, L4

SYLLABUS

Unit I – Electrical Power Generation Concepts and Types **12 Hours**

Sources of electrical energy, Thermal/Hydro/Nuclear/Gas power plants (schematics), comparison, importance of renewable energy, diversified energy mix

Self-Learning Topics: Solar and Wind Energy: Growth Trends and India's 500 GW Renewable Energy Target by 2030 **CO's: CO1**

Unit II – Transmission and Distribution Concepts **12 Hours**

Conductor types (ACSR, AAC, AAAC), transmission line parameters, classification (short/medium/long), performance of short lines, substations, distribution systems (radial/ring main/interconnected), cables vs. overhead lines

Self-Learning Topics: High Voltage Direct Current (HVDC) Transmission. **CO's: CO2**

Unit III – Protection and Grounding **12 Hours**

Types of faults (symmetrical/unsymmetrical), fuses, circuit breakers (air/oil/SF6/vacuum), relays (overcurrent, differential), lightning arresters, grounding, neutral grounding methods (solid/resistance/reactance/Peterson coil)

Self-Learning Topics: Numerical Relays and Their Advantages over Electromechanical Relays in Modern Substations **CO's: CO3**

Unit IV – Economic Aspects **12 Hours**

Load curves (daily, weekly, duration), load factor, demand factor, utilisation factor, tariff types (flat, step, block, two-part, three-part, ToU), cost of electrical energy, numerical problems

Self-Learning Topics: Smart Metering and Time-of-Use Tariff: Enabling Consumer Demand Side Management **CO's: CO4**

Unit V – Power Factor Improvement and Voltage Control 12 Hours

Causes/effects of low power factor, shunt capacitor compensation, series capacitor, most economical PF, numerical problems, need for voltage control, tap changing transformers (OLTC), induction regulators, SVC, synchronous condensers

Self-Learning Topics: STATCOM for Dynamic Reactive Power Control in Power Systems

CO's: CO5

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Principles of Power System – V.K. Mehta and Rohit Mehta, S. Chand & Company, 4th Edition, 2008.
2. Electrical Technology – B.L. Theraja and A.K. Theraja, S. Chand & Co., Volume II, 2014.

Reference Books:

1. Generation, Distribution and Utilization of Electrical Energy – C.L. Wadhwa, Wiley Eastern Ltd., 2002.
2. Utilization of Electrical Energy – E. Openshaw Taylor, Orient Longman, 5th Edition, 2003.
3. Switchgear Protection and Power Systems – Sunil S. Rao, Khanna Publishers, 14th Edition, 2014.
4. A Course in Electrical Power – Wadhwa C.L., New Age International, 7th Edition, 2013.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee59
2. https://powermin.gov.in/
3. https://www.powersystemsdesign.com

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---

L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. List the main components of a thermal power plant.
2. Name the types of conductors used in overhead transmission lines.
3. List the types of faults that occur in a power system.
4. Define load factor and demand factor.
5. State the effects of low power factor on an electrical system.
6. List the types of voltage regulating devices.

L2: Understand

1. Explain the working principle of a hydro power plant with a neat schematic diagram.
2. Describe the construction and operating principle of a vacuum circuit breaker.
3. Explain the principle of operation of a lightning arrester.
4. Describe the daily load curve and explain its significance in power system planning.
5. Explain resistance grounding and state its advantages over solid grounding.
6. Describe the working principle of an on-load tap changer (OLTC) transformer.

L3: Apply

1. A short transmission line has resistance 10 ohm and reactance 20 ohm. Find voltage regulation and efficiency for a given load.
2. Calculate the load factor and demand factor for a given daily load curve data.
3. Determine the kVAR of capacitor bank and capacitance required to improve the power factor of a given load from 0.7 to 0.95 lagging.
4. Calculate the cost of electrical energy for a consumer under a given two-part tariff and load data.

5. Compare the annual cost of generation for two power plants with given fixed and running cost data.

L4: Analyze

1. Compare thermal, hydro, nuclear, and gas power plants on the basis of efficiency, cost, reliability, and environmental impact.
2. Analyze the advantages and disadvantages of ring main distribution over radial distribution.
3. Examine the difference between SF6 and vacuum circuit breakers in terms of arc interruption, ratings, and applications.
4. Analyze the effect of power factor improvement on KVA demand, current and annual electricity bill for an industrial consumer.
5. Compare the methods of neutral grounding and identify the most suitable method for different types of distribution systems.

L5: Evaluate

1. Evaluate the economic justification for installing a capacitor bank for power factor correction at an industrial installation.
2. Assess the suitability of hydro power versus thermal power for meeting peak load demand in a power system.
3. Justify the preference for XLPE underground cables over overhead lines for an urban distribution network.

L6: Create

1. Design a power factor correction scheme for an industrial consumer with given load data, specifying capacitor rating, savings in KVA demand, and payback period.
2. Develop a daily load curve for a given set of loads and consumers, compute load factor and demand factor, and recommend suitable tariff for the consumer.
3. Design a protection scheme for a 33/11 kV substation specifying circuit breaker type, relay type, lightning arrester rating, and neutral grounding method.

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R24EEPC15 **Power Electronics Lab** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The students are able to understand the,

1. To learn the characteristics of various power electronic devices and analyze firing circuits and commutation circuits of SCR.
2. To analyze the performance of single–phase and three–phase full–wave bridge converters with both resistive and inductive loads.
3. To understand the operation of AC voltage regulator with resistive and inductive loads, to understand working of Buck and Boost Converters and single-phase & three-phase inverters.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													Do K
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC15.1	Understand and analyze the characteristics of power semiconductor devices and triggering circuits.	3	3	2	2	3	1	-	-	1	-	2	3	2	L2, L3
R24EEPC15.2	Analyze and evaluate the performance of controlled rectifiers, AC voltage regulators, and cycloconverters with different loads.	3	3	2	3	3	2	-	-	1	1	2	3	2	L2, L3
R24EEPC15.3	Design, implement, and analyze DC-DC converters and inverter circuits using PWM techniques.	3	3	3	3	3	2	1	1	2	2	3	3	3	L4, L5

List of Experiments

1. Characteristics of SCR - Power MOSFET & Power IGBT. CO:CO1
2. R - RC & UJT firing circuits for SCR. CO:CO1
3. Single -Phase semi-converter with R & RL loads. CO:CO2
4. Single -Phase full-converter with R & RL loads. CO:CO2
5. Three- Phase full-converter with R & RL loads. CO:CO2

6. Single-phase dual converter in circulating current & non circulating current mode of operation. CO:CO2
7. Single-Phase AC Voltage Regulator with R & RL Loads. CO:CO2
8. Single-phase step down Cycloconverter with R & RL Loads. CO:CO2
9. Boost converter in Continuous Conduction Mode operation. CO:CO3
10. Buck converter in Continuous Conduction Mode operation. CO:CO3
11. Single -Phase half bridge inverter with R & RL Loads. CO:CO3
12. Single -Phase full bridge inverter with R & RL Loads. CO:CO3
13. Single - Phase PWM inverter. CO:CO3
14. Three-phase bridge inverter with 1200 and 1800 conduction mode CO:CO3
15. SPWM control of Three-phase bridge inverter CO:CO3

NOTE: Any 10 experiments are to be conducted

Exercise Problems

1. **Characteristics of SCR, Power MOSFET & Power IGBT**

1. Plot and analyze V-I characteristics of SCR and determine latching and holding current.
2. Calculate gate current required to trigger SCR if gate sensitivity is given.
3. Compare switching characteristics of MOSFET and IGBT with suitable waveforms.
4. Determine conduction losses in MOSFET for given ON resistance.
5. Explain why IGBT is preferred over MOSFET in high power applications.

2. R, RC & UJT Firing Circuits for SCR

1. Calculate firing angle range for RC triggering circuit given R and C values.
2. Design an RC triggering circuit for firing angle variation from 0° to 180°.
3. Determine peak voltage across capacitor in UJT firing circuit.
4. Explain synchronization issues in firing circuits.
5. Compare R and UJT triggering methods in terms of control accuracy.

3. Single-Phase Semi-Converter with R & RL Loads

1. For a given input voltage, calculate average output voltage of semi-converter.
2. Draw output voltage and current waveforms for R load.
3. Determine power factor of the converter.
4. Analyze effect of inductance on load current waveform.
5. Calculate ripple factor for given load conditions.

4. Single-Phase Full-Converter with R & RL Loads

1. Calculate average output voltage for firing angle 60°.

2. Draw voltage waveform for RL load showing continuous conduction.
3. Determine input power factor for given firing angle.
4. Explain commutation overlap effect.
5. Compare semi-converter and full-converter performance.

5. Three-Phase Full-Converter with R & RL Loads

1. Calculate average output voltage for a 3-phase converter at $\alpha = 30°$.
2. Draw line and phase voltage waveforms.
3. Determine ripple frequency of output voltage.
4. Analyze effect of source inductance on output.
5. Calculate efficiency of converter for given data.

6. Single-Phase Dual Converter (Circulating & Non-Circulating Mode)

1. Explain operation of dual converter in circulating current mode.
2. Calculate circulating current for given inductance.
3. Compare circulating and non-circulating modes.
4. Determine output voltage when both converters operate simultaneously.
5. Discuss advantages and disadvantages of dual converters.

7. Single-Phase AC Voltage Regulator with R & RL Loads

1. Calculate RMS output voltage for firing angle 90°.
2. Draw output voltage waveform for R load.
3. Analyze power factor variation with firing angle.
4. Determine THD of output voltage.
5. Compare regulator performance for R and RL loads.

8. Single-Phase Step-Down Cycloconverter with R & RL Loads

1. Determine output frequency for given input frequency.
2. Draw output waveform for step-down operation.
3. Analyze harmonics present in output.
4. Calculate RMS output voltage.
5. Explain circulating current in cycloconverters.

9. Boost Converter (Continuous Conduction Mode)

1. Derive output voltage equation for boost converter.
2. Calculate duty cycle for given input and output voltages.
3. Determine inductor current ripple.

4. Design inductor value for CCM operation.
5. Analyze efficiency considering switching losses.

10. Buck Converter (Continuous Conduction Mode)

1. Calculate output voltage for given duty cycle.
2. Determine ripple current in inductor.
3. Design filter capacitor for given ripple voltage.
4. Compare buck and boost converters.
5. Analyze effect of switching frequency on performance.

11. Single -Phase full bridge inverter with R & RL Loads.

1. Explain the working principle of a single-phase full bridge inverter with R load using appropriate switching sequence and waveforms.
2. Draw the circuit diagram of a single-phase full bridge inverter and explain its operation with RL load.
3. Compare half bridge and full bridge inverters based on circuit configuration, output voltage, and applications.

12. Single -Phase half bridge inverter with R & RL Loads.

1. Explain the operation of a single-phase half bridge inverter with R load using suitable waveforms.
2. Draw the circuit diagram of a single-phase half bridge inverter and explain the function of freewheeling diodes in RL load operation.
3. Compare the output voltage and current waveforms of a half bridge inverter for R load and RL load.
4. Derive the expression for RMS output voltage of a single-phase half bridge inverter.
5. A single-phase half bridge inverter is supplied with a DC input of 200 V. Determine the RMS value of output voltage across the load.

13. Single-Phase PWM Inverter

1. Explain sinusoidal PWM technique.
2. Calculate modulation index for given output voltage.
3. Draw PWM waveform and gating signals.
4. Determine harmonic reduction using PWM.
5. Compare square wave and PWM inverter outputs.

14. Three-Phase Bridge Inverter (120° & 180° Conduction Mode)

1. Compare 120° and 180° conduction modes.
2. Draw line voltage waveform for both modes.
3. Calculate RMS output voltage.
4. Analyze harmonic content in each mode.
5. Explain switching sequence of devices.

15. SPWM Control of Three-Phase Bridge Inverter

1. Explain SPWM generation using sine and carrier signals.
2. Calculate modulation index and its effect on output voltage.
3. Draw SPWM gating signals.
4. Analyze harmonic reduction using SPWM.
5. Compare SPWM with square wave operation.

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R24EEPC16 **Renewable Energy Systems Lab** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To provide practical knowledge of solar photovoltaic systems, battery energy storage systems, and renewable energy conversion technologies through the design, implementation, and testing of renewable energy hardware systems.
2. To develop the ability to analyze the performance and operating characteristics of renewable energy system components, including solar PV systems, charge controllers, batteries, and energy storage systems.
3. To impart skills in modeling, simulation, and performance evaluation of renewable energy systems such as solar PV, wind energy conversion systems, hybrid energy systems, battery energy storage systems, grid-connected systems, and EV charging applications using MATLAB/Simulink.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC16.1	Apply the fundamental principles of solar photovoltaic systems, battery energy storage systems, and renewable energy conversion technologies to analyze their operating characteristics and performance.	3	3	1	2	1	3	-	-	-	-	2	2	3	L1, L2
R24EEPC16.2	Design, implement, and experimentally evaluate renewable energy system components, including solar PV-powered systems, charge controllers, and battery energy storage systems.	2	2	3	3	2	2	1	2	2	1	2	3	3	L2, L3
R24EEPC16.3	Model, simulate,	2	3	2	3	3	1	-	1	1	-	3	3	3	L2,

	and analyze renewable energy systems such as solar PV, wind energy conversion systems, hybrid energy systems, battery storage systems, and grid-connected applications using MATLAB/Simulink.														L3

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Hardware Experiments

1. Design and testing of a PWM solar charge controller for lead-acid battery charging. CO's: CO2
2. Design of a standalone solar PV powered DC lighting system and measurement of energy yield. CO's: CO2
3. Charging and discharging characteristics of batteries used in renewable energy systems. CO's: CO2

MATLAB/Simulink Experiments

1. Simulation of a Solar PV Cell/Module and Analysis of I–V and P–V Characteristics. CO's: CO3
2. Modeling and Simulation of MPPT Algorithms for Solar PV Systems. CO's: CO3
3. Simulation of Grid-Connected Solar PV System. CO's: CO3
4. Simulation of a DC-DC boost converter interfaced with a solar PV module for MPPT operation. CO's: CO3
5. Simulation of a standalone solar PV system with battery storage and PWM charge controller. CO's: CO3
6. Simulation of a grid-connected solar PV system and analysis of power quality parameters using MATLAB/Simulink. CO's: CO3
7. Modeling and Simulation of Wind Energy Conversion System CO's: CO3
8. Simulation of Battery Energy Storage System Integrated with Renewable Sources. CO's: CO3
9. Modeling and Simulation of a Hybrid Renewable Energy System (Solar PV–Wind–Battery) for Standalone Operation. CO's: CO3

10. Modeling and Simulation of an Electric Vehicle (EV) Charging System Integrated with Renewable Energy Sources and Battery Energy Storage. CO's: CO3

Any 10 Experiments are to be conducted

Online Learning Resources:

1. NPTEL – Design of Photovoltaic Systems: https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ee71
2. MATLAB Documentation – Simscape Electrical (Solar PV): https://in.mathworks.com/help/physmod/sps/

References:

1. C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, 3/e, PHI Learning Pvt. Ltd., 2015.
2. Tapan K. Bhattacharya, Terrestrial Solar Photovoltaics, Narosa Publishing House, 1998.
3. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, 2/e, Wiley-IEEE Press, 2013.
4. John A. Duffie and William A. Beckman, Solar Engineering of Thermal Processes, 4/e, Wiley, 2013.

L1: Remember

1. What is a photovoltaic cell and how does it convert solar energy into electricity?
2. Name the major components of a standalone solar PV system.
3. What is the significance of the Maximum Power Point (MPP) in a PV system?
4. What are the different types of solar charge controllers?

L2: Understand

1. How does irradiance and temperature affect the I-V and P-V characteristics of a solar PV module?
2. Explain the working principle of the Perturb and Observe (P&O) MPPT algorithm.
3. What is the effect of partial shading on the output power of a PV array? How are bypass diodes used to mitigate it?
4. Compare the performance of PWM and MPPT charge controllers.

L3: Apply

1. Design a standalone solar PV system to meet a daily load demand of 5 kWh. Determine the PV array size and battery capacity.

2. Simulate and plot the I-V characteristics of a PV module under different irradiance levels using MATLAB/Simulink.
3. How would you size a grid-connected solar PV system for a residential building with a monthly energy consumption of 300 kWh?
4. Analyze and compare the MPPT efficiency of P&O and Incremental Conductance algorithms through MATLAB simulation.

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R24EESC01 **Design of Electrical Systems using Auto-CAD** Lab **0 0 3 1.5**
(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To provide practical knowledge of AutoCAD for electrical drafting.
2. To develop skills in preparing electrical wiring diagrams and layouts.
3. To design residential, commercial, and industrial electrical systems and familiarize with electrical symbols, standards (IEC/IS), and CAD practices.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EESC01.1	Create electrical schematics using AutoCAD tools.	3	2	3	1	3	1	-	1	2	1	2	3	2	L1,L2
R24EESC01.2	Design wiring layouts for buildings.	3	3	3	2	3	2	-	1	2	2	2	3	2	L2,L3
R24EESC01.3	Develop panel and substation drawings and Work on real-time electrical design problems using CAD tools.	3	3	3	3	3	2	1	2	2	2	3	3	3	L2,L3

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List of Experiments

1. Introduction to Auto CAD interface and commands CO: CO1
2. Drawing basic electrical symbols (switches, lamps, sockets) CO: CO1
3. Creating simple electrical circuit diagrams CO: CO1
4. Preparation of single-line diagram (SLD) CO: CO1
5. Design of house wiring layout (1BHK / 2BHK) CO: CO2
6. Switchboard and load distribution plan CO: CO2

7. Earthing and protection system basics CO: CO2
8. Lighting system design for office/shop CO: CO2
9. Panel board layout design CO: CO2
10. Control panel wiring diagram CO: CO2
11. Single-line diagram of 11kV/440V substation CO: CO3
12. Relay and control circuit schematics CO: CO3

Lab Activity:

Mini-project: Design and documentation of electrical system for a small apartment, lab, or factory setup

Software Requirements: AutoCAD Electrical (Student or Institutional License)

Optional: E-Plan, Draft Sight, or similar tools for advanced users

TEXT BOOKS:

1. K.B. Raina and S.K. Bhattacharya "Electrical Design Estimating and Costing" New Age International.
2. Prof.Sham Tickoo "AutoCAD Electrical 2023 for Electrical Control Designers" CADCIM Technologies.
3. Surjit Singh " Basic Electrical Engineering Drawing" Dhanpat Rai & Co

REFERENCE BOOKS:

1. Frederic P. Hartwell and Herbert P. Richter " Practical Electrical Wiring" Park Publishing
2. James A. Leach and Shawna Lockhart "AutoCAD 2023 Instructor" SDC Publications
3. Ray C. Mullin and Phil Simmons "Electrical Wiring Residential" Cengage Learning
4. IS 732: Code of Practice for Electrical Wiring Installations
5. National Electrical Code (NEC) – India.

Online Resources:

1. Autodesk Knowledge Network: https://knowledge.autodesk.com.
2. NPTEL: Basic Electrical Drawing and CAD-related modules (search under "Electrical Engineering")

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R24HS07 Quantitative Aptitude & Effectual Communication skills 0 0 2 1
(Common to all UG Programmes)

Course Objectives:

1. **Develop problem-solving skills**: Students will be able to apply advanced concepts of Mensuration, Statistics, and Pure Mathematics to solve complex quantitative problems. (L3)
2. **Enhance data analysis skills**: Students will be able to Utilize principles of Permutations, Combinations, and Probability to estimate outcomes and interpret data from various charts. (L3)
3. **Develop effective communication skills**: Students will be able to Demonstrate effective verbal, non-verbal, and written communication skills suitable for professional environments. (L2)
4. **Enhance personal development skills**: Students will be able to Perform self-assessment and apply emotional intelligence and time management techniques for personal development. (L4)
5. **Develop leadership skills**: Students will be able to Exhibit leadership, teamwork, and conflict resolution skills during group interactions and collaborative tasks. (L3)

At the end of the course, students will be able to:

Course Code	Course Outcomes	PO1	PO7	PO9	P011	Dok
R24HS07.1	Solve advanced problems in Mensuration, Statistics, and Pure Math.	3	---	---	---	L3
R24HS07.2	Analyze data and estimate probabilities for decision making.	3	---	---	2	L3
R24HS07.3	Communicate effectively through verbal, non-verbal, and written modes.	---	1	2	---	L2
R24HS07.4	Apply self-awareness and EQ to manage time, stress, and goals.	---	---	3	2	L4
R24HS07.5	Demonstrate interpersonal skills, leadership, and team collaboration.	---	---	3	1	L3

SYLLABUS

UNIT-I: Quantitative computation **15 Hours**

Advanced concepts on – Mensuration-2D: basic formulas of Triangles, Square, Rectangle, Parallelogram, Rhombus, Trapezium and Circles and explain advanced problems on Mensuration-2D, Mensuration-3D: basic formulas of Cube, Cuboid, Cylinder, Sphere, Cone, Prism and Pyramid and explain advanced problems on Mensuration-3D, Statistics: basic concepts of Mean, Mode and Median and explain advanced problems on Statistics and Pure Math's: Geometry, Surds, Quadratic

Equations, Logarithms.

Self-Learning Topic: Mixture and Allegations

UNIT-II: Quantitative Estimation **15 Hours**

Permutations & Combinations: basic formulas of Permutations & Combinations and Advanced Problems on linear and circular arrangement, problem based on with and without replacement, repetition and non-repetition, Probability: basic concepts of Probability & Advanced Problems on Coin based and Dice problems. Data Interpretation: Explain Advanced problems on Bar Chart, Pie Chart, Line Chart and Tabular Chart.

Self-Learning Topic: Algebra

UNIT-III: Communication Skills **12 Hours**

Verbal Communication: Effective speaking and articulation, Active listening and paraphrasing, Providing and receiving constructive feedback. Non-Verbal Communication: Body language (gestures, posture, eye contact), Facial expressions and their interpretation, Dress code and professional appearance. Written Communication: Email Etiquette (tone, structure, clarity), Writing professional reports, notices, and memos, Clarity, coherence, and grammar basics for professional settings. Presentation Skills: Structuring a presentation (introduction, body, conclusion), Designing effective slides, Managing stage fright and engaging the audience.

Self Learning Topic: Active Listening Exercise

UNIT-IV: Self-Awareness & Personal Development **12 Hours**

Self-Awareness: Performing a SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats), Understanding personal values and identifying goals. Emotional Intelligence (EQ): Defining EQ and its importance in the workplace, Self-management: regulating emotions and adapting to change, Empathy and understanding others' perspectives. Attitude and Motivation: Cultivating a positive attitude and a growth mindset, Developing self-confidence and assertiveness, Techniques for self-motivation and discipline. Time and Stress Management: Goal setting and prioritization (e.g., Eisenhower Matrix), Effective planning and avoiding procrastination, Stress management techniques and maintaining emotional well-being.

Self Learning Topic: Stress Management Techniques

UNIT-V: Interpersonal and Team Skills **11 Hours**

Teamwork and Collaboration: Defining a team versus a group, Roles within a team and stages of team formation, Effective contribution and shared responsibility. Conflict Resolution: Identifying sources of conflict, Strategies for managing and resolving workplace disagreements, Negotiation skills and achieving win-win outcomes. Leadership and Influence: Different styles of leadership., Delegation and guiding team members, The difference between formal and informal leadership. Group Discussions (GD): Techniques for initiating, contributing, and concluding a GD, Demonstrating listening and analytical skills during a discussion.

Self Learning Topic: Role Plays on Conflict Techniques

Text Books:

1. Quantitative Aptitude for competitive examinations by R.S.Agrawal - S.Chand publications.
2. Business Communication by C.S.G Krishnamacharyulu & Lalitha Ramakrishna – Himalaya publishing house
3. Goleman, Daniel, Emotional Intelligence, Bantam Books.

Reference Books:

1. Numerical Aptitude and Reasoning Ability tests in Competitive exams by Prof.A.Balasubramanian.
2. Numerical Ability and Mathematical Aptitude by Dr.A.B.Rao
3. Communication skills and soft skills by E.Suresh Kumar , p.sreehari & j.savithri
4. Alex K., Soft Skills: Know Yourself & Know the World, S.Chand Publishing.

Web References:

1. https://faceprep.in/ logical reasoning
2. www.sawaal.com
3. http://nptel.ac.in/courses
4. www.prepinsta.com

Model Questions from Quantitative Aptitude & Effectual Communication skills

L1: Remember

1. A cone and a sphere have the same radius of 18cm. If the cone and the sphere have the same volume, then what is the height (in cm) of the cone?
2. A metallic cuboid was processed by way of which its length, breadth and height got increased by 10%, decreased by 8% and increased by 5% respectively. What is the percentage (correct up to two decimal places) change in its volume?
3. If the perimeter of equilateral triangle is 72 cm, then what is its area in cm?
4. The perimeter of a regular hexagon with area 21 square root 3cm is:
5. The day-wise figures for the number of bags sold by a seller during a 30 - day period are as follows: 24, 26, 21, 25, 20, 35, 37, 45, 44, 10, 13, 15, 28, 27, 14, 34,12, 16, 19, 21, 20, 23, 11, 24, 23, 28, 26, 29, 25, 20.
   Find the median number of bags sold in a day for the given data?
6. A variable takes six values: 621, 622, 623, 625, 626,627. Find the ratio between its standard deviation and mean?
7. What is the Mean Deviation of the first ten natural numbers?
8. Find the Mode of the given data:
   25, 66, 42, 52, 64, 25, 48, 52, 59, 52, 68, 25, 47, 52, 48,66, 85, 26, 48, 66
9. If the Mode of a data is 12 and arithmetic mean is 6. then the median is?
10. What is the difference between the mean and the median of the given data?
    5, 9, 8, 15, 12, 9, 2, 19, 21, 11
11. What is the mean deviation (correct to three decimal places) of the number of days in a calendar month for the year 2020?
12. Calculate Mean – Mode + 2Median of the following data
    89, 92, 98, 99, 88, 86, 76, 88, 94, 96

L2: Understand

1. How many different words can be formed with the letters of the word "HARIYANA"?
2. From a group of 12 players a team of 5 players is formed in which one is captain and one is vice-captain. In how many different ways team can be formed?
3. How many different 6-digit numbers can be formed using 1,2,3,5,6,7,8 and 9 such that only even digit comes at even places?

4. The letters of BOTTLE are permutated in all possible ways. How many of these words have all the vowels occupying even places?
5. Ashmita has 3 novels and 4 dictionaries. Determine the number of ways in which all 7 books can be arranged on the shelf, if the novels are on the left and the dictionaries are on the right?
6. A bag contains 4 strawberries and 8 grapes. If 2fruits are drawn, what is the probability that both the fruits taken out from the bag are strawberries?
7. Carl has a standard deck of 52 cards. He pulls out three cards from the deck back to back. What is the probability that first two are king and the last cardis a queen.
8. The probability of snowfall on Wednesday and Friday is 0.4 and 0.50 respectively. What is the probability of snowfall on both days?

L3: Apply

1. What is meant by verbal and non-verbal communication? Give two examples of each.
2. List the barriers to effective communication in a professional environment.
3. Define Emotional Intelligence (EQ) and mention its key components.
4. What are the essential elements that should be included in a professional resume?
5. Name any four types of leadership styles.
6. What is business etiquette? List any four commonly accepted workplace etiquette practices.

L4: Analyzing

1. Draft a professional email to your supervisor requesting approval for a one-day leave of absence.
2. Write a cover letter for the position of Software Trainee at an IT company, highlighting your technical and soft skills.
3. The manager asked the team to _____ their responsibilities clearly to avoid overlap during the project. (fill in the blank)
4. Prepare a short group discussion outline on the topic: 'Is work-life balance achievable in today's fast-paced world?'
5. Describe a time when you had to adapt quickly to a new work environment or assignment. What steps did you take?
6. Outline a one-week time management plan for a student preparing for campus placements.

L5: Evaluating

1. How would you differentiate between assertive and aggressive communication? Support with examples.
2. Explain how active listening contributes to effective interpersonal communication.
3. The new employee felt _____ because his team members did not acknowledge his contributions. (sentence completion)
4. Describe a situation where a team conflict could be resolved through negotiation rather than confrontation.
5. How does emotional intelligence help in managing stress and maintaining work-life balance?
6. Explain the importance of grooming and professional image in the workplace.

R24EEPC19 **Power System Analysis** **3 0 0 3**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Introduce the fundamentals of power system network representation using graph theory, bus admittance matrix formation, and per-unit system for power system analysis.
2. Develop the ability to analyze power flow in interconnected power systems using various numerical techniques such as Gauss-Seidel, Newton-Raphson, and Fast Decoupled methods.
3. Provide knowledge of Z-Bus formation techniques and symmetrical fault analysis for determining fault currents and fault levels in power systems.
4. Familiarize students with symmetrical component theory and its application in the analysis of unsymmetrical faults in power systems.
5. Enable students to evaluate power system stability under steady-state and transient conditions and understand methods for improving system stability.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC19.1	Apply graph theory concepts, per-unit representation, and network modeling techniques to formulate power system matrices and network representations.	3	2	1	-	2	-	-	-	-	-	1	3	1	L1,L2,L3
R24EEPC19.2	Analyze power flow in interconnected power systems using Gauss-Seidel, Newton-Raphson, and Fast Decoupled load flow methods.	3	3	2	2	3	-	-	-	-	-	1	3	1	L2, L3,L4

R24EEPC19.3	Analyze Z-Bus formation procedures and evaluate symmetrical fault currents and fault levels in power systems.	3	3	1	2	2	1	-	-	-	-	1	3	1	L3, L4
R24EEPC19.4	Analyze unsymmetrical faults using symmetrical component theory, sequence networks, and fault analysis techniques	3	3	1	2	2	1	-	-	-	-	1	3	1	L4,L5
R24EEPC19.5	Evaluate the steady-state and transient stability of power systems using swing equation, equal area criterion, and stability enhancement methods.	3	3	2	2	2	2	-	-	-	-	2	3	2	L5,L6

SYLLABUS

Unit –I: Circuit Topology & Per Unit Representation **12 Hours**

Graph theory definitions – Formation of element node incidence and bus incidence matrices – Primitive network representation – Formation of Y_{bus} matrix by singular transformation and direct inspection methods.

Per Unit Quantities–Single line diagram – Impedance diagram of a power system – Numerical Problems.

Self-Learning Topics: Basics of Graph Theory in Electrical Networks, Types of Graphs: Oriented and Non-Oriented Graphs. **CO's: CO1**

Unit –II: Power Flow Studies **14 Hours**

Necessity of power flow studies – Derivation of static power flow equations – Power flow solution using Gauss-Seidel Method – Newton Raphson Method (Rectangular and polar coordinates form) –

Decoupled and Fast Decoupled methods – Algorithmic approach – Numerical Problems on 3–bus system only.

Self-Learning Topics: Importance and Applications of Load Flow Studies in Power System, Classification of Buses: Slack Bus, PV Bus and PQ Bus. **CO's: CO2**

Unit –III: Z-Bus Algorithm and Symmetrical Fault Analysis **12 Hours**

Formation of Z_{bus}**:** Algorithm for the Modification of Z_{bus} Matrix (without mutual impedance)– Numerical Problems.

Reactance's of Synchronous Machine–Three Phase Short Circuit Currents – Short circuit MVA calculations for Power Systems – Numerical Problems.

Self-Learning Topics: Computer-aided formation and applications of Z-Bus matrix in power system analysis, Short-circuit MVA calculations and circuit breaker selection for power system protection. **CO's: CO3**

Unit –IV: Symmetrical Components & Unsymmetrical Fault analysis **12 Hours**

Definition of symmetrical components – symmetrical components of unbalanced three phase systems – Power in symmetrical components – Sequence impedances and Sequence networks of Synchronous generator, Transformers and Transmission line- Numerical Problems.

Various types of faults: LG–LL– LLG and LLL on unloaded alternator -Numerical problems.

Self-Learning Topics: Need for Symmetrical Components in Fault Analysis, Fortescue Theorem and Its Significance. **CO's: CO4**

Unit –V: Power System Stability **15 Hours**

Introduction to power system stability, Classification of power system stabilities, Steady state and transient stability limits, Power angle curve, Derivation of swing equation, Equal area criterion, Determination of critical clearing angle, Numerical problems, Methods to improve the stability limits.

Self-Learning Topics: Impact of renewable energy sources on power system stability, Applications of Flexible AC Transmission Systems (FACTS) controllers for stability enhancement. **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 3

Approved in ACM No: 03

Text Books:

1. Power System Analysis by Grainger and Stevenson-Tata McGraw Hill.2003
2. Modern Power system Analysis by I.J. Nagrath & D.P. Kothari : Tata McGraw–Hill

Publishing Company - 3rd edition - 2007.

Reference Books

1. Power System Analysis – by A.R. Bergen –Prentice Hall-2nd edition -2009.
2. Power System Analysis by Hadi Saadat–Tata McGraw–Hill3rd edition -2010.
3. Power System Analysis by B.R.Gupta -A H Wheeler Publishing Company Limited -1998.
4. Power System Analysis and Design by J.Duncan Glover -M.S.Sarma -T.J.Overbye – Cengage Learning publications -5th edition -2011

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc19_ee62
2. http://www.digimat.in/nptel/courses/video/108107127/L10.htm

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What is a node in a network graph?
2. What is a slack bus?
3. List the modifications used in Z_{BUS} formation.
4. Define positive sequence components.

L2: Understand

1. Explain the formation of Y_{BUS} matrix using singular transformation method.
2. Derive the static power flow equations.
3. Describe the procedure for short-circuit MVA calculations.
4. Explain sequence networks of generators, transformers, and transmission lines.
5. Explain equal area criterion with suitable diagrams.

L3: Apply

1. Form the Y_{BUS} matrix for a given network using direct inspection method.
2. Determine real and reactive power mismatches in a 3-bus system
3. Form the Z_{BUS} matrix using the building algorithm for a given network.
4. Calculate fault currents for LG, LL, and LLG faults
5. Determine power transfer using the power-angle equation.

L4: Analyzing

1. Compare primitive network representation and bus incidence matrix representation
2. Compare Decoupled and Fast Decoupled load flow methods
3. Compare bus impedance and bus admittance matrices.
4. Analyze the behavior of power systems under unsymmetrical faults.
5. Analyze transient stability of a single-machine infinite-bus system.
6. Analyze the power-angle curve during fault and post-fault conditions.

L5: Evaluating

1. Evaluate the advantages and limitations of per unit system.
2. Assess the importance of power flow studies in power system operation
3. Evaluate the severity of different types of faults in power systems.
4. Evaluate methods used for improving system stability.

L6: Create

1. Design a single-line diagram and corresponding impedance diagram for a simple system.
2. Develop an algorithm for Gauss-Seidel load flow analysis.
3. Develop complete sequence network models for fault analysis..

Chairperson
Board of Studies (EEE)

R24EEPC19 Electrical Measurements and Instrumentation Lab 0 0 3 1.5

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Understand the principles and working of electrical measuring instruments and calibration methods.
2. Measure electrical parameters such as resistance, inductance, capacitance, and power using different bridge and experimental methods.
3. Study and analyze the performance of electrical transducers and measurement systems used in practical applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC19.1	Calibrate energy meters, wattmeters, ammeters, and voltmeters using standard methods.	3	2	1	2	3	-	-	-	1	-	1	3	1	L1,L2
R24EEPC19.2	Measure resistance, inductance, capacitance, and power using bridge and other methods.	3	3	1	3	3	-	-	-	1	-	1	3	1	L1,L2
R24EEPC19.3	Study and evaluate transducers such as LVDT, strain gauge, thermocouple, capacitive transducer, and DC potentiometer systems.	3	2	1	2	3	1	-	-	2	-	2	2	3	L2,L3

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

LIST OF EXPERIMENTS:

1. Calibration and Testing of Single Phase Energy Meter COs: CO1

2. Measurement of resistance using Kelvin's double Bridge. COs:CO2
3. Measurement of Inductance and Capacitance using Anderson Bridge and Schering Bridge. COs: CO2
4. Calibration of dynamometer wattmeter using phantom loading COs:CO1
5. Calibration of dynamometer wattmeter using phantom loading COs:CO1
6. Determination of the characteristics of a LVDT. COs:CO3
7. Measurement of single-phase power using a three voltmeter method. COs:CO2
8. Measurement of single-phase power using a three ammeter method. COs:CO2
9. Measurement of strain for a bridge strain gauge. COs:CO3
10. Measurement of Choke coil parameters. COs:CO2
11. Calibration of LPF Wattmeter by direct loading. COs:CO2
12. Determination of the characteristics of a Thermocouple. COs:CO3
13. Determination of the characteristics for a capacitive transducer COs:CO3
14. Crompton DC Potentiometer – Calibration of PMMC Ammeter & PMMC voltmeter COS:CO3

NOTE: Any 10 experiments are to be conducted

L1: Remember

1. What is the calibration of a single-phase energy meter?
2. What is Kelvin's double bridge used for?
3. What are Anderson Bridge and Schering Bridge used for?
4. What is LVDT?
5. What is a choke coil?

L2: Understand

1. How is a single-phase energy meter calibrated?
2. Why is Kelvin's double bridge preferred for low resistance measurement?
3. How does Anderson Bridge measure inductance?
4. How does Schering Bridge measure capacitance?
5. Why is phantom loading used in wattmeter calibration?

L3: Apply

1. What precautions are required while using Kelvin's double bridge?
2. Why Anderson Bridge is considered accurate?
3. Where is phantom loading practically used?
4. What are the applications of LVDT?
5. How are PMMC ammeter and voltmeter calibrated using Crompton potentiometer?

Chairperson
Board of Studies (EEE)

R24HS08 MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS 2 0 0 2

(Common to EEE, Mechanical, ECE, CSE, CSE- AI&ML, CSE-D)

Course Objectives:

1. To inculcate the basic knowledge of microeconomics and financial accounting
2. To make the students learn how demand is estimated for different products, input-output relationship for optimizing production and cost
3. To Know the Various types of market structure pricing methods and strategy
4. To give an overview of investment appraisal methods to encourage the students to learn
5. how to plan long-term investment decisions.
6. To provide fundamental skills in accounting and to explain the process of preparing
7. financial statements.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	
R24HS05	Understand what Managerial Economics is and how demand and its factors affect business decisions.	3	2	-	-	2	-	-	-	2	2		3	L1, L2
R24HS05	Learn how to predict future demand and understand how production and costs work in a business.	3	3	2	3	-	-	-	-	2	2	2	3	L2, L3
R24HS05	Know different types of markets and how companies decide prices in various situations.	3	3	2	2	2	-	-	-	2	2	2	3	L3, L4
R24HS05	Understand types of business organizations, business cycles, and how to plan for long-term investments.	2	2	-	-	3	-	-	-	3	3		3	L4, L5
R24HS05	Learn how to prepare and read financial statements and check a company's financial health using simple tools.	2	2	-	2	3	-	-	2	3	3	3	3	L5, L6

SYLLABUS

UNIT I **10 Hours**

Managerial Economics and Demand Analysis: Definition, nature, and scope of Managerial Economics – Relationship with other disciplines (Accounting, Finance, Behavioral Economics) – Basic economic tools: Opportunity Cost, Marginal Analysis, Discounting Principle – Demand:

Meaning, types, determinants – Law of Demand and its exceptions – Elasticity of Demand: Types and measurement (Total Outlay, Point, Arc Methods) – Significance in pricing decisions. **CO's-CO1**

Self-Learning Topics

Study how managerial economics supports business decision-making in modern organizations. Analyze real-world examples of demand fluctuations and examine how elasticity of demand influences pricing strategies in different industries.

UNIT II **8 Hours**

Demand Forecasting and Production-Cost Analysis: Demand Forecasting: Meaning, factors, methods (Survey, Statistical, Delphi) – Forecasting for new products – Characteristics of a good forecasting method – Production Function: Isoquants, Isocosts, MRTS – Cobb-Douglas, CES functions – Cost concepts: Fixed vs. Variable, Explicit vs. Implicit, Opportunity Cost – Break-even analysis: Meaning, graphical representation, managerial significance **CO's-CO2**

Self-Learning Topics

Explore various demand forecasting techniques used by organizations and compare their effectiveness in predicting market demand. Prepare a simple break-even analysis for a business scenario and interpret its managerial significance.

UNIT III **12 Hours**

Market Structures and Pricing Policies Market Structures: Features of Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly – Price-output determination under different market conditions – Pricing Methods: Cost-based, Marginal Cost, Value-based, Skimming, Penetration, Bundling, Surge Pricing – Internet Pricing Models: Flat Rate, Usage-based, Smart Market Mechanism. **CO's-CO3**

Self-Learning Topics

Investigate different market structures and identify businesses operating under each type of market condition. Study modern pricing strategies such as dynamic pricing, surge pricing, and online pricing models used by digital platforms and e-commerce companies.

UNIT IV **12 Hours**

Industrial Organization and Capital Budgeting: Forms of Business Organization: Sole Proprietorship, Partnership, Joint Stock Company, Co-operative Societies, LLPs – Public Enterprises: Types and features – Business Cycles: Phases and characteristics – Capital Budgeting: Need, importance – Methods: Payback Period, ARR, IRR, NPV, Profitability Index (simple problems). **CO's-CO4**

Self-Learning Topics

Analyze the advantages and limitations of different forms of business organizations in India. Prepare simple capital budgeting calculations using Payback Period, ARR, NPV, and IRR methods and interpret their usefulness in investment decision-making.

UNIT V **12 Hours**

Financial Accounting and Analysis: Accounting Principles – Double-entry system – Journal, Ledger, Trial Balance, Final Accounts (with simple adjustments) – Introduction to Tally/ERP tools – Limitations of Financial Statements – Financial Statement Analysis: Liquidity, Profitability, Solvency Ratios – Fund Flow Statement – Cash Flow Statement (basic concepts as per AS-3).

CO's-CO5

Self-Learning Topics

Explore the preparation and interpretation of financial statements using basic accounting principles. Study the importance of ratio analysis, fund flow, and cash flow statements in evaluating the financial

performance and liquidity position of organizations.

Textbooks:

1. Varshney & Maheswari: Managerial Economics, Sultan Chand.
2. Aryasri: Business Economics and Financial Analysis, 4/e, MGH.

Reference Books:

1. Ahuja Hl Managerial economics Schand.
2. S.A. Siddiqui and A.S. Siddiqui: Managerial Economics and Financial Analysis, New Age International.
3. Joseph G. Nellis and David Parker: Principles of Business Economics, Pearson, 2/e, New Delhi.
4. Domnick Salvatore: Managerial Economics in a Global Economy, Cengage.

Web References:

1. .https://www.slideshare.net/123ps/managerial-economics-ppt
2. .https://www.slideshare.net/rossanz/production-and-cost-45827016
3. .https://www.slideshare.net/darkyla/business-organizations-19917607
4. .https://www.slideshare.net/balarajbl/market-and-classification-of-mark
5. .https://www.slideshare.net/ruchi101/capital-budgeting-ppt-59565396
6. https://www.slideshare.net/ashu1983/financial-accounting

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	17	-
L2	17	-
L3	33	30
L4	33	30
L5	-	28
L6	-	14
Total (%)	**100**	**100**

Sample Short and Long Answers to Questions of Various Cognitive Levels

Short Answer Questions:

1. Define Managerial Economics. (L1)
2. What is the Law of Demand? (L1)
3. List any three determinants of demand. (L1)
4. Explain the relationship between Managerial Economics and other disciplines. (L2)
5. Differentiate between the Total Outlay Method and the Arc Method. (L2)

Long Answer Questions:

1. Explain the types and significance of elasticity of demand. (L2)
2. Analyze the role of elasticity in business decision-making. (L4)

Unit II: Demand Forecasting & Production-Cost Analysis

Short Answer Questions:

1. Define Demand Forecasting. (L1)
2. List two qualitative forecasting methods. (L1)
3. What is the difference between Isoquant and Isocost? (L2)
4. Classify costs into fixed and variable types. (L3)
5. Identify the break-even point from the given data. (L3)

Long Answer Questions:

1. Describe demand forecasting methods and explain one in detail. (L2)
2. Draw isoquants and isocosts; explain MRTS. (L3)
3. Analyze managerial implications of break-even analysis. (L4)

Unit III: Market Structures & Pricing Policies

Short Answer Questions:

1. Define Perfect Competition. (L1)
2. List features of Monopolistic Competition. (L1)
3. Explain Penetration Pricing. (L2)
4. Compare Perfect Competition and Monopoly. (L4)
5. Suggest a pricing strategy for a new e-commerce service. (L6)

Long Answer Questions:

1. Explain various pricing methods with examples. (L2)
2. Evaluate Smart Market Mechanism in digital services. (L5)
3. Analyze the Indian retail sector's market structure. (L4)

Unit IV: Industrial Organization & Capital Budgeting

Short Answer Questions:

1. List forms of business organization. (L1)
2. What are the features of a Joint Stock Company? (L2)
3. Define Capital Budgeting. (L1)
4. Identify suitable capital budgeting methods for short-term projects. (L3)
5. Differentiate between ARR and IRR. (L2)

Long Answer Questions:

1. Compare business forms and their startup suitability. (L4)
2. Explain Payback, NPV, and IRR with examples. (L2)
3. Evaluate a capital investment using the Profitability Index. (L5)

Unit V: Financial Accounting & Analysis

Short Answer Questions:

1. What is Double-entry Accounting? (L1)
2. Define Trial Balance and its purpose. (L1)
3. Explain the limitations of financial statements. (L2)
4. Prepare a Trial Balance from given transactions. (L3)
5. Identify liquidity ratios and explain their use. (L2)

Long Answer Questions:

1. Prepare Final Accounts from a Trial Balance. (L3)
2. Analyze financial health using ratios. (L4)
3. Create a Fund Flow Statement using data. (L6)

Chairperson
Board of Studies (MBA)

R24EEPE06 Machine Learning & Deep Learning and its Applications 3 0 0 3
(Professional Elective-II)

Course Objectives:

The main objectives of the course is to

1. To understand basic concepts of Machine Learning and Deep Learning.
2. To learn regression and classification techniques.
3. To study neural network models and learning algorithms.
4. To analyze ANN and CNN architectures.
5. To apply ML/DL techniques in electrical engineering applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE06.1	Explain fundamentals of Machine Learning concepts.	3	2	-	1	2	-	-	-	-	-	2	1	1	L1,L2
R24EEPE06.2	Apply regression and classification algorithms.	3	3	2	2	3	1	-	-	-	-	2	2	2	L2, L3
R24EEPE06.3	Understand basic deep learning models and perceptrons.	3	2	1	1	2	-	-	-	-	-	2	1	1	L3, L4
R24EEPE06.4	Implement ANN and CNN techniques.	3	3	2	3	3	1	-	-	1	-	2	3	2	L4,L5
R24EEPE06.5	Apply ML/DL methods in electrical engineering problems.	3	3	3	3	3	2	-	-	1	1	3	3	3	L5,L6

SYLLABUS

UNIT-I: Introduction to Machine Learning **12 Hours**

Definition, Relation between AI, ML, DL, Need of Machine Learning, Types of Machine Learning, Applications, Challenges of Machine Learning, Data Acquisition. Features selections and features extraction, Over fitting Vs Under fitting, Bias and variance

Self-Learning Topics: Evolution-Paradigm-Architecture-Preprocessing. **CO's: CO1**

UNIT-II: Regression and Classification Techniques **12 Hours**

Linear Regression, Non-Linear Regression: Introduction, Key differences between Linear Regression and Non-Linear Regression-Logistic Regression: Binary Classification

Classification Types (Binary, Multi-class, Multi-label), Imbalanced Classification, Decision Tree Representation, ID3 Algorithm, Random Forest Algorithm.

Self-Learning Topics: Normalization- encoding- visualization of data sets. **CO's: CO2**

UNIT-III: Introduction to Deep Learning **12 Hours**

Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm.

Self-Learning Topics: Deep Architectures, Training Techniques **CO's: CO3**

UNIT-IV: Artificial Neural Networks (ANN) and Convolutional Neural Networks (CNN)

12 Hours

Architecture (Input, Hidden, Output Layers), Back propagation, Gradient Descent, Activation Functions. Introduction & Importance, Convolution & Pooling Operations, CNN Architectures.

Self-Learning Topics: Weight Initialization Methods -Batch Normalization -Stride & Padding, Feature Maps- Data Augmentation **CO's: CO4**

UNIT-V: Recurrent Neural Networks (RNN) and Electrical Application **14 Hours**

Sequential Data Processing & Basics of RNN, Vanishing Gradient Problem & LSTMs, Word Embeddings -Attention Mechanisms & Transformers.

Load Forecasting, Fault Detection & Diagnosis, Predictive Maintenance of Electrical Machines, Smart Grid Optimization, Renewable Energy Prediction

Self-Learning Topics: Power Quality Analysis-Battery Health Estimation **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

TEXT BOOKS:

1. Machine Learning, Tom M. Mitchell, First Edition, 2017, McGraw Hill Education
2. Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, Aurelien Geron, Third Edition, 2022, O'Reilly

REFERENCES:

1. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, 2012, MIT Press
2. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, 2012, MIT Press

Web References:

1. 1.Introduction to Machine Learning: https://nptel.ac.in/courses/106105152/.
2. Introduction to Machine Learning : https://nptel.ac.in/courses/106106139/.
3. Machine Learning : https://nptel.ac.in/courses/106106202/.

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define Machine Learning and Deep Learning.
2. List types of Machine Learning.
3. What is over fitting and under fitting?
4. Define linear regression and logistic regression.
5. What is ANN and CNN?

L2: Understand

1. Explain the relationship between AI, ML, and DL.
2. Describe classification types (binary, multi-class, multi-label).
3. Explain perceptron learning algorithm.
4. Discuss activation and loss functions.
5. Explain RNN and LSTM concepts.

L3: Apply

1. Apply linear regression to a dataset.
2. Use decision tree for classification.
3. Implement ANN for prediction.
4. Apply CNN for image classification.

5. Use RNN/LSTM for sequence prediction.

L4: Analyze

1. Compare regression and classification techniques.
2. Analyze bias-variance tradeoff.
3. Compare ANN, CNN, and RNN architectures.
4. Examine vanishing gradient problem.
5. Analyze ML applications in electrical systems.

L5: Evaluate

1. Evaluate performance of ML models.
2. Justify use of CNN over ANN.
3. Assess effectiveness of random forest.
4. Evaluate deep learning techniques for real-world problems.
5. Critique ML applications in smart grids and fault detection.

L6: Create

1. Design a complete ML model pipeline.
2. Develop a deep learning model for classification.
3. Create a CNN-based object detection system.
4. Build an RNN model for load forecasting.
5. Design an intelligent electrical system using ML/DL.

Chairperson
Board of Studies (EEE)

R24EEPE07 **Switchgear and Protection** **3 0 0 3**
(Professional Elective-II)

Course Objectives:

The main objectives of the course are to

1. Understand the working principles and applications of circuit breakers used in power systems.
2. Analyze electromagnetic relay protection schemes for fault detection and system protection.
3. Study protection methods for generators and transformers under abnormal conditions.
4. Understand feeder and busbar protection using advanced relays and protection schemes.
5. Evaluate over-voltage protection methods and neutral grounding practices in power systems.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE07.1	Understand the operation and characteristics of circuit breakers and arc interruption techniques.	3	2	1	1	2	1	-	-	-	-	1	2	1	L1,L2
R24EEPE07.2	Analyze relay-based protection systems for fault detection and isolation.	3	3	2	2	3	1	-	-	-	-	1	3	2	L3,L4
R24EEPE07.3	Design protection schemes for generators and transformers against various	3	3	3	2	3	2	1	-	1	1	2	3	2	L5,L6

	faults.														
R24EEPE07.4	Implement feeder and busbar protection using distance and static relays.	3	3	2	3	3	1	-	-	1	-	2	3	2	L3.L4
R24EEPE07.5	Evaluate over-voltage protection and grounding methods in power systems.	3	3	2	2	2	3	2	-	-	-	2	2	3	L5.L6

SYLLABUS

Unit – I: Circuit Breakers **14 Hours**

Miniature Circuit Breaker (MCB), Elementary principles of arc interruption, Re-striking voltage and recovery voltage, Restriking phenomenon, Rate of Rise of Re-striking Voltage (RRRV), Average and maximum RRRV, Current chopping and resistance switching, Oil circuit breakers, Air blast circuit breakers, Vacuum and SF6 circuit breakers, Circuit breaker ratings and specifications, Concept of auto reclosing.

Self-Learning Topics: Modern Smart Circuit Breakers **CO's: CO1**

Unit – II: Electromagnetic Protection **12 Hours**

Relay connections, Attracted armature relay, Induction disc and induction cup relays, Torque equation, Classification of relays, Instantaneous, DMT and IDMT relays, Over current and under voltage relays, Directional relays, Differential and percentage differential relays, Universal torque equation, Distance relays – Impedance, Reactance, Mho and offset Mho relays, Characteristics and comparison of distance relays.

Self-Learning Topics: Digital and Numerical Relays

CO's: CO2

Unit – III: Generator and Transformer Protection **14 Hours**

Generator Protection: Protection against stator faults, Rotor faults and abnormal conditions, Restricted earth fault protection, Inter-turn fault protection, Numerical examples.

Transformer Protection: Percentage differential protection, Design of CT ratios, Buchholz relay protection, Numerical examples.

Self-Learning Topics: Modern Protection Schemes for Power Transformers **CO's: CO3**

Unit – IV: Feeder, Busbar Protection and Static Relays 12 Hours

Over current protection schemes, Plug Setting Multiplier (PSM), Time Multiplier Setting (TMS), Numerical examples, Carrier current protection, Three-zone distance relay using impedance relays, Busbar protection using differential protection, Introduction to static relays, Classification and basic components of static relays.

Self-Learning Topics: Microprocessor Based Protection Systems **CO's: CO4**

Unit – V: Protection against Over Voltages and Grounding 12 Hours

Generation of over voltages in power systems, Protection against lightning over voltages, Valve type and Zinc oxide lightning arresters, Grounded and ungrounded neutral systems, Effects of ungrounded neutral on system performance, Methods of neutral grounding – Solid grounding, Resistance grounding, Reactance grounding, Arcing grounds and grounding practices.

Self-Learning Topics: Smart Grid Protection Techniques **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Power System Protection and Switchgear, Tata McGraw Hill Publications, 2nd Edition, 2011.
2. Power System Protection – Static Relays with Microprocessor Applications, Tata McGraw Hill, 2nd Edition.

Reference Books:

1. Fundamentals of Power System Protection, PHI, 2003.
2. Art and Science of Protective Relaying, Wiley Eastern Ltd.

Web References:

1. NPTEL – Power System Protection: https://archive.nptel.ac.in/courses/108/107/108107167
2. NPTEL – Switchgear and Protection: https://archive.nptel.ac.in/courses/108/105/108105167

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---

L3	30	---
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define restriking voltage in circuit breakers.
2. List the types of electromagnetic relays.
3. Define Buchholz relay.
4. State the need for neutral grounding.

L2: Understand

1. Explain the principle of arc interruption in circuit breakers.
2. Illustrate the operation of induction disc relay.
3. Explain the protection scheme for generator stator faults.
4. Explain the operation of lightning arresters.

L3: Apply

1. Calculate the RRRV for a given circuit breaker system.
2. Apply percentage differential protection for transformer protection.
3. Design CT ratios for transformer protection schemes.
4. Apply impedance relay characteristics for feeder protection.

L4: Analyze

1. Compare oil, vacuum and SF6 circuit breakers.
2. Analyze the operation of IDMT relays for overcurrent protection.
3. Differentiate between impedance, reactance and Mho distance relays.
4. Analyze the three-zone distance protection scheme for feeders.

L5: Evaluate

1. Evaluate the performance of SF6 circuit breakers in high voltage systems.

2. Justify the use of percentage differential protection for transformers.
3. Evaluate the effectiveness of busbar protection using differential relays.
4. Assess the neutral grounding methods for power system stability.

L6: Create

1. Design a complete protection scheme for a large power transformer.
2. Develop a busbar protection system using differential protection principles.
3. Formulate a feeder protection plan using distance relays for a radial distribution system.
4. Create a neutral grounding scheme for an industrial power system.

Chairperson
Board of Studies (EEE)

R24EEPE08 **Power Semiconductor Drives** **3 0 0 3**

(Professional Elective-II)

Course Objectives:

The main objectives of the course are to

1. Understand the fundamentals of electric drives and various braking methods used in electrical drives.
2. Analyze converter-fed DC motor drives and four quadrant operation using dual converters.
3. Study DC–DC converter control techniques for DC motors operating in different quadrants.
4. Understand speed control methods of three-phase induction motor drives using inverter and rotor side control techniques.
5. Evaluate speed control mechanisms and closed-loop operation of synchronous motor drives.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE09.1	Explain the fundamentals of electric drives and electrical braking methods.	3	2	1	1	2	1	-	-	-	-	1	2	1	L1, L2
R24EEPE09.2	Analyze converter-fed DC motor drives and dual converter based four quadrant operation.	3	3	2	2	3	1	-	-	-	-	1	3	2	L4, L5
R24EEPE09.3	Apply DC–DC converter control techniques for DC motor drives operating in various quadrants.	3	3	2	2	3	1	-	-	1	-	1	3	2	L3, L4

R24EEPE09.4	Analyze speed control methods of induction motor drives using stator and rotor side control techniques.	3	3	2	2	3	2	-	-	-	-	2	3	3	L4, L5
R24EEPE09.5	Evaluate speed control techniques and closed loop control of synchronous motor drives.	3	3	3	3	3	2	1	-	1	1	2	3	3	L5, L6

SYLLABUS

Unit – I: Fundamentals of Electric Drives **12 Hours**

Electric drive and its components, Fundamental torque equation, Load torque components, Nature and classification of load torques, Steady state stability, Load equalization, Four quadrant operation of electric drives (hoist control), Electrical braking methods – Dynamic braking, Plugging and Regenerative braking, Numerical problems.

Self-Learning Topics: Applications of Electric Drives in Electric Vehicles **CO's: CO1**

Unit – II: Converter Fed DC Motor Drives **12 Hours**

Single phase half-controlled and fully-controlled converter fed separately excited and self-excited DC motor drives under continuous and discontinuous current modes, Three-phase fully-controlled converter fed DC motor drives, Output voltage and current waveforms, Speed-torque characteristics, Three-phase dual converter fed DC motor drives, Four quadrant operation, Numerical problems.

Self-Learning Topics: Digital Control of DC Motor Drive **CO's: CO2**

Unit – III: DC–DC Converter Fed DC Motor Drives **12 Hours**

Single quadrant, two quadrant and four quadrant DC–DC converter fed separately excited and self-excited DC motors, Continuous current mode operation, Output voltage and current waveforms, Speed-torque characteristics, Closed loop operation of DC drives (qualitative treatment), Numerical problems.

Self-Learning Topics: Chopper Controlled Electric Vehicle Drives **CO's: CO3**

Unit – IV: Control of Three-Phase Induction Motor Drives **14 Hours**

Stator voltage control using three-phase AC voltage controllers, Waveforms and speed-torque characteristics, Variable Voltage Variable Frequency (VVVF) control using PWM voltage source

inverter, Closed loop V/f control of induction motor drives (qualitative treatment), Static rotor resistance control, Slip power recovery schemes, Static Scherbius drive, Static Kramer drive, Performance analysis and speed-torque characteristics, Numerical problems.

Self-Learning Topics: Vector Control and Direct Torque Control of Induction Motors **CO's: CO4**

Unit – V: Control of Synchronous Motor Drives **12 Hours**

Permanent Magnet Synchronous Motor (PMSM) – Basic operation and advantages, Separate control of synchronous motor, Self-control of synchronous motor using load commutated thyristor inverter, Closed loop control of synchronous motor drives (qualitative treatment), Numerical problems.

Self-Learning Topics: Applications of PMSM in Industrial Automation and EVs **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No:03,

Approved in ACM No:03

Text Books:

1. Fundamentals of Electric Drives, Narosa Publications, 2nd Edition, 2002.
2. Power Semiconductor Drives, Wiley India, 1984.

Reference Books:

1. Electric Motors and Drives Fundamentals, Types and Applications, Newnes, 4th Edition, 2013.
2. Thyristor Control of Electric Drives, Tata McGraw Hill Publications, 1987.
3. Power Electronic Circuits, Devices and Applications, PHI, 3rd Edition, 2009.

Web References:

1. NPTEL – Electric Drives: https://archive.nptel.ac.in/courses/108/104/108104140
2. NPTEL – Power Electronics and Drives: https://nptel.ac.in/courses/108104011

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	35	---
L2	35	---
L3	30	---
L4	---	35
L5	---	45

L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define electric drive and list its components.
2. State the different types of electrical braking methods.
3. Define slip power recovery scheme.
4. List the advantages of PMSM drives.

L2: Understand

1. Explain the four quadrant operation of electric drives.
2. Illustrate the operation of a three-phase converter fed DC motor drive.
3. Explain V/f control of induction motor drives.
4. Explain the operation of load commutated inverter fed synchronous motor drives.

L3: Apply

1. Calculate speed and torque characteristics of converter-fed DC motor drives.
2. Apply dual converter principles for four quadrant operation of DC motors.
3. Determine output voltage for a DC–DC converter fed DC motor drive.
4. Apply slip power recovery techniques for induction motor speed control.

L4: Analyze

1. Compare plugging, regenerative braking and dynamic braking methods.
2. Analyze stator side and rotor side control methods of induction motors.
3. Compare static Scherbius and static Kramer drives.
4. Analyze speed-torque characteristics of PWM inverter fed induction motors.

L5: Evaluate

1. Evaluate the performance of converter-fed DC motor drives under continuous and discontinuous conduction modes.
2. Justify the use of PWM voltage source inverters in induction motor drives.
3. Evaluate the advantages of PMSM drives in industrial applications.
4. Assess the effectiveness of closed loop control in electric drives.

L6: Create

1. Design a closed loop speed control scheme for a separately excited DC motor using converter.
2. Develop a VVVF drive system for induction motor speed control.
3. Formulate a four quadrant operation scheme for DC–DC converter fed DC motor drive.
4. Create a regenerative braking scheme for an induction motor drive.

Chairperson
Board of Studies (EEE)

R24EEPE09 **High Voltage Engineering** **3 0 0 3**
(Professional Elective-II)

Course Objectives:

The main objectives of the course are to

1. Understand breakdown phenomena and dielectric behavior of gaseous insulating materials used in high voltage engineering.
2. Analyze breakdown mechanisms in liquid and solid dielectric materials.
3. Study the generation techniques of high AC and DC voltages used in testing and insulation systems.
4. Understand the generation and control of impulse voltages and currents.
5. Learn measurement techniques for high AC, DC and impulse voltages and currents.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE09.1	Explain dielectric properties and breakdown mechanisms of gaseous and vacuum insulating materials.	3	2	1	1	1	1	-	-	-	-	1	2	1	L1,L2
R24EEPE09.2	Analyze breakdown phenomena in liquid and solid dielectric materials.	3	3	1	2	2	1	-	-	-	-	1	3	1	L3,L4
R24EEPE09.3	Describe the generation methods of high AC and DC voltages used in high	3	2	1	1	2	-	-	-	-	-	1	2	1	L2,L3

	voltage laboratories.														
R24EEPE09.4	Analyze impulse voltage and current generation circuits and wave shaping techniques.	3	3	2	3	3	1	-	-	1	-	2	3	2	L4,L5
R24EEPE09.5	Evaluate measurement techniques for high AC, DC and impulse voltages and currents.	3	3	2	3	3	2	1	-	1	-	2	3	2	L5,L6

SYLLABUS

Unit – I: Breakdown Phenomena in Gaseous and Vacuum Dielectrics **12 Hours**

Insulating materials – Types, properties and applications, Gases as insulating media, Collision process, Ionization process, Townsend's criteria of breakdown and its limitations, Streamer theory of breakdown, Time lag, Paschen's law and Paschen's curve, Penning effect, Breakdown mechanisms in vacuum.

Self-Learning Topics: Applications of SF6 Gas in High Voltage Equipment **CO's: CO1**

Unit – II: Breakdown Phenomena in Liquid and Solid Dielectrics **12 Hours**

Breakdown in Liquids: Liquid as insulator, Pure and commercial insulating liquids, Breakdown mechanisms in pure and commercial liquids.

Breakdown in Solids: Intrinsic breakdown, Electromechanical breakdown, Thermal breakdown, Breakdown of composite solid dielectrics.

Self-Learning Topics: Nano Dielectrics and Modern Insulation Materials **CO's: CO2**

Unit – III: Generation of High AC and DC Voltages **12 Hours**

Generation of High DC Voltages: Voltage doubler circuits, Voltage multiplier circuits, Van de Graaff generator. Generation of High AC Voltages: Cascaded transformers, Resonant transformers, Tesla coil.

Self-Learning Topics: Applications of High Voltage Testing Laboratories **CO's: CO3**

Unit – IV: Generation of Impulse Voltages and Currents **12 Hours**

Generation of Impulse Voltages: Specifications of impulse waves, Analysis of RLC circuits, Marx impulse generator circuit. Generation of Impulse Currents: Definitions, Circuits for impulse current generation, Wave shaping techniques, Tripping and control of impulse generators.

Self-Learning Topics: Lightning and Switching Surge Simulation Techniques **CO's: CO4**

Unit – V: Measurement of High Voltages and Currents **12 Hours**

Measurement of High AC and DC Voltages: Resistance potential divider, Generating voltmeter, Capacitor Voltage Transformer (CVT), Electrostatic voltmeters, Sphere gaps. Measurement of Impulse Voltages and Currents: Potential dividers with CRO, Hall generator, Rogowski coils.

Self-Learning Topics: Digital Measurement Techniques in High Voltage Engineering **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03 ,

Approved in ACM No: 03

Text Books:

1. High Voltage Engineering Fundamentals, Elsevier, 2nd Edition.
2. High Voltage Engineering, TMH Publications, 3rd Edition.

Reference Books:

1. High Voltage Engineering and Technology, IET Publishers, 2nd Edition.
2. High Voltage Engineering, New Age International, 1997.
3. High Voltage Insulation Engineering, New Age International, 1995.

Web References:

1. NPTEL – High Voltage Engineering: https://archive.nptel.ac.in/courses/108/104/108104048
2. High Voltage Engineering Course Notes: https://bharatsrajpurohit.weebly.com/high-voltage-engineering-course.html

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	35	---
L2	35	---
L3	30	---
L4	---	35

L5	---	45
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define ionization process in gaseous dielectrics.
2. State Paschen's law.
3. List different methods of generating high AC voltages.
4. Define impulse voltage wave.

L2: Understand

1. Explain Townsend's breakdown mechanism in gases.
2. Illustrate the breakdown phenomenon in liquid dielectrics.
3. Explain the operation of Van de Graaff generator.
4. Explain the working principle of generating voltmeters.

L3: Apply

1. Calculate breakdown voltage using Paschen's law for a given gap spacing.
2. Apply Marx circuit principles for impulse voltage generation.
3. Determine output voltage of voltage multiplier circuits.
4. Apply Rogowski coil principles for current measurement.

L4: Analyze

1. Compare Townsend and Streamer theories of breakdown.
2. Analyze the breakdown characteristics of solid and liquid dielectrics.
3. Compare cascaded transformers and resonant transformers.
4. Analyze impulse wave shaping circuits using RLC parameters.

L5: Evaluate

1. Evaluate the effectiveness of SF6 gas as an insulating medium.
2. Justify the use of impulse generators in insulation testing.
3. Evaluate various high voltage measurement techniques.
4. Assess the importance of high voltage testing in power systems.

L6: Create

1. Design a high voltage testing setup for AC insulation testing.
2. Develop a Marx impulse generator circuit for specified impulse voltage ratings.
3. Formulate a measurement system for high impulse current testing.
4. Create a suitable insulation coordination scheme for high voltage equipment.

Chairperson
Board of Studies (EEE)

R24EEOE06 **Basics of Electrical Machines** **3 0 0 3**

(Open Elective-II)

Course Objectives:

The main objectives of the course is to

1. Understand magnetic circuits and energy conversion principles.
2. Analyse DC machine performance and control.
3. Explain construction and operation of AC machines
4. Study transformers and their testing methods.
5. Introduce special electrical machines and applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE06.1	Apply the concepts of magnetic circuits and electromagnetic principles to explain energy conversion in electrical machines.	3	2	-	1	1	-	-	-	-	-	1	3	1	L1,L2
R24EEOE6.2	Evaluate the working, characteristics, and speed control methods of DC machines.	3	3	2	2	2	1	-	-	-	-	1	3	1	L2, L3
R24EEOE6.3	Analyze the construction, operation, and performance characteristics of AC machines, especially induction motors.	3	3	2	2	2	1	-	-	-	-	1	3	2	L3, L4
R24EEOE6.4	Analyze the performance of transformers using equivalent circuits, efficiency, voltage regulation, and testing methods.	3	3	1	3	2	1	-	-	-	-	1	3	1	L4,L5

R24EE0E6.5	Identify and explain the construction, working principles, and applications of special electrical machines.	2	1	1	-	1	1	-	-	-	-	2	2	2	L5,L6

SYLLABUS

Unit –I: Fundamentals of Electrical Machines **14 Hours**

Basic Concepts of Magnetic circuits, Principle of energy conversion in Electrical Machines: Faraday's Law of Electromagnetic Induction Principle, Lorentz Force law, Types and Classification of Electrical Machines, Introduction to Different types of Losses in an Electrical Machines, Efficiency of Electrical Machines.

CO's: CO1

Self-Learning Topics: Magnetic Materials and Their Properties, Magnetization Curve and Hysteresis Loop.

Unit –II: DC Machines **12 Hours**

Introduction to DC Machines, Construction and working of DC generators and motors, EMF Equation and Torque equation of DC Machines, Classification and Types DC Machines, Speed Control Methods of DC Machines, Applications of DC machines, Numerical Problems on DC Machines. **CO's: CO2**

Self-Learning Topics: Electromagnetic Principle of DC Generators and Motors.

Unit –III: AC Machines **14 Hours**

Classification of different types of AC Machines, Principle of operation Ac Machines, Construction of Induction Motors (squirrel cage and slip ring), Torque-slip characteristics of Induction Motors, Starting methods of Induction Motors, Speed control techniques of different types of Induction Motors, Applications Induction Motors. **CO's: CO3**

Self-Learning Topics: Evolution and Industrial Importance of AC Machines

Unit –IV: Transformers **12 Hours**

Principle of operation of Transformers, Construction of Transformer, EMF equation of a Transformer, Types of Transformers, Losses and Efficiency of a Transformer, Voltage Regulation, Equivalent Circuit of a Transformers, Testing's of a Transformers, Numerical Problems on Testing's of a Transformers, Applications of Transformers. **CO's: CO4**

Self-Learning Topics: Electromagnetic Induction Principle in Transformers

Unit –V: Introduction to Special types of Electrical Machines **12 Hours**

Classification of Special types of Electrical Machines, Construction and Working Principle of Stepper Motor, Construction and Working Principle of Servo Motor, BLDC Motor, PMSM Motor, Applications of Different Types of Special Electrical Machines **CO's: CO5**

Self-Learning Topics: Classification of Special Purpose Electrical Machines

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1.Electrical Machinery by Dr. P S Bimbhra, Fully Revised edition, Khanna Publishers, New Delhi,2021

2. Electric Machinery by A.E. Fitzgerald, Charles Kingsley, Stephen D.Umans, TMH

Reference Books:

1. Electrical Machines by D. P.Kothari, I .J .Nagarth, McGraw Hill Publications, 5th edition, 2017.
2. Electrical Machinery Fundamentals by Stephen J Chapman McGraw Hill education 2017
3. Generalized Theory of Electrical Machines by Dr. P S Bimbhra, 7th Edition, Khanna Publishers, 2021.
4. Theory & Performance of Electrical Machines by J.B.Gupta, S.K.Kataria& Sons,2013.
5. Electric Machinery by Fitzgerald, A.E.,Kingsley, Jr.,C.,& Umans, S. D, 7th edition, McGraw-Hill Education, 2014.

Web References:

1. https://archive.nptel.ac.in/courses/108/105/108105112/
2. https://archive.nptel.ac.in/courses/108/105/108105155/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20

Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. State the Faraday's Law of Electromagnetic Induction
2. What are the types of induction motors?
3. What is voltage regulation of a Transformer?
4. List the properties of positive real functions?
5. What is the step angle of stepper motor?

L2: Understand

1. Explain the principle of energy conversion using Faraday's law and Lorentz Force Law.
2. Explain construction and working of induction motor.
3. Explain construction and working of DC generator.
4. Explain working principle of transformer.
5. Explain working of servo motor with block diagram.

L3: Apply

1. Derive the relation between MMF, flux, and reluctance.
2. Apply torque-slip concept to explain motor performance.
3. Derive EMF equation of DC generator.
4. Derive EMF equation of transformer.

L4: Analyzing

1. Analyze different losses in electrical machines.
2. Analyze torque-slip characteristics of induction motor.
3. Analyze characteristics of DC motors.
4. Analyze OC and SC tests.
5. Analyze BLDC motor operation.

L5: Evaluating

1. Evaluate different starting methods of induction motors.
2. Evaluate speed control methods of DC motors.
3. Evaluate efficiency and voltage regulation.

L6: Create

1. Design a DC motor speed control system for an electric vehicle application and justify the chosen method.
2. Create a torque-slip characteristic curve for an induction motor and analyze its impact on machine performance.

3. Formulate the EMF equation of a transformer and apply it in transformer design calculations.

Chairperson
Board of Studies (EEE)

R24EEOE07 Fundamentals of Electrical Measurements and Instrumentation 3 0 0 3
(Open Elective-II)

Course Objectives:

The main objectives of the course is to

1. Interpret the working principles of various analog measuring instruments.
2. Understand the concepts behind power and energy measurement procedures.
3. Calculate resistance, inductance, and capacitance using various bridges.
4. Evaluate the importance of and understand the concepts of various transducers.
5. Comprehend the types of digital meters and their functionalities.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO5	PO5	PO5	PO5	PO5	PSO1	PSO2	
R24EEOE07.1	Explain the principles and operation of analogue measuring instruments.	3	1	-	-	1	-	-	-	-	-	1	2	-	L1,L2
R24EEOE07.2	Analyze the measurement of power and energy using analogue instruments.	3	3	1	2	2	1	-	-	-	-	1	3	1	L2, L3
R24EEOE07.3	Apply bridge methods to measure electrical parameters.	3	2	2	2	3	-	-	-	-	-	1	3	1	L3, L4
R24EEOE07.4	Explain the operation and applications of transducers and sensors.	2	1	1	1	2	1	-	-	-	-	1	2	2	L4,L5
R24EE0E07.5	Analyze the operation and applications of digital measuring instruments.	3	3	1	2	3	1	-	-	-	-	2	3	2	L5,L6

SYLLABUS

Unit –I: Fundamentals of Analogue Instruments 14 Hours

Analogue Ammeter and Voltmeter: Classification of instruments – Deflecting, controlling, and damping torques. Types of Instruments: PMMC and Moving Iron type – Construction, working principle, advantages and disadvantages. Applications and simple numerical problems. **CO's: CO1**

Self-Learning Topics: Classification of Measuring Instruments: Absolute and Secondary Instruments

Unit –II: Measurement of Power and Energy **12 Hours**

Analogue Wattmeter: Electrodynamometer-type watt meters – Low Power Factor (LPF) and Unity Power Factor (UPF) designs, advantages and disadvantages. Energy Meters: Induction-type Energy Meter – Construction and working principle. Simple numerical problems. **CO's: CO2**

Self-Learning Topics: Types of Electrical Power: Active, Reactive, and Apparent Power

Unit –III: Measurement of Electrical Parameters **12 Hours**

DC Bridges: Measurement of resistance – Low (Kelvin's double bridge), medium (Wheatstone bridge), and high resistance (Loss of charge method), Megger and its uses.

AC Bridges: Measurement of inductance (Maxwell's Bridge) and capacitance (Schering Bridge), Numerical problems. **CO's: CO3**

Self-Learning Topics: Principle of Null Deflection Method in Bridge Circuits

Unit –IV: Transducers and Sensors **10 Hours**

Classification of Transducers: Basics and Applications. Resistive: Strain Gauge. Inductive: Linear Variable Differential Transformer (LVDT). Capacitive: Piezoelectric – Applications. **CO's: CO4**

Self-Learning Topics: Applications of fuzzy logic in industrial systems**.**

Unit –V: Introduction to Digital Instruments **12 Hours**

Digital Instruments: Digital Voltmeters (Successive approximation type), Digital Frequency Meters and Multimeters, Digital Tachometers and Energy Meters – Overview and applications.**CO's: CO5**

Self-Learning Topics: Characteristics of Transducers: Sensitivity, Linearity, Resolution, and Accuracy.

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Electrical & Electronic Measuring Instruments by A.K.Sawhney, Dhanpat Rai & Co. Publications – 19th revised edition - 2011.

2. Electronic Instrumentation by H.S.Kalsi - THM.

Reference Books:

1. Electrical Measurements and Measuring Instruments by E.W. Golding and F.C.Widdis - 5 th Edition - Wheeler Publishing.
2. Modern Electronic Instrumentation and Measurement Techniques by A.D. Helfrick and W.D. Cooper - PHI - 5th Edition - 2002.
3. Electrical and Electronic Measurements and Instrumentation by R.K.Rajput - S.Chand - 3rd edition.

Web References:

1. https://archive.nptel.ac.in/courses/108/105/108105153

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers to Questions of Various Cognitive Levels

L1: Remember

1. Name the types of analogue measuring instruments.
2. List types of wattmeters.
3. Define the Wheatstone bridge.
4. Define transducer and sensor.
5. List types of digital instruments.

L2: Understand

1. Explain the working principle of PMMC instruments.
2. Explain the working principle of the electrodynamometer wattmeter.
3. Explain the working principle of Kelvin’s double bridge.

4. Explain the working principle of LVDT.
5. Explain the working principle of successive approximation DVM.

L3: Apply

1. Calculate the current through a PMMC instrument for a given resistance and voltage.
2. Calculate energy consumption using meter readings.
3. Calculate unknown resistance using Wheatstone bridge.
4. Apply piezoelectric transducers in measurement systems.
5. Apply digital multimeter concepts for electrical measurements.

L4: Analyzing

1. Compare PMMC and Moving Iron instruments.
2. Analyse the operation of induction energy meters.
3. Analyze the operation of AC bridges.
4. Analyze characteristics of resistive and inductive transducers.
5. Analyze advantages of digital instruments over analogue instruments.

L5: Evaluating

1. Evaluate the suitability of PMMC instruments for DC measurements.
2. Evaluate the performance of the electrodynamometer wattmeters.
3. Evaluate the suitability of bridges for parameter measurement.
4. Evaluate the applications of LVDT in industries.
5. Evaluate the performance of digital instruments in measurement systems.

Chairperson
Board of Studies (EEE)

R24EEOE08 **Applications of Electrical Energy** **3 0 0 3**
(Open Elective-II)

Course Objectives:

The main objectives of the course is to

1. To understand the principles and industrial applications of electric heating methods.
2. To explain the operation, characteristics, and applications of electric welding techniques.
3. To study the fundamentals of illumination engineering and energy-efficient lighting systems.
4. To analyse the operation and control of AC and DC electric drives used in industrial applications.
5. To introduce electric traction systems and electric vehicles with their architecture and applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE08.1	Explain and analyse the principles, methods, and industrial applications of electric heating systems.	3	2	2	1	2	2	-	-	-	-	1	2	2	L1,L2
R24EEOE8.2	Illustrate and evaluate different electric welding techniques and their industrial applications.	3	2	2	1	2	2	-	-	-	-	1	2	2	L2, L3
R24EEOE8.3	Explain and analyse the laws of illumination, lighting systems, and energy-efficient lamps.	3	2	2	1	2	3	-	-	-	-	1	1	3	L3, L4
R24EEOE8.4	Analyse and apply the characteristics and control methods of AC and DC	3	3	2	2	3	2	-	-	1	-	2	3	3	L4,L5

	electric drives.														
R24EE0E8.5	Explain and evaluate electric traction systems and electric vehicle architecture with their applications.	3	3	3	2	2	3	1	-	1	1	2	3	3	L5,L6

SYLLABUS

Unit –I: Electric Heating **12 Hours**

Introduction to Electric Heating, Advantages and Disadvantages of Electric Heating, Types of Electric Heating, Resistance Heating, Induction heating, Dielectric Heating, Arc Heating, Industrial Applications of Electric heating. **CO's: CO1**

Self-Learning Topics: Comparison between Conventional Heating and Electric Heating, Advantages of Electric Heating in Industrial Applications.

Unit –II: Electric Welding **12 Hours**

Introduction to Electric Welding, Advantages and Disadvantages of Electric Welding, Types of Electric Welding, Resistance Welding, Spot Welding, Seam Welding, Projection Welding, Arc Welding, Ac & Dc Welding, Welding Equipment and Characteristics, Advantages and Disadvantages of Types of Welding, Applications of Electric Weldings. **CO's: CO2**

Self-Learning Topics: Historical Development of Electric Welding, Advantages of Electric Welding in Industrial Manufacturing.

Unit –III: Illumination Engineering **12 Hours**

Basics of lighting and illumination, Laws of illumination, Types of lamps, Incandescent lamp, Fluorescent lamp, LED lamp, Lighting Schemes and design considerations, Energy Efficiency of different types of lighting systems. **CO's: CO3**

Self-Learning Topics: Importance of Lighting in Domestic, Commercial, and Industrial Applications.

Unit –IV: Electric Drives **15 Hours**

Introduction to Electric Drives, Types of Drives, AC Drives, DC Drives, Characteristics of Motors for Drives, Speed Control Methods of AC & DC Drives, Selection of motors for Different applications. **CO's: CO4**

Self-Learning Topics: Advantages of Electric Drives over Mechanical Drives, Components of an Electric Drive System.

Unit –V: Electric Traction and Electric Vehicles **15 Hours**

Introduction to Electric Traction, Types of Electric Traction Systems, Speed – Time and Tractive Effort Characteristics, Electric Braking Methods, Advantages of Electric Traction.

Introduction to Electric Vehicles, History of Electric Vehicles, Electric Vehicles Architecture and its applications. **CO's: CO5**

Self-Learning Topics: Classification of Electric Traction Systems, Components of an Electric Traction System.

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Utilization of Electric Energy, E. Openshaw Taylor and V. V. L. Rao, Universities Press, 2009.
2. Art & Science of Utilization of electrical Energy, Partab, Dhanpat Rai & Co., 2004.
3. Utilization of Electrical Power including Electric drives and Electric traction – byJ.B.Gupta, S.K. Kataria & Sons.
4. Iqbal Hussein - Electric and Hybrid Vehicles: Design Fundamentals - CRC Press - 2021.

Reference Books:

1. Generation, distribution and utilization of electrical energy, C.L Wadhwa, Wiley Eastern Limited,1993.
2. Electrical Power, S. L. Uppal, Khanna Publishers, 1988.

Web References:

1. https://archive.nptel.ac.in/courses/108/104/108104140
2. https://nptel.ac.in/courses/108105060

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20

Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define electric heating.
2. Define electric welding.
3. State laws of illumination.
4. List types of electric drives.
5. List types of electric braking methods.

L2: Understand

1. Explain the principle of resistance heating.
2. Explain the working principle of arc welding.
3. Explain the operation of fluorescent lamps.
4. Explain the characteristics of motors used in drives.
5. Explain the working of regenerative braking.

L3: Apply

1. Apply dielectric heating in industrial applications.
2. Apply projection welding in industrial applications.
3. Apply illumination laws for lighting calculations.
4. Apply speed control methods for AC drives.
5. Demonstrate the operation of electric vehicle systems.

L4: Analyzing

1. Analyze the advantages and disadvantages of electric heating.
2. Compare AC and DC welding methods.
3. Analyze different lighting schemes.
4. Analyze the performance characteristics of electric drives.
5. Compare conventional vehicles and electric vehicles.

L5: Evaluating

1. Evaluate the suitability of electric heating for industrial processes.
2. Evaluate advantages and disadvantages of resistance welding.
3. Assess energy-efficient lighting methods.
4. Evaluate the suitability of electric drives for industrial loads.
5. Evaluate the advantages of electric traction systems.

L6: Create

1. Develop a comparative analysis model for resistance, induction, dielectric, and arc heating

techniques based on efficiency and applications.

2. Create a welding equipment layout for industrial fabrication processes with suitable safety measures.
3. Develop a comparative study model for incandescent, fluorescent, and LED lamps based on efficiency and applications.

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Board of Studies (EEE)

R24EEOE09 Fundamentals of Utilization of Electrical Energy 3 0 0 3

(Open Elective-II)

Course Objectives:

The main objectives of the course is to

1. Able to maintain electric drives used in industries.
2. Able to identify a heating/welding scheme for a given application.
3. Able to maintain/ Trouble shoot various lamps and fittings in use.
4. Able to figure out the different traction schemes and its main components.
5. Able to design a suitable scheme of speed control for the traction systems.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE09.1	Explain and analyse the principles, characteristics, and applications of electric drives and industrial loads.	3	3	2	1	2	1	-	-	-	-	1	3	2	L1,L2
R24EEOE09.2	Illustrate and evaluate different methods of electric heating and welding techniques used in industrial applications.	3	2	2	1	2	2	-	-	-	-	1	2	2	L2, L3
R24EEOE09.3	Explain and analyse the fundamentals of illumination, lighting systems, and various light sources.	3	2	2	1	2	3	-	-	-	-	1	1	3	L3, L4
R24EEOE09.4	Analyse and evaluate electric traction systems, traction motors, and braking methods used in railway electrification.	3	3	2	2	2	3	-	-	-	-	1	3	3	L4,L5

R24EE0E09.5	Apply and analyze speed-time curves and calculate tractive effort, power, and energy consumption in electric traction systems.	3	3	1	3	3	2	-	-	-	-	2	3	2	L5,L6

SYLLABUS

Unit –I: Electric Drives **12 Hours**

Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise – cooling and heating time constant, applications of electric drives, types of industrial loads, continuous, intermittent and variable loads, load equalization. **CO's: CO1**

Self-Learning Topics: Advantages of Electric Drives over Mechanical Drives, Components and Block Diagram of an Electric Drive System.

Unit –II: Electric Heating and Welding **14 Hours**

Advantages and methods of electric heating, resistance heating, induction heating and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding. **CO's: CO2**

Self-Learning Topics: Comparison between Conventional Heating and Electric Heating, Advantages and Limitations of Electric Heating.

Unit –III: Fundamentals of Illumination **14 Hours**

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. Discharge lamps, MV and SV lamps – comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and flood lighting. **CO's: CO3**

Self-Learning Topics: Importance of Proper Illumination in Daily Life and Industries.

Unit –IV: Electric Traction – I **12 Hours**

System of electric traction and track electrification, Review of existing electric traction systems in India, Special features of traction motor, methods of electric braking- plugging, rheostatic braking and regenerative braking. **CO's: CO4**

Self-Learning Topics: Classification of Electric Traction Systems.

Unit –V: Electric Traction –II **12 Hours**

Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves. Calculations of tractive effort, power, specific energy consumption

for given run, effect of varying acceleration and braking retardation, dead weight, adhesive weight, braking retardation, and coefficient of adhesion. **CO's: CO5**

Self-Learning Topics: Fundamentals of Train Movement and Train Dynamics, Forces Acting on a Moving Train.

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Utilization of Electric Energy, E. Openshaw Taylor and V. V. L. Rao, Universities Press, 2009.
2. Art & Science of Utilization of electrical Energy, Partab, Dhanpat Rai & Co., 2004.
3. Utilization of Electrical Power including Electric drives and Electric traction – byJ.B.Gupta, S.K. Kataria & Sons.

Reference Books:

1. Generation, distribution and utilization of electrical energy, C.L Wadhwa, Wiley Eastern Limited,1993.
2. Electrical Power, S. L. Uppal, Khanna publishers, 1988.

Web References:

1. https://archive.nptel.ac.in/courses/108/104/108104140
2. https://nptel.ac.in/courses/108105060

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers to Questions of Various Cognitive Levels

L1: Remember

1. Define electric drive.
2. List methods of electric heating.
3. Define luminous intensity.
4. Define regenerative braking.
5. List types of speed-time curves.

L2: Understand

1. Explain the starting characteristics of electric drives.
2. Explain the principle of induction heating.
3. Explain the working of fluorescent lamps.
4. Explain the features of traction motors.
5. Explain quadrilateral speed-time curve.

L3: Apply

1. Apply speed control methods for DC motor drives.
2. Apply dielectric heating in industrial applications.
3. Apply illumination laws for lighting calculations.
4. Apply plugging method in traction systems.
5. Apply speed-time curves for train movement analysis.

L4: Analyzing

1. Analyze the characteristics of continuous and intermittent loads.
2. Analyze the advantages of electric heating methods.
3. Analyze polar curves of lighting systems.
4. Compare DC and AC traction systems.
5. Compare trapezoidal and quadrilateral speed-time curves.

L5: Evaluating

1. Evaluate the performance of electric drives for industrial applications.
2. Evaluate the suitability of induction heating for industries.
3. Assess the efficiency of discharge lamps
4. Assess the performance of traction motors.
5. Assess the importance of adhesive weight in traction systems.

L6: Create

1. Develop a comparative analysis model for different types of electric drives based on industrial applications.
2. Design an electric heating system suitable for industrial furnace applications and justify the chosen heating method.

3. Formulate an energy-efficient lighting strategy for commercial and industrial buildings.

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Board of Studies (EEE)

R24EEOE10 **Electrical Safety** **3 0 0 3**
(Open Elective-II)

Course Objectives:

The main objectives of the course is to

1. To impart knowledge about safety requirements
2. To guide the prevention of electrical shocks
3. To study the various first aid methods
4. To create awareness about various Hazardous areas
5. To familiarise with safety management.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE010.1	Explain and analyze electrical hazards, safety principles, fire prevention methods, and IE safety regulations.	3	3	2	1	1	3	3	-	-	-	1	1	2	L1,L2
R24EEOE010.2	Analyze and apply safety precautions, earthing systems, and preventive measures against electrical shocks.	3	3	2	2	2	3	2	-	-	-	1	2	3	L2, L3
R24EEOE010.3	Demonstrate and apply first aid techniques and emergency response procedures for electrical accidents.	2	2	1	1	1	3	3	2	2	-	1	1	2	L3, L4
R24EEOE010.4	Explain and evaluate safety requirements, hazardous zones, and protective equipment used in hazardous electrical areas.	3	3	2	1	2	3	3	-	-	-	1	2	3	L4,L5
R24EE0E010.5	Analyze and assess fire extinguishing	3	3	3	2	2	3	3	1	1	1	2	2	3	L5,L

	systems, fire protection techniques, and electrical safety management practices.														6

SYLLABUS

UNIT –I: Introduction **12 Hours**

General Background - Objectives of safety and security measures - Hazards associated with electric current and voltage - principles of electrical safety - Approaches to Prevent Accidents - Fundamentals of fire, initiation of fire, types - Fire Prevention and Fire Fighting - Objectives and scope of IE act and IE rules-General requirements for electrical safety as per IE rules - Do's and Don'ts for safety in the use of electrical appliances. **CO's: CO1**

Self-Learning Topics: Objectives of Safety and Security Measures, Common Electrical Hazards in Workplaces and Homes.

UNIT –II: Electrical Shocks And Their Prevention **12 Hours**

Primary and Secondary Electric Shocks - Occurrence of Electric Shock - Shocks Due to Flashovers/Spark-overs - Lightning Strokes on Overhead Transmission Lines and Outdoor Substations - Safety Precautions in Small LV Installations, Residential Buildings, Shops -Safety Procedures in Electrical Plant Installation and description of Earthing System - Equipment Earthing - Substation Earthing. **CO's: CO2**

Self-Learning Topics: Difference between Primary and Secondary Electric Shocks, Causes of Electrical Accidents in Domestic and Industrial Systems.

UNIT –III: First Aid **14 Hours**

Introduction - Removal of Contact with Live Conductor- First Principles of Actions after Electric Shock - Artificial Respiration - Schafer's Prone Pressure Method - Silvester's Method - Nielson's Arm-lift Back - pressure Method - Mouth to Mouth Method - Use of Artificial Resuscitator - External Cardiac Massage - Cardiac Pulmonary Resuscitation - First aid treatment of Heat Exhaustion and heatstroke. **CO's: CO3**

Self-Learning Topics: Safety Precautions Before Rescuing an Electric Shock Victim. Immediate Actions after Electric Shock Accidents.

UNIT –IV: Electrical Safety in Hazardous Areas **12 Hours**

Introduction - Classification of Hazardous zones - Causes of sparks and flashovers in electrical plants and machines - Functional requirements of electrical equipment and installations for hazardous area/zones - Classification of equipment/enclosure for hazardous locations. **CO's: CO4**

Self-Learning Topics: Characteristics of Hazardous Locations and Risk Factors, Classification of Hazardous Areas and Zones.

UNIT –V: Fire Extinguisher And Electrical Safety Management **12 Hours**

Fire Extinguisher - Extinguishing techniques - Prevention of fire - Types of fire extinguishers - Fire detection and alarm system - CO2 and Halogen schemes - Foam schemes. Principles of safety management - Management's safety policy - Safety organization - Organization charts for construction phase of a project, maintenance mode of a plant and for safety department - Safety auditing. **CO's: CO5**

Self-Learning Topics: Fire Prevention Techniques in Electrical Systems, Classification of Fires: Class A, B, C, D, and Electrical Fires.

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. S. Rao and H.L. Saluja, "Electrical Safety, Fire Safety and Safety Management", Khanna Publishers, 2012.
2. 2. W.F.Cooper, "Electrical Safety Engineering", Butterworth and Company, London, 1998.

Reference Books:

1. J. Cadick, D. Neitzel and A. Winfield, "Electrical Safety Handbook", McGraw Hill Education, 2012.
2. J. Maxwell Adams, "Electrical Safety-A Guide to the Causes and Prevention of Electric Hazards", The Institution of Electric Engineers, 3rdReprint, 2009.
3. Martha J. Boss and Gayle Nicoll, "Electrical Safety - Systems, Sustainability and Stewardship", CRC Press, 2015.

Web References:

1. https://archive.nptel.ac.in/courses/108/104/108104140
2. https://nptel.ac.in/courses/108105060

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)

L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers to Questions of Various Cognitive Levels

L1: Remember

1. Define electrical safety.
2. List types of earthing systems.
3. List methods of artificial respiration.
4. List classifications of hazardous areas.
5. Define safety auditing

L2: Understand

1. Explain the objectives of safety and security measures.
2. Explain substation earthing system.
3. Explain Schafer's prone pressure method.
4. Explain safety requirements for hazardous areas.
5. Explain foam fire extinguishing scheme.

L3: Apply

1. Apply IE safety rules for domestic electrical appliances.
2. Demonstrate earthing procedures in electrical plants.
3. Demonstrate first aid treatment for electric shock victims.
4. Demonstrate selection of enclosures for hazardous locations.
5. Apply fire extinguishing techniques for electrical fires.

L4: Analyzing

1. Analyze causes of electrical fires in installations.
2. Compare equipment earthing and substation earthing.
3. Compare Silvester's and Nielson's methods.
4. Compare different enclosure types used in hazardous locations.
5. Compare CO_2 and foam extinguishing systems.

L5: Evaluating

1. Evaluate the effectiveness of electrical safety practices.
2. Assess preventive measures against electric shocks in industries.
3. Assess first aid procedures for heat stroke victims.
4. Evaluate equipment suitability for hazardous environments.
5. Assess fire safety auditing procedures in industries.

L6: Create

1. Create a fire prevention and firefighting strategy for electrical installations in commercial buildings.
2. Develop a protection scheme to minimize electric shocks and flashover hazards in substations.
3. Formulate selection criteria for electrical equipment and enclosures used in hazardous locations.

Chairperson
Board of Studies (EEE)

R24EEPC19 Electrical Measurements and Instrumentation Lab 0 0 3 1.5

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Understand the principles and working of electrical measuring instruments and calibration methods.
2. Measure electrical parameters such as resistance, inductance, capacitance, and power using different bridge and experimental methods.
3. Study and analyze the performance of electrical transducers and measurement systems used in practical applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC19.1	Calibrate energy meters, wattmeters, ammeters, and voltmeters using standard methods.	3	2	1	2	3	-	-	-	1	-	1	3	1	L1,L2
R24EEPC19.2	Measure resistance, inductance, capacitance, and power using bridge and other methods.	3	3	1	3	3	-	-	-	1	-	1	3	1	L1,L2
R24EEPC19.3	Study and evaluate transducers such as LVDT, strain gauge, thermocouple, capacitive transducer, and DC potentiometer systems.	3	2	1	2	3	1	-	-	2	-	2	2	3	L2,L3

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

LIST OF EXPERIMENTS:

1. Calibration and Testing of Single Phase Energy Meter COs: CO1

2. Measurement of resistance using Kelvin's double Bridge. COs:CO2
3. Measurement of Inductance and Capacitance using Anderson Bridge and Schering Bridge. COs: CO2
4. Calibration of dynamometer wattmeter using phantom loading COs:CO1
5. Calibration of dynamometer wattmeter using phantom loading COs:CO1
6. Determination of the characteristics of a LVDT. COs:CO3
7. Measurement of single-phase power using a three voltmeter method. COs:CO2
8. Measurement of single-phase power using a three ammeter method. COs:CO2
9. Measurement of strain for a bridge strain gauge. COs:CO3
10. Measurement of Choke coil parameters. COs:CO2
11. Calibration of LPF Wattmeter by direct loading. COs:CO2
12. Determination of the characteristics of a Thermocouple. COs:CO3
13. Determination of the characteristics for a capacitive transducer COs:CO3
14. Crompton DC Potentiometer – Calibration of PMMC Ammeter & PMMC voltmeter COS:CO3

NOTE: Any 10 experiments are to be conducted

L1: Remember

1. What is the calibration of a single-phase energy meter?
2. What is Kelvin's double bridge used for?
3. What are Anderson Bridge and Schering Bridge used for?
4. What is LVDT?
5. What is a choke coil?

L2: Understand

1. How is a single-phase energy meter calibrated?
2. Why is Kelvin's double bridge preferred for low resistance measurement?
3. How does Anderson Bridge measure inductance?
4. How does Schering Bridge measure capacitance?
5. Why is phantom loading used in wattmeter calibration?

L3: Apply

1. What precautions are required while using Kelvin's double bridge?
2. Why Anderson Bridge is considered accurate?
3. Where is phantom loading practically used?
4. What are the applications of LVDT?
5. How are PMMC ammeter and voltmeter calibrated using Crompton potentiometer?

Chairperson
Board of Studies (EEE)

R24EEPC20 **Power Systems Lab** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course are:

1. To analyze sequence impedances and parameters of power system components.
2. To evaluate the performance of transmission lines under different conditions.
3. To apply theoretical concepts of electrical machines, insulation coordination, and high-voltage engineering to real-world power system applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC20.1	Analyze sequence impedances and parameters of power system components.	3	3	-	2	1	-	-	-	-	-	2	3	1	L2, L3
R24EEPC20.2	Evaluate the performance of transmission lines under different operating conditions.	3	3	2	2	1	-	-	-	-	-	2	3	2	L2, L3
R24EEPC20.3	Apply concepts of electrical machines, insulatio	3	3	3	2	2	-	-	-	-	-	2	3	3	L2, L3

	n coordination, and high-voltage engineering to practical power system applications.														

List of Experiments

1. Determination of sequence impedances of an alternator by direct method. **CO's:** CO1
2. Determination of sequence impedances of an alternator by fault analysis. **CO's:** CO1
3. Measurement of ABCD parameters on transmission line. **CO's:** CO2
4. Measurement of sequence impedances of a three-phase transformer. **CO's:** CO1
5. Study of Ferranti effect in long transmission line. **CO's:** CO2
6. Calibration of Tong tester. **CO's:** CO1
7. Measurement of string efficiency. **CO's:** CO2
8. Performance of medium transmission line with and without compensation. **CO's:** CO2
9. Performance of long transmission line with and without compensation. **CO's:** CO2
10. Measurement of dielectric strength of Transformer oil test kit **CO's:** CO3
11. Power angle characteristics of a salient pole Synchronous Machine **CO's:** CO3
12. Determination of Flashover characteristics of a Pin Insulator **CO's:** CO3

Any 10 experiments are to be conducted

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,
Approved in ACM No : 03

Online Learning Resources:

1. https://nptel.ac.in
2. https://virtual-labs.ac.in

References:

1. C.L. Wadhwa, Electrical Power Systems, New Age International.

2. Hadi Saadat, Power System Analysis, McGraw Hill.
3. I.J. Nagrath & D.P. Kothari, Modern Power System Analysis, McGraw Hill.

L1: Remember

1. What are sequence components in power systems?
2. What is Ferranti effect?
3. Define string efficiency.
4. What is Pin Insulator?

L2: Understand

1. How are ABCD parameters used in transmission line analysis?
2. What is the significance of compensation in transmission lines?
3. How the dielectric strength of transformer oil effects?
4. Explain the power-angle characteristic of a salient pole synchronous machine.

L3: Apply

1. Analyze why sequence impedances differ in an alternator.
2. Compare direct method and fault analysis method for sequence impedance determination.
3. Analyze the factors affecting string efficiency and suggest improvements.
4. Analyze the factors affecting the dielectric strength of transformer oil.

Chairperson
Board of Studies (EEE)

R24EESC02 **IoT Applications in Electrical Engineering Lab** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To familiarize students with IoT hardware platforms such as Arduino and Raspberry Pi for Electrical Engineering applications.
2. To interface various sensors and actuators with microcontroller platforms and write programs for real-time monitoring and control.
3. To simulate IoT experiments using virtual labs and understand communication protocols used in IoT systems.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													Do K
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	
R24EESC02.1	Apply knowledge of IoT hardware and software to interface basic components with Arduino/Raspberry Pi.	2	2	-	1	2	-	-	1	1	-	2	2	1	L1, L2
R24EESC02.2	Interface sensors and actuators with Arduino to monitor and control electrical parameters.	2	2	2	3	2	-	-	1	1	-	2	3	2	L2, L3
R24EESC02.3	Simulate IoT protocols and cloud integration for remote monitoring and control of electrical systems.	2	2	2	2	3	1	-	1	1	-	3	2	3	L2, L3

Board of Studies : Electrical & Electronics Engineering

Approved in BOS No : 03,

Approved in ACM No : 03

List of Experiments

1 Familiarization with Arduino/Raspberry Pi and perform necessary software installation. CO 1

2	Interfacing of LED with Arduino and write a program to turn ON LED for 1 sec after every 2 seconds.	CO 1
3	Interfacing of Push button with Arduino and write a program to turn ON LED when push button is pressed or at sensor detection.	CO 1
4	Write a program for Interfacing of multiple motors (DC Motor & Servo Motor) with Arduino.	CO 2
5	Write a program for Interfacing of 7 Segment Display with Arduino.	CO 1
6	Interfacing of temperature sensor with Arduino and write a program to print temperature and humidity readings.	CO 2
7	Interfacing of Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.	CO 2
8	Write a program for Interfacing of Analog Input & Digital Output with Arduino.	CO 2
9	Write a program for Night Light Controlled & Monitoring System.	CO 2
10	Write a program on Arduino/Raspberry Pi to upload and retrieve temperature and humidity data to ThingSpeak cloud.	CO 3

Virtual Lab-(Self Learning)

11	To simulate interfacing of multiple sensors (Ultrasonic sensor, PIR Sensor, DHT sensor, Soil Moisture, MQ135 Sensors) with Arduino.	CO 2
12	Simulation of sending live sensors data on IoT Platform using HTTP Protocols and ESP8266/ESP32.	CO 3
13	Simulation of sending live sensors data on IoT Platform using MQTT Protocols and ESP8266/ESP32.	CO 3
14	Simulation of establishing master slave model using Arduino and I2C Protocols.	CO 3
15	Simulation of establishing interrelation between cloud (AWS, Microsoft Azure, ThingSpeak and IBM Bluemix) and ESP8266/ESP32.	CO 3
16	To create IoT Dashboard for remote monitoring.	CO 3
17	To create IoT Application using LoRaWAN and ESP8266/ESP32.	CO 3

Online Learning Resources:

1. https://iot-dei.vlabs.ac.in/Introduction.html

References:

1. ArshdeepBahga and Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press, 2014.
2. Adrian McEwen and Hakim Cassimally, Designing the Internet of Things, Wiley, 2013.

L1: Remember

1. What is Arduino and what is its role in IoT applications?
2. What is the difference between digital and analog pins in Arduino?
3. Name the components required to interface an LED with Arduino.

L2: Understand

1. How does a push button work when interfaced with a microcontroller?
2. Explain how a temperature and humidity sensor (DHT11/DHT22) communicates with Arduino.
3. What is the function of a Bluetooth module in an Arduino-based IoT system?

L3: Apply

1. Write a program logic to turn ON an LED for 1 second after every 2 seconds.
2. How would you modify the program to control multiple LEDs using a single push button?
3. Design a simple IoT application using MQTT protocol to send sensor data to a cloud platform.

Chairperson
Board of Studies (EEE)

R24HS09 **High Level Reasoning & Employability Skills** **0 0 2 1**
(Common to all UG Programmes)

Course Objectives:

1. **Develop professional skills**: Students will be able to apply professional etiquette and effective problem-solving processes to make ethical decisions in workplace settings.
2. **Enhance interview skills**: Students will be able to Develop professional career artifacts, including resumes and cover letters, while demonstrating effective interview and networking skills.
3. **Develop logical thinking skills**: Students will be able to Solve advanced logical problems involving Syllogisms, Venn Diagrams, Cubes & Dices, and Coded Inequalities.
4. **Improve problem-solving skills**: Students will be able to Analyze complex seating arrangements, data sufficiency, and mathematical operations to derive logical conclusions.
5. **Enhance analytical skills**: Students will be able to Evaluate analytical reasoning puzzles and critical reasoning statements, including assumptions, arguments, and cause-effect relationships.

At the end of the course, students will be able to:

Course Code	Course Outcomes	PO1	PO7	PO9	P011	Dok
R24HS09.1	Professional Etiquette & Decision Making	---	1	2	---	L3
R24HS09.2	Career Prep & Interview Skills	---	---	3	2	L3
R24HS09.3	Logical Thinking (Syllogism, Venn, Cubes)	3	---	---	---	L3
R24HS09.4	Problem Solving (Arrangements & Data Sufficiency)	3	---	---	1	L4
R24HS09.5	Analytical Reasoning & Critical Thinking	2	---	---	1	L5

SYLLABUS

UNIT-I: Professional Etiquette & Ethics **13 Hours**

Problem-Solving and Decision-Making: The problem-solving process (identifying, analyzing, generating solutions), Critical and creative thinking, Making effective and ethical decisions. Professional Etiquette and Manners: Workplace etiquette (cubicle, meeting, and break room behavior), Telephone and virtual meeting etiquette, Interacting with clients and superiors.

Self Learning Topic: Corporate Etiquette Simulation

UNIT-II: Interview Skills & Career Planning **12 Hours**

Career Preparation: Developing a Resume/CV and cover letter, Interviewing skills (pre-interview preparation, common questions, post-interview follow-up), Networking and building professional relationships.

Self Learning Topic: Mock Interviews and GD Practice

UNIT-III: Logical Thinking Skills **13 Hours**

Syllogism: Explain Advanced Concepts on Universal Statements and Particular Statements. Venn Diagrams: Explain Advanced Concepts on group-based problems and datatype and diagram-based problems. Cubes & Dices and Coded Inequalities.

Self Learning Topic: Sequence & Alphabet Test

UNIT-IV: Problem Solving Skills **15 Hours**

Seating Arrangements: Explain advanced problems on Linear, Circular and Square based problems. Data Sufficiency and Mathematical Operations.

Self Learning Topic: Non-Verbal Reasoning

UNIT-V: Analytical Thinking Skills **12 Hours**

Analytical Reasoning: Explain advanced problem solving and puzzle-based questions, Critical Reasoning: Explain advanced problems on Statements-Conclusions, Statements-Assumptions, Statements-Arguments, Statements-Course of Action and Cause-effect.

Self Learning Topic: Eligibility Criteria

Text Books:

1. Quantitative Aptitude for competitive examinations by R.S.Agrawal - S.Chand publications.
2. Business Communication by C.S.G Krishnamacharyulu & Lalitha Ramakrishna – Himalaya publishing house
3. Barun K. Mitra, Personality Development and Soft Skills, Oxford University Press.

Reference Books:

1. Numerical Aptitude and Reasoning Ability tests in Competitive exams by Prof.A.Balasubramanian.
2. Numerical Ability and Mathematical Aptitude by Dr.A.B.Rao
3. Communication skills and soft skills by E.Suresh Kumar , p.sreehari & j.savithri

Web References:

1. https://faceprep.in/ logical reasoning
2. www.sawaal.com
3. http://nptel.ac.in/courses
4. www.prepinsta.com

Model Questions from High Level Reasoning & Employability Skills

L1: Remember

1. Compare and contrast the leadership styles of a democratic leader and an authoritarian leader. Which style is more effective in a diverse team?
2. Analyze the following conversation and identify the communication barriers present: Manager: 'Just do whatever you think is best.' Employee: 'I'm not sure what you want me to do exactly.'
3. A candidate performed well technically but failed in the HR interview. Analyze the possible soft skills gaps and suggest improvements.
4. How do group dynamics and individual behavior influence the decision-making process of a team? Provide examples.
5. Evaluate the role of empathy in conflict resolution within a workplace team that includes members from diverse cultural backgrounds.
6. Identify the logical errors in the following group discussion argument: 'Young employees should not be given leadership roles because they lack experience in all situations.'

L2: Understand

1. Critically evaluate the importance of soft skills versus technical skills in long-term career success. Support your argument with real-world examples.
2. A job applicant's resume lists 'excellent communication skills' but struggles during the mock interview. Evaluate what specific areas need improvement and design a remediation plan.
3. Assess the effectiveness of the following interview response to 'Tell me about yourself:' and suggest improvements: 'I am a hardworking student. I like coding and I have done many projects. I want a good job.'
4. Evaluate the impact of poor time management on an employee's professional growth and team performance. Propose strategies to overcome this.
5. A group discussion panel observed that one participant dominated the conversation while others were silent. Evaluate the group dynamics and suggest how the facilitator should manage the situation.
6. Compare the effectiveness of verbal feedback versus written feedback in a professional training context. Which approach is more likely to improve employee performance and why?
7. Design a comprehensive self-improvement plan for a student who wants to develop strong interview skills, professional etiquette, and emotional intelligence within three months.

L3: Apply

1. Statements: Some dogs are bags. No bag is lion. All rooms are lions.
   Conclusions: I. Some rooms are bags. II. Some dogs are lions. III. Some rooms are dogs.
2. Statements: All rings are birds. Some birds are cages. All cages are kites.
   Conclusions: I. All kites are cages. II. Some kites are rings. III. Some birds are kites.
3. Statements: Some buses are houses. All houses are taxis. All rickshaws are taxis.
   Conclusions: I. Some rickshaws are houses. II. Some taxis are houses. III. Some taxis are buses.
4. Statements: All ducks are pigeons. All pigeons are crows.
   Conclusions: I. Some crows are ducks. II. Some crows are pigeons.

5. A survey was conducted on 70 students regarding the subjects they like. According to the survey, 31students like Math. 36 like English, and English 27 like History. Also 19 like Math and English, 11 like Math and History, and 5 like History and English. 3 students like all the three subjects. How many students do not like any of the three subjects?
6. In a class of 80 students, 37 study French, 62 study German, and everyone in the class studies either French or German. How many of the students study French but not German?
7. Given signs signify something and on that basis, assume the given statements to be true and find which of the two conclusions I and II is/are definitely true
   A+B means A is equal to B, A-B means A is not equal to B, A=B means A is greater than B
   A*B means A is greater than equal to B, A/B means A is less than B
   Statements: S/T, T+U, U*V
   Conclusions: I. S/U II. T*V
8. A cube is colored red on all faces. It is cut into 64 smaller cubes of equal size. Now, answer the following questions based on these statements. How many cubes have no face colored?

L4: Analyzing

1. Six friends - P, Q, R, S, T, and U (not necessarily in the same order) are sitting around a circular table, all facing the center. P and Q are not facing each other. Q is sitting second to the left of P and third to the right of R. T is sitting second to the left of S. Who is sitting fourth to the left of S?
2. Five cars parked in a row facing Eastward. E is parked to the left of A, B and C. B, C and A are parked to the left of D, C is parked between A and B. if B is parked fourth from the left, how far is A parked from the right?
3. Six friends Amit, Bhuwan, Chetan, Dilip, Lalit and Fahim are sitting in a row facing west direction. Chetan is between Amit and Lalit. Bhuwan is to the immediate left of Lalit and to the immediate right of Dilip. Fahim is not at the left end. Which pair is sitting beside Dilip?
4. The given question is followed by two statements I and II. Decide if the statements contain sufficient information to answer the question. Problem Question: Among the four students of grade 5 - Richie, Martha, Kelly, and Gretchen, who is the tallest?
   Statements: I) Martha is shorter than Richie but taller than Gretchen.
   II) Kelly is taller than Martha.
5. Problem Question: M, P, A and K are four boxes having different weights. Which among them is the heaviest box? Statements: I. P is the heavier than M and K but lighter than A.
   II. M is lighter than P and A but heavier than K.

L5: Evaluating

1. Statement: Population increase coupled with depleting resources is going to be the scenario of many developing countries in days to come.
   Conclusions:
   I. The population of developing countries will not continue to increase in future.
   II. It will be very difficult for the governments of developing countries to provide decent quality of life.
2. Statement: Facebook is a company committed to giving the people power to build communities and closer together.
   Assumptions: I. The headquarter of Facebook is in California, United states.
   II. Facebook is an American social media conglomerate corporation.

3. Statement: In the recent census report, it is stated that the female to male ratio is alarmingly low.
   Courses of Action: I. The government should conduct another census to verify the results
   II. The government should immediately issue orders to all the departments to encourage people to improve the ratio.
4. Direction: Read the following information carefully and answer the questions given below.
   Five friends P, Q, R, S and T stay in a hostel but indifferent wings i.e. wing A, wing B, wing C, wing D and wing E. All of them watch different TV channels Following is some more information.
   1. 'P' does not watch Star Plus or Discovery channel but stays in wing A.
   2. 'Q' does not watch CNN.
   3. 'S' stays in wing C but he is not interested in watching Zee or Star plus channel.
   4. 'R' watches ETV and does not stay in wing D.
   5. The person who stays in wing E watches the CNN channel.
   The friend who stays in wing C watches which channel?

R24EEPC21 **Power System Operation and Control** **3 0 0 3**
(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. Introduce the principles of economic operation of power systems and optimal generation scheduling considering generation costs and transmission losses.
2. Develop the ability to analyze and solve hydrothermal scheduling problems for the optimal utilization of thermal and hydroelectric resources.
3. Provide knowledge of unit commitment techniques and optimization methods for determining the optimal scheduling of generating units.
4. Familiarize students with load frequency control concepts, mathematical modeling of power system components, and frequency regulation in interconnected power systems.
5. Enable students to understand reactive power control and compensation techniques for improving voltage regulation, power transfer capability, and system stability.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC21.1	Analyze economic load dispatch problems and determine optimal generation allocation considering generation costs and transmission line losses.	3	3	2	2	2	2	–	–	–	2	1	3	2	L1, L2,L4
R24EEPC21.2	Analyze hydrothermal scheduling problems for the optimal operation of integrated hydro and thermal power systems.	3	3	2	2	2	2	–	–	–	1	1	3	2	L3, L4
R24EEPC21.3	Apply unit commitment techniques and optimization methods to determine the optimal	3	3	3	2	2	1	–	–	–	2	1	3	2	L4, L5

	scheduling of generating units under operational constraints.														
R24EEPC21.4	Analyze load frequency control strategies in single-area and multi-area power systems using dynamic models and control techniques	3	3	2	2	3	2	–	–	–	1	2	3	2	L4, L5
R24EEPC21.5	Evaluate reactive power control and compensation methods for enhancing voltage regulation, transmission efficiency, and power system performance.	3	3	2	2	3	3	–	–	–	1	2	3	2	L5, L6

SYLLABUS

Unit –I: Economic Operation of Power Systems **12 Hours**

Optimal operation of generators in thermal power stations – Heat rate curve – Cost curve – Incremental fuel and production costs – Input-output characteristics – Optimum generation allocation with line losses neglected – Optimum generation allocation including the effect of transmission line losses – Loss coefficients – General transmission line loss formula – Penalty factors.

Self-Learning Topics: AI-based Economic Dispatch in Smart Grids

CO's: CO1

Unit –II: Hydro Thermal Scheduling **14 Hours**

Optimal scheduling of hydrothermal system – Hydroelectric power plant models – Reservoir characteristics – Short-term hydrothermal scheduling problem – Long-term hydrothermal scheduling – Coordination equations for hydrothermal systems – Solution by method of Lagrange multipliers – Discretized approach using dynamic programming, environmental constraints.

Self-Learning Topics: Reservoir operation and modeling for hydroelectric power plants, Optimization techniques for short-term hydrothermal scheduling. **CO's: CO2**

Unit –III: Unit Commitment **12 Hours**

Optimal unit commitment problem–Need for unit commitment–Constraints in unit commitment–

Cost function formulation – Solution methods – Priority ordering – Dynamic programming**.**

Self-Learning Topics: Application of AI-based optimization techniques for Unit Commitment problems. **CO's: CO3**

Unit –IV: Load Frequency Control **15 Hours**

Modeling of steam turbine - Modeling of Hydro turbine – Generator – Mathematical modeling of speed governing system–Transfer function–Necessity of keeping frequency constant–Control area – Single area power system – Block diagram representation of an isolated power system – Steady state analysis - Dynamic response of Uncontrolled case. Proportional plus Integral control of single area- Steady State Response .Tie-line bias control, Block diagram development of Load Frequency Control of two area system- uncontrolled case and controlled case, Economic dispatch control, – Introduction to SCADA and Energy Management Systems.

Self-Learning Topics: Automatic Generation Control (AGC) in interconnected power systems, Load Frequency Control in renewable energy integrated power systems. **CO's: CO4**

Unit –V: Reactive Power Control **15 Hours**

Overview of reactive power control – Reactive power compensation in transmission systems – Advantages and disadvantages of different compensating equipment – Load compensation – Specifications of load compensator – Uncompensated and compensated transmission lines: shunt and series compensation – SVC and STATCOM for reactive power management – Power factor correction methods.

Self-Learning Topics: Reactive power compensation techniques for voltage stability enhancement. **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 3

Approved in ACM No: 03

Text Books:

1. Electric Energy systems Theory–by O.I. Elgerd,Tata McGraw–Hill Publishing Company Ltd., Second edition.
2. Modern Power System Analysis–by I.J. Nagrath & D.P.Kothari Tata McGraw Hill Publishing Company Ltd, 2nd edition.

Reference Books

1. Power System Analysis and Design by J. Duncan Glover and M.S .Sarma., Thompson, 3rd Edition.
2. Power System Analysis by Grainger and Stevenson, Tata McGraw Hill.

3. Power System Analysis by Hadi Saadat –TMH Edition.
4. Power System stability & control, Prabha Kundur, TMH

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc19_ee62
2. http://www.digimat.in/nptel/courses/video/108107127/L10.htm

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What is an input-output characteristic curve?
2. Explain the need for hydrothermal scheduling
3. Describe various constraints involved in the UC problem.
4. Describe the components of a speed governing system.
5. Explain the need for reactive power control in power systems.

L2: Understand

1. Explain the criterion for optimum generation allocation when transmission losses are neglected.
2. Discuss reservoir constraints in hydrothermal scheduling.
3. Explain the formulation of the unit commitment problem.
4. Explain the mathematical modeling of a steam turbine and governor.
5. Explain load compensation and its specifications.

L3: Apply

1. Determine the optimal generation schedule considering transmission losses..
2. Determine the optimal allocation of hydro and thermal generation for a given load demand.

3. Apply dynamic programming to determine the optimal commitment schedule.
4. Determine the frequency response of a PI-controlled single-area system.
5. Determine the compensation needed to improve transmission line performance.

L4: Analyzing

1. Examine the influence of loss coefficients on generator scheduling.
2. Analyze the trade-off between water utilization and fuel cost minimization.
3. Compare various solution techniques used for UC problems
4. Analyze the block diagram representation of a two-area load frequency control system

L5: Evaluating

1. Evaluate the effectiveness of classical economic dispatch methods.
2. Evaluate the advantages of hydrothermal coordination in power system operation.
3. Assess the limitations of conventional unit commitment methods.

L6: Create

1. Develop a mathematical model for short-term hydrothermal scheduling.
2. Develop an AGC strategy for renewable-energy integrated power systems.
3. Design a reactive power compensation scheme for a transmission network

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R24HS11 ENTREPRENEURSHIP AND DEVELOPMENT 2 0 0 2

(Common to EEE, Mechanical, ECE, CSE, CSE- AI&ML, CSE-DS)

Course Objectives

1. To provide basic knowledge of entrepreneurship and entrepreneurial development.
2. To develop entrepreneurial skills and motivation among students.
3. To familiarize students with business opportunities, project preparation, and business planning.
4. To impart understanding of small business management and entrepreneurial practices.
5. To create awareness about emerging trends and challenges in entrepreneurship development.

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs											Dok
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	
R24HS11.1	Explain the concepts, characteristics, and importance of entrepreneurship and entrepreneurial development.	3	2	1	-	-	1	2	1	2	2	2	L1, L2
R24HS11.2	Identify business opportunities and understand the role of MSMEs and institutional support systems.	2	2	2	1	1	1	2	3	2	3	2	L2, L3
R24HS11.3	Prepare simple business plans and analyze feasibility aspects of small business enterprises.	2	3	1	2	1	2	3	3	2	2	2	L3, L4
R24HS11.4	Apply basic managerial concepts related to marketing, finance, and operations in small businesses.	3	3	3	2	2	1	1	2	2	3	2	L4, L5
R24HS11.5	Examine emerging trends, ethical practices, and challenges in entrepreneurship and business development.	2	3	3	3	2	2	3	3	3	3	3	L5, L6

SYLLABUS

UNIT – I **14 Hours**

Introduction to Entrepreneurship: Meaning and Definition of Entrepreneurship – Characteristics and Functions of an Entrepreneur – Types of Entrepreneurs – Importance of Entrepreneurship in Economic Development – Role of Entrepreneurship in Employment Generation – Qualities and Skills of Successful Entrepreneurs – Entrepreneurial Motivation – Women Entrepreneurship – Rural Entrepreneurship – Challenges faced by Entrepreneurs. **COS–CO1**

Self-Learning Topics:

Study the role of entrepreneurship in economic and social development and identify the qualities required to become a successful entrepreneur.

UNIT – II **14 Hours**

Entrepreneurial Development and Business Opportunities: Concept of Entrepreneurial Development – Entrepreneurial Development Programmes (EDPs) – Process of Entrepreneurship Development – Identification of Business Opportunities – Sources of Business Ideas – Small Scale Enterprises – Start-ups and Innovation – Government Support for Entrepreneurship – MSMEs and their Importance – Institutional Support for Entrepreneurs. **COS–CO2**

Self-Learning Topics:

Identify simple business opportunities in local markets and study the role of MSMEs and government support in promoting entrepreneurship.

UNIT – III **10 Hours**

Business Planning and Project Preparation: Business Plan – Importance and Components of Business Plan – Steps in Setting up a Small Business Enterprise – Project Identification and Selection – Feasibility Study – Market Feasibility – Technical Feasibility – Financial Feasibility – Sources of Finance for Small Enterprises – Basic Financial Planning and Budgeting. **COS–CO3**

Self-Learning Topics:

Prepare a simple business plan for a small business idea and examine the importance of feasibility analysis before starting a business.

UNIT – IV **10 Hours**

Management of Small Business Enterprises: Forms of Business Organization – Sole Proprietorship, Partnership and Company – Basic Marketing Concepts for Entrepreneurs – Pricing and Promotion – Human Resource Management in Small Business – Production and Operations Basics – Business Communication – Customer Relationship Management – Digital Marketing for Small Businesses.

COS–CO4

Self-Learning Topics:

Study how small businesses use marketing, communication, and customer relationship practices for business growth and sustainability.

UNIT – V **10 Hours**

Entrepreneurship Growth and Emerging Trends: Business Ethics and Social Responsibility – Risk Management in Entrepreneurship – Problems faced by Start-ups – E-Commerce and Online Business – Green Entrepreneurship – Social Entrepreneurship – Innovation and Creativity in Business – Entrepreneurial Success Stories – Emerging Trends in Entrepreneurship. **COS–CO5**

Self-Learning Topics:

Examine emerging entrepreneurial trends such as digital business, green entrepreneurship, and social entrepreneurship and analyze their impact on modern business practices.

Board of Studies: Master of Business Administration

Approved in BOS No: 01, 27th May, 2026

Approved in ACM No: 01

Text Books

1. Entrepreneurship Development, S. S. Khanka, S. Chand Publishing.
2. Entrepreneurship, McGraw Hill Education.
3. Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House.
4. Entrepreneurship Development and Small Business Enterprises, Pearson Education.
5. Fundamentals of Entrepreneurship, PHI Learning.

Reference Books

1. Entrepreneurship Development, Sultan Chand & Sons.
2. Small Scale Industries and Entrepreneurship, Himalaya Publishing House.
3. Entrepreneurship: Theory, Process and Practice, Cengage Learning.
4. Innovation and Entrepreneurship, Harper Business.
5. Entrepreneurial Development, New Age International Publishers.

Web references

1. https://www.msme.gov.in
2. https://www.startupindia.gov.in
3. https://www.niesbud.nic.in
4. https://www.sidbi.in
5. https://www.nsic.co.in
6. https://www.udyamregistration.gov.in
7. https://www.investindia.gov.in
8. https://www.swayam.gov.in

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	17	-
L2	17	-
L3	33	30
L4	33	30
L5	-	28
L6	-	14
Total (%)	**100**	**100**

Sample Short and Long Answers to Questions of Various Cognitive Levels

PART – A: 2 MARK QUESTIONS

LEVEL – 1 (Remembering)

1. Define entrepreneurship.
2. Who is an entrepreneur?
3. State any two qualities of an entrepreneur.
4. What is women entrepreneurship?
5. Define MSME.
6. What is a business plan?
7. Define feasibility study.
8. What is digital marketing?
9. Define social entrepreneurship.
10. What is innovation?

LEVEL – 2 (Understanding)

1. Explain the importance of entrepreneurship.
2. Describe the functions of an entrepreneur.
3. Explain the concept of entrepreneurial development.
4. Discuss the role of EDPs.
5. Explain the importance of business opportunities.
6. Describe the components of a business plan.
7. Explain the importance of market feasibility.
8. Discuss the role of marketing in small business.
9. Explain the concept of green entrepreneurship.
10. Describe the importance of business ethics.

LEVEL – 3 (Applying)

1. Illustrate how entrepreneurship generates employment.
2. Apply entrepreneurial skills in identifying business opportunities.
3. Demonstrate the preparation of a simple business plan.
4. Apply feasibility analysis for a small business.
5. Illustrate the use of digital marketing by entrepreneurs.
6. Apply budgeting techniques in small businesses.
7. Demonstrate customer relationship practices in business.
8. Apply promotional methods for a new product.
9. Illustrate the role of innovation in entrepreneurship.
10. Apply risk management practices in start-ups.

LEVEL – 4 (Analyzing)

1. Differentiate between entrepreneur and manager.
2. Compare rural and urban entrepreneurship.

3. Analyze the role of MSMEs in economic development.
4. Differentiate between market feasibility and financial feasibility.
5. Analyze the importance of project selection.
6. Compare sole proprietorship and partnership forms of business.
7. Analyze the challenges faced by entrepreneurs.
8. Differentiate between traditional marketing and digital marketing.
9. Analyze the impact of e-commerce on small businesses.
10. Examine the role of institutional support for entrepreneurs.

LEVEL – 5 (Evaluating)

1. Evaluate the effectiveness of EDPs.
2. Assess the importance of entrepreneurship in economic growth.
3. Evaluate the role of government support for entrepreneurs.
4. Assess the effectiveness of business planning.
5. Evaluate the importance of customer relationship management.
6. Assess the role of innovation in business success.
7. Evaluate the impact of social entrepreneurship.
8. Assess the significance of ethical business practices.
9. Evaluate the role of digital business models.
10. Assess the contribution of women entrepreneurs to society.

LEVEL – 6 (Creating)

1. Design a simple business idea for a local market.
2. Develop a business plan for a small enterprise.
3. Prepare a marketing strategy for a start-up.
4. Design a promotional campaign for a new product.
5. Develop a customer relationship strategy.
6. Create a financial plan for a small business.
7. Design an innovative business model.
8. Develop strategies for risk management in business.
9. Prepare a project report for a small enterprise.
10. Create a social entrepreneurship model for community development.

PART – B: ESSAY QUESTIONS

LEVEL – 1 (Remembering)

1. Define entrepreneurship and explain its importance.
2. Explain the characteristics and functions of an entrepreneur.
3. Describe the role of entrepreneurship in economic development.
4. Explain the concept of entrepreneurial development.

5. Define MSMEs and explain their importance.
6. Explain the meaning and objectives of a business plan.
7. Define feasibility study and explain its types.
8. Explain the forms of business organization.
9. Define innovation and explain its role in entrepreneurship.
10. Explain the concept of social entrepreneurship.

LEVEL – 2 (Understanding)

1. Explain the role of entrepreneurship in employment generation.
2. Discuss the importance of Entrepreneurial Development Programmes.
3. Explain the process of identifying business opportunities.
4. Describe the steps involved in preparing a business plan.
5. Explain the significance of market feasibility analysis.
6. Discuss the role of digital marketing in small business.
7. Explain the importance of customer relationship management.
8. Describe the role of institutional support agencies for entrepreneurs.
9. Explain the concept of green entrepreneurship.
10. Discuss the importance of business ethics and social responsibility.

LEVEL – 3 (Applying)

1. Illustrate how entrepreneurial qualities contribute to business success.
2. Apply entrepreneurial development concepts in starting a small business.
3. Demonstrate the preparation of a business plan for a start-up.
4. Apply feasibility analysis techniques to a business project.
5. Illustrate the use of promotional strategies for a new business.
6. Apply digital marketing tools for business growth.
7. Demonstrate financial planning for a small enterprise.
8. Apply customer relationship practices in entrepreneurship.
9. Illustrate the use of innovation in product development.
10. Apply risk management strategies in entrepreneurship.

LEVEL – 4 (Analyzing)

1. Differentiate between entrepreneurs and managers.
2. Compare women entrepreneurship and rural entrepreneurship.
3. Analyze the role of MSMEs in economic development.
4. Compare different forms of business organization.
5. Analyze the challenges faced by start-ups.
6. Differentiate between traditional and digital marketing approaches.
7. Analyze the importance of business feasibility studies.

8. Compare social entrepreneurship and commercial entrepreneurship.
9. Analyze the impact of e-commerce on entrepreneurship.
10. Examine the role of government support in entrepreneurship development.

LEVEL – 5 (Evaluating)

1. Evaluate the effectiveness of entrepreneurship development programmes.
2. Assess the contribution of entrepreneurship to economic growth.
3. Evaluate the role of innovation in entrepreneurial success.
4. Assess the importance of business planning for entrepreneurs.
5. Evaluate the role of digital marketing in business development.
6. Assess the effectiveness of customer relationship management practices.
7. Evaluate the importance of ethical practices in entrepreneurship.
8. Assess the role of women entrepreneurs in society.
9. Evaluate the impact of social entrepreneurship on community development.
10. Assess the role of institutional support systems for entrepreneurs.

LEVEL – 6 (Creating)

1. Design a business model for a start-up enterprise.
2. Develop a business plan for a small manufacturing unit.
3. Prepare a marketing and promotional strategy for a new product.
4. Design a financial plan for a start-up business.
5. Develop a customer relationship management strategy for small businesses.
6. Create an innovative entrepreneurial idea for rural development.
7. Design a social entrepreneurship project for community welfare.
8. Develop strategies for sustainable and green entrepreneurship.
9. Prepare a project report for a new business venture.
10. Create an entrepreneurship development framework for young entrepreneurs.

Chairperson

Board of Studies (MBA)

R24EEPE11 **Programmable Logic Controllers** **3 0 0 3**
(Professional Elective-I)

Course Objectives:

The main objectives of the course is to

1. To understand PLC system architecture and operation.
2. To develop PLC programs using ladder logic.
3. To learn Boolean logic and PLC register operations.
4. To apply PLC functions in industrial automation.
5. To understand advanced PLC and PID control applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE11.1	Explain PLC architecture and interfacing.	3	2	1	1	2	-	-	-	-	-	1	2	2	L1,L2
R24EEPE11.2	Develop basic PLC ladder programs.	3	2	2	2	3	-	-	1	1	-	2	3	3	L2, L3
R24EEPE11.3	Construct ladder diagrams using Boolean logic.	3	3	2	2	3	-	-	1	1	-	2	3	3	L3, L4
R24EEPE11.4	Apply PLC functions in automation systems.	3	3	2	2	3	1	-	1	1	-	2	3	3	L4,L5
R24EEPE11.5	Analyze advanced PLC and PID applications.	3	3	3	3	3	2	-	1	1	1	3	3	3	L5,L6

SYLLABUS

UNIT-I: Introduction to PLC Systems **12 Hours**

PLC system, I/O modules and interfacing, CPU processor, programming Equipment, Programming formats, construction of PLC ladder diagrams, Devices connected to I/O modules.

Self-Learning Topics: Interfacing sensors and actuators with PLC systems-Architecture and working of PLC processors-Memory organization and scan cycle operation in PLC **CO's: CO1**

UNIT-II :PLC Programming Fundamentals and Industrial Applications 12 Hours

PLC Programming: Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drill press operation

Self-Learning Topics: PLC programming for motor control applications-Automation of drill press operation using PLC ladder diagrams **CO's: CO2**

UNIT-III: Ladder Diagram Development, and PLC Registers 12 Hours

Digital logic gates, programming in the Boolean algebra system, conversion examples Ladder Diagrams for process control: Ladder diagrams & sequence listings, ladder diagram construction and flowchart for spray process system. PLC Registers: Characteristics of Registers, module addressing, holding registers, Input Registers, Output Registers.

Self-Learning Topics: PLC Memory-Ladder Programming **CO's: CO3**

UNIT-IV: PLC Functions 12 Hours

Timer functions & Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions. Data Handling functions: SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CLR & Sweep functions and their applications

Self-Learning Topics: FIFO Operations-FAL Functions-One Shot (ONS) Functions-CLR Functions **CO's: CO4**

UNIT-V: Advanced PLC 12 Hours

Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two-axis & three axis Robots with PLC, Matrix functions.

ANALOG PLC OPERATION: Analog modules & systems, Analog signal processing, Multi bit Data Processing, Analog output Application Examples, PID principles, position indicator with PID control, PID Modules, PID tuning, PID functions

Self-Learning Topics: Robot Control using PLC-Two-Axis Robot Control-Three-Axis Robot Control-Matrix Functions **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

TEXT BOOKS:

1. John W. Webb & Ronald A.Reiss,"Programmable Logic Controllers-Principles and Applications", Fifth Edition, PHI, 2009.

REFERENCES:

1. Jr. Hackworth & F.D Hackworth Jr., "Programmable Logic Controllers- Programming Method and Applications", Pearson, 2003.

2. Gary Dunning, "Introduction to Programmable Logic Controllers", Delmar Thomas Learning,3rd Edition,2005.

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What is a PLC system?
2. Define ladder logic programming.
3. State the function of PLC CPU.
4. List different types of PLC I/O modules.
5. Define timer and counter functions.

L2: Understand

1. Explain the PLC scan cycle operation.
2. Explain the function of input and output modules.
3. Describe the working of ladder diagrams.
4. Explain Boolean algebra used in PLC programming.
5. Discuss the applications of PID control.

L3: Apply

1. Develop a ladder program for motor start-stop control.
2. Construct a PLC ladder diagram for drill press operation.
3. Apply timer instructions in an industrial automation system.
4. Use counter instructions for sequential operation control.
5. Develop a PLC program using arithmetic functions.

L4: Analyze

1. Compare relay logic control and PLC control systems.
2. Analyze the working of PLC registers.
3. Differentiate between analog and digital PLC operations.
4. Analyze sequence functions used in PLC automation.
5. Examine the role of PID tuning in process control.

L5: Evaluate

1. Evaluate the advantages of PLC-based automation systems.
2. Assess the importance of data handling functions in PLC.
3. Evaluate robot control using PLC systems.
4. Justify the use of analog modules in PLC applications.
5. Assess the effectiveness of ladder logic in industrial control.

L6: Create

1. Design a ladder diagram for spray process control.
2. Develop a PLC program using timers and counters.
3. Create a PLC-based automation system for conveyor control.
4. Design a PID-controlled position indicator system.
5. Develop a PLC program for two-axis robot control

Chairperson
Board of Studies (EEE)

R24EEPE12 **Flexible AC Transmission Systems** **3 0 0 3**
(Professional Elective-III)

Course Objectives:

The main objectives of the course are to

1. To understand power flow control limitations and FACTS controller types in AC transmission systems.
2. To analyze the operation and control of voltage source and current source converters used in FACTS.
3. To evaluate shunt compensation using SVC and STATCOM for voltage regulation and stability improvement.
4. To assess series compensation methods including TCSC and SSSC for power flow control.
5. To understand the operation of combined controllers such as UPFC and IPFC in transmission systems.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE12.1	Explain power flow control fundamentals, loading limits, and classify FACTS controllers and high-power semiconductor devices.	3	2	-	1	1	1	-	-	-	-	1	3	2	L1, L2
R24EEPE12.2	Analyse the operation of single-phase and three-phase voltage source and current source converters used in FACTS.	2	3	-	2	2	-	-	-	-	-	1	3	2	L3, L4
R24EEPE12.3	Evaluate the performance of shunt compensators (TSC, TCR, SVC, STATCOM) for voltage regulation and	2	3	2	2	2	2	-	-	-	-	1	3	2	L4, L5

	stability enhancement.														
R24EEPE12.4	Assess series compensation techniques (SSSC, TCSC, TSSC) for power oscillation damping and transient stability improvement.	2	3	1	2	2	1	-	-	-	-	1	3	2	L4, L5
R24EEPE12.5	Apply the principles of UPFC and IPFC for simultaneous control of active and reactive power flow in transmission systems.	2	2	3	2	2	2	-	-	-	-	2	3	2	L5, L6

SYLLABUS

Unit –I: Introduction to FACTS and Power Flow Control **12 Hours**

Power flow in an AC system – Loading capability limits: thermal, dielectric, and stability limits – Dynamic stability considerations – Importance of controllable parameters – Basic types of FACTS controllers: series, shunt, series-series, series-shunt – Benefits from FACTS controllers – Requirements and characteristics of high-power semiconductor devices – Voltage and current ratings – Losses and speed of switching – GTO, IGBT, and IGCT devices .

Self-Learning Topics: Wide Area Monitoring Systems (WAMS) and FACTS Integration in Smart Grids **CO's: CO1**

Unit –II: Voltage Source and Current Source Converters **12 Hours**

Concept of voltage source converter (VSC) – Single-phase bridge converter – Square-wave voltage harmonics for a single-phase bridge converter – Three-phase full-wave bridge converter – Harmonic analysis of three-phase bridge converter – Three-phase current source converter – PWM-based VSC – Comparison of current source converter with voltage source converter. **CO's: CO2**

Self-Learning Topics: Modular Multi-Level Converters (MMC) and Their Role in HVDC and FACTS

Unit –III: Shunt Compensators **14 Hours**

Objectives of shunt compensation – Mid-point voltage regulation for line segmentation – End-of-line voltage support to prevent voltage instability – Improvement of transient stability – Power oscillation damping – Thyristor Switched Capacitor (TSC) – Thyristor Controlled Reactor (TCR) – Fixed Capacitor-Thyristor Controlled Reactor (FC-TCR) – Static VAR Compensator (SVC): regulation slope, transfer function and dynamic performance – Transient stability enhancement – Static Compensator (STATCOM): operating principles, V-I characteristics – Comparison of SVC and STATCOM.

Self-Learning Topics: D-STATCOM Applications in Distribution Networks and Microgrids

CO's: CO3

Unit –IV: Series Compensators **12 Hours**

Static series compensators: concept of series capacitive compensation – Impedance characteristics – Improvement of transient stability – Power oscillation damping – Functional requirements – ThyristorSwitched Series Capacitor (TSSC) – Thyristor Controlled Series Capacitor (TCSC): operating modes, impedance characteristics – GTO Thyristor-Controlled Series Capacitor (GCSC) – Static Synchronous Series Compensator (SSSC): operating principles, V-I characteristics

Self-Learning Topics: Sub-Synchronous Resonance Mitigation using SSSC in Series Compensated Systems **CO's: CO4**

Unit –V: Combined and Multi-Functional Controllers **12 Hours**

Unified Power Flow Controller (UPFC): schematic, basic operating principles – Active and reactive power control using UPFC – UPFC control strategies – Series voltage injection control – Shunt current injection control – Interline Power Flow Controller (IPFC): concept and operating principles

Self-Learning Topics: UPFC Applications in Optimal Power Flow and Congestion Management

CO's: CO5

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Understanding FACTS – N.G. Hingorani and L. Gyugyi, IEEE Press, Standard Publications, 2001.
2. FACTS Controllers in Power Transmission and Distribution – Padiyar K.R., New Age Int. Publishers, 2007.

Reference Books:

1. Flexible AC Transmission System (FACTS) – Edited by Yong Hua Song and Allan T. Johns, Institution of Electrical Engineers, London.
2. Thyristor-based FACTS Controllers for Electrical Transmission Systems – R. Mohan Mathur and Rajiv K. Varma, Wiley-IEEE Press.
3. HVDC and FACTS Controllers – Vijay K. Sood, Kluwer Academic Publishers, 2004.
4. Power System Stability and Control – PrabhaKundur, McGraw Hill, 1994.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee35

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. List the basic types of FACTS controllers and their classification.
2. State the loading capability limits of a transmission line.
3. Define the term power oscillation damping in the context of FACTS.
4. List the major differences between SVC and STATCOM.

L2: Understand

1. Explain the importance of controllable parameters in AC power flow.
2. Describe the operating principle of Thyristor Controlled Series Capacitor (TCSC).
3. Explain the regulation slope and transfer function of a Static VAR Compensator.
4. Discuss the concept of sub-synchronous resonance and its relation to series compensation.

L3: Apply

1. Calculate the power flow change in a transmission line due to series capacitive compensation.
2. Determine the required reactive power compensation for voltage support at the receiving end of a transmission line.
3. Compute the V-I characteristic of an SVC for given thyristor ratings and firing angles.
4. Apply the power flow equations to determine the effect of UPFC on active and reactive power.

L4: Analyse

1. Compare the transient stability improvement achieved by SVC and STATCOM for a given system.
2. Examine the impact of SSSC on power flow under different operating conditions.
3. Compare the performance of UPFC and IPFC for multi-line power flow control.
4. Analyse the power oscillation damping performance of TCSC using eigenvalue analysis.

L5: Evaluate

1. Evaluate the cost-benefit of installing a UPFC versus separate shunt and series compensators.
2. Justify the selection of STATCOM over SVC for voltage support in a weak grid.
3. Assess the effectiveness of TCSC in mitigating sub-synchronous resonance.

L6: Create

1. Design a SVC-based compensation scheme for a given transmission system to maintain voltage within specified limits and improve transient stability.
2. Develop a UPFC control strategy for simultaneous voltage and power flow regulation in a two-machine power system.
3. Formulate the optimal placement and sizing of a STATCOM in a radial distribution network to minimize power loss.

Chairperson
Board of Studies (EEE)

R24EEPE13 **IoT Applications in Electrical Engineering** **3 0 0 3**
(Professional Elective-III)

Course Objectives:

The main objectives of the course are to

1. To understand the evolution, enabling technologies, and architecture of the Internet of Things.
2. To analyze IoT communication protocols including IEEE 802.15.4, LoRaWAN, 6LoWPAN, CoAP, and MQTT.
3. To design and develop IoT systems using embedded platforms such as Raspberry Pi and Arduino for electrical engineering applications.
4. To apply cloud computing, data analytics, and IoT supporting services for electrical engineering data management.
5. To evaluate real-world IoT applications in smart metering, energy monitoring, protection, and industrial electrical systems.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE13.1	Explain the evolution of IoT, enabling technologies, M2M communication, IoT architecture, and role of sensors and actuators in electrical engineering.	2	2	-	1	2	1	-	-	-	-	-	2	2	L1, L2
R24EEPE13.2	AnalyseIoT access technologies, network layer protocols (6LoWPAN, IPv6), and application layer protocols (CoAP,	-	3	2	2	2	-	-	-	-	-	-	2	2	L2, L3

	MQTT, SCADA) for electrical engineering systems.														
R24EEPE13.3	Design IoT systems using Raspberry Pi and Arduino with appropriate sensors, actuators, and embedded logic for electrical measurement and control applications.	-	3	3	2	3	-	-	-	-	-	-	2	2	L3, L4
R24EEPE13.4	Apply cloud platforms and data analytics techniques to process, store, and visualiseIoT data from electrical engineering systems.	-	3	2	2	2	1	-	-	-	-	-	1	2	L3, L4
R24EEPE13.5	Evaluate and implement IoT applications in smart energy metering, motor monitoring, power system protection, renewable energy, and Industry 4.0 for electrical engineering.	-	3	3	2	3	1	-	-	-	-	-	-	2	L5, L6

SYLLABUS

Unit –I: Fundamentals of IoT **14 Hours**

Evolution of Internet of Things – Definition, characteristics, and key features – Enabling Technologies: embedded systems, wireless sensor networks, cloud computing, big data, communication technologies, and cyber-physical systems – M2M (Machine to Machine) Communication: concept, architecture, and applications – IoT World Forum (IoTWF) standardized architecture – Simplified IoT Architecture – Core IoT Functional Stack – Fog, Edge and Cloud in IoT:

roles and differences – Functional blocks of an IoT ecosystem – Sensors: types, characteristics, and selection – Actuators: types and applications in electrical systems – Smart Objects: definition and properties – Connecting Smart Objects: wired and wireless methods.

Self-Learning Topics: Digital Twin and Cyber-Physical Systems: Bridging IoT and Electrical Engineering Applications **CO's: CO1**

Unit –II: IoT Protocols **12 Hours**

IoT Access Technologies: Physical and MAC layers – Topology and Security of IEEE 802.15.4 (ZigBee), 802.11ah (Wi-Fi HaLow) and LoRaWAN: frame structure, addressing, star and mesh topology, security features – Network Layer: IP versions (IPv4 and IPv6) – Constrained Nodes and Constrained Networks – 6LoWPAN: adaptation layer, header compression, fragmentation and reassembly – Application Transport Methods: SCADA (Supervisory Control and Data Acquisition): architecture, Modbus, DNP3 – Application Layer Protocols: CoAP (Constrained Application Protocol): message types, request-response model, observe option – MQTT (Message Queuing Telemetry Transport): broker, publisher, subscriber, QoS levels, retain and last will message.

Self-Learning Topics:

5G and NB-IoT for Smart Grid and Advanced Metering Infrastructure (AMI) **CO's: CO2**

Unit –III: Design and Development of IoT Systems **12 Hours**

Design Methodology: requirement analysis, prototype design, testing, and deployment – Embedded computing logic: microcontroller versus microprocessor – Microcontroller: GPIO, ADC, PWM, timers, UART, I2C, SPI interfaces – System on Chips (SoC): ESP32, ESP8266 – IoT system building blocks: power supply, sensing, processing, communication, actuation. IoT Platform overview: Raspberry Pi: hardware specifications (GPIO, USB, HDMI, camera), Raspbian OS, Python programming for GPIO, interfacing sensors – Arduino Board: hardware details (ATmega328, digital/analog pins), Arduino IDE, sketch structure, libraries for IoT.

Self-Learning Topics:

FPGA-Based IoT Edge Nodes for Real-Time Electrical Signal Processing **CO's: CO3**

Unit –IV: Data Analytics and Supporting Services **12 Hours**

Data Analytics: Introduction to IoT data analytics – Structured Versus Unstructured Data: types and examples in IoT – Data in Motion versus Data at Rest: stream processing and batch processing – IoT Data Analytics Challenges: volume, velocity, variety, veracity – Data Acquiring and Organizing in IoT/M2M: data collection, storage, and pre-processing. Supporting Services: Computing using a Cloud Platform for IoT/M2M Applications and Services: AWS IoT Core, Microsoft Azure IoT Hub, Google

Cloud IoT, ThingSpeak – Everything as a Service (XaaS): SaaS, PaaS, IaaS – Cloud Service Models: public, private, hybrid cloud..

Self-Learning Topics:

Machine Learning on the Edge: AI-Powered IoT Analytics for Electrical Fault Prediction **CO's: CO4**

Unit –V: IoT Applications in Electrical Engineering 14 Hours

IoT in Smart Energy Metering: smart energy meter using ESP32 and PZEM-004T – parameters measured (kWh, kVAh, PF, maximum demand) – Automatic Meter Reading (AMR) – prepaid metering concept – anti-tamper detection. IoT in Electrical Machines: induction motor condition monitoring – current, temperature, vibration (ADXL345) monitoring using IoT – motor protection against overload, single phasing, and overheating via IoT alerts. IoT in Power Systems and Protection: IoT-based transformer health monitoring (oil temperature, load current, Buchholz relay status) – remote monitoring of substation parameters using SCADA-IoT integration – smart circuit breaker status monitoring and trip alert via IoT. IoT in Renewable Energy: solar PV monitoring (panel voltage, current, irradiance, yield) – wind turbine monitoring (wind speed, RPM, power output) – battery energy storage system (BESS) monitoring (SoC, temperature, charge/discharge current).

Self-Learning Topics:

Vehicle-to-Grid (V2G) and Smart EV Charging using IoT for Grid Frequency Support **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Internet of Things: A Hands-On Approach – ArshdeepBahga and Vijay Madisetti, VPT, 2014.
2. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things – David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, Cisco Press, 2017.

Reference Books:

1. Designing the Internet of Things – Adrian McEwen and Hakim Cassimally, Wiley, 2013.
2. IoT and Edge Computing for Architects – Perry Lea, Packt Publishing, 2nd Edition, 2020.
3. Programming the Raspberry Pi – Getting Started with Python – Simon Monk, McGraw-Hill, 3rd Edition, 2021.
4. Practical Node-RED Programming – TaijiHagino, Packt Publishing, 2021.

Web References:

1. https://www.cisco.com/c/en/us/solutions/internet-of-things/overview.html
2. https://mqtt.org/
3. https://coap.technology/
4. https://nodered.org/
5. https://thingspeak.mathworks.com
6. https://nptel.ac.in/courses/106105166

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define Internet of Things (IoT) and list its enabling technologies.
2. State the difference between M2M communication and IoT.
3. List the layers of the IoT World Forum (IoTWF) standardised architecture.
4. Define fog computing and state how it differs from cloud computing in IoT.
5. List the IoT application layer protocols and state their primary use.

L2: Understand

1. Explain the Core IoT Functional Stack and describe the role of each layer with an electrical engineering example.
2. Describe the IEEE 802.15.4 standard and explain its topology and security features for use in smart grid sensor networks.
3. Explain the 6LoWPAN adaptation layer and describe how it enables IPv6 over constrained wireless networks.

4. Describe the MQTT protocol architecture and explain the role of broker, publisher, and subscriber in an IoT energy monitoring system.
5. Explain structured versus unstructured data in IoT and give two examples from electrical engineering.

L3: Apply

1. Design an IoT node using Arduino and ACS712 sensor to measure AC current and transmit data to ThingSpeak using MQTT over Wi-Fi.
2. Configure a Raspberry Pi to interface with a DS18B20 temperature sensor and log transformer winding temperature to a CSV file with timestamp.
3. Implement a PZEM-004T power meter with ESP32 to measure voltage, current, power, and energy and display on an OLED and Blynk dashboard.
4. Design a Node-RED flow that reads MQTT data from a smart energy meter, displays it on a dashboard, and sends an email alert when power exceeds a threshold.
5. Apply LoRaWAN communication to transmit monthly energy readings from a remote AMR node to a central server for rural utility metering.

L4: Analyze

1. Compare IEEE 802.15.4 (ZigBee), LoRaWAN, and NB-IoT as access technologies for smart metering in terms of range, data rate, power consumption, and cost.
2. Analyse the IoT data challenges (volume, velocity, variety, veracity) for a utility company managing 10,000 smart meters reporting every 15 minutes.
3. Compare CoAP and MQTT as application layer protocols for an industrial IoT system monitoring 50 motors in a factory.
4. Examine the role of SCADA and IoT integration in substation automation and compare their data acquisition capabilities.
5. Analyse the cloud service models (SaaS, PaaS, IaaS) and identify the most suitable model for deploying an electrical energy monitoring application.

L5: Evaluate

1. Evaluate the technical and economic benefits of deploying IoT-based smart metering for a distribution company managing 5,000 consumers.
2. Justify the selection of ThingSpeak over a custom cloud server for a small-scale solar PV monitoring system in a college campus.
3. Assess the cybersecurity risks in an industrial IoT system for a power plant and evaluate the countermeasures based on IEC 62443.

L6: Create

1. Design a complete IoT-based energy management system for a medium-scale industry with sub-metering for 10 machines, real-time Grafana dashboard, demand monitoring, automated alerts for abnormal conditions, and MQTT communication — specifying all hardware, software, and communication components.
2. Develop an IoT-based induction motor health monitoring system using current, temperature, and vibration sensors connected to ESP32, with edge-based threshold detection, MQTT data upload to AWS IoT Core, and mobile alert for fault conditions.
3. Formulate an IoT solution for a 33/11 kV substation integrating Raspberry Pi-based data acquisition for transformer parameters, SCADA-IoT interface using Modbus TCP, cloud storage on Azure, real-time anomaly detection, and automated circuit breaker trip alert.

Chairperson
Board of Studies (EEE)

R24EEPE14 **VLSI Technology** **3 0 0 3**

(Professional Elective-III)

Course Objectives:

The main objectives of the course are to

1. To understand the fundamental principles of MOS transistor theory and VLSI fabrication processes.
2. To analyze CMOS logic design styles including static, dynamic, and pass transistor logic families.
3. To understand memory circuit design including SRAM, DRAM, ROM, and Flash memory architectures.
4. To learn VLSI testing methodologies including fault models, DFT, and BIST techniques.
5. To understand advanced nano-scale CMOS device challenges and emerging device technologies.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE14.1	Explain MOS transistor models, CMOS fabrication steps, and analyse MOSFET characteristics and scaling effects.	3	2	1	2	1	1	-	-	-	-	2	2	2	L1, L2
R24EEPE14.2	Design and analyse CMOS combinational and sequential logic circuits using static, dynamic, and pass transistor logic styles.	2	2	3	2	2	1	-	-	-	-	1	2	2	L4, L5
R24EEPE14.3	Evaluate the design and operation of SRAM, DRAM, ROM, and Flash memory cells and array architectures.	2	2	2	2	2	-	-	-	-	-	2	2	1	L4, L5

R24EEPE14.4	Apply VLSI testing methodologies including fault models, test vector generation, DFT, and boundary scan (JTAG) techniques.	2	2	3	2	3	-		-	-	-	1	2	1	L3, L4
R24EEPE14.5	Analyse advanced nano-scale CMOS challenges including leakage, variability, FinFET, and emerging device technologies.	2	3	1	2	2	1	-	-	-	-	3	2	2	L3, L4

SYLLABUS

Unit –I: MOS Transistor Theory and CMOS Fabrication **12 Hours**

The Metal Oxide Semiconductor (MOS) structure – Threshold voltage – Body effect – MOSFET I-V characteristics: ideal and second-order effects – Channel length modulation – Velocity saturation – Mobility degradation – CMOS fabrication process: twin-tub process, silicon-on-insulator (SOI) – Layout design rules – MOSFET scaling: constant field and constant voltage scaling – Hot electron effects – Short channel effects (SCE) – Drain-induced barrier lowering (DIBL) – Latch-up in CMOS and prevention methods.

Self-Learning Topics: FinFET and Gate-All-Around (GAA) Transistor Fabrication **CO's: CO1**

Unit –II: CMOS Logic Design **12 Hours**

Static complementary CMOS logic: NAND, NOR, complex gates – Pass transistor logic (PTL) and transmission gate logic – Pseudo-NMOS logic – Dynamic CMOS logic: domino logic, NP domino, NORA logic – Clocked CMOS logic (C2MOS) – Combinational circuit design: adders, multiplexers, comparators – Sequential circuit design: D-latch, master-slave flip-flop, sense amplifier based flip-flop – Power dissipation in CMOS: dynamic, short circuit, and static power – Low power design techniques: clock gating, power gating, multi-threshold CMOS (MTCMOS) – Interconnect delay: Elmore delay model.

Self-Learning Topics: Adiabatic CMOS Logic for Ultra-Low Power IoT Applications **CO's: CO2**

Unit –III: Memory Circuit Design **12 Hours**

Overview of memory organisation – SRAM cell: 6T cell operation, read and write stability – SRAM sense amplifier – SRAM cell sizing – DRAM cell: 1T-1C cell, refresh operation – DRAM timing and array organisation – ROM: masked ROM, PROM – Programmable logic: PLA and PAL – Flash memory: NOR flash, NAND flash – Flash cell operation: programming, erasing, and reading – Wear levelling and error correction in flash memory – Embedded memory design considerations.

Self-Learning Topics: Emerging Non-Volatile Memories: MRAM, RRAM, and Phase Change Memory (PCM) **CO's: CO3**

Unit –IV: VLSI Testing and Design for Testability **12 Hours**

Need for testing in VLSI – Fault models: stuck-at fault, bridging fault, delay fault, stuck-open fault – Test vector generation: Boolean difference, D-algorithm, PODEM, FAN algorithm – Fault coverage and fault simulation – Design for Testability (DFT): ad-hoc DFT, structured DFT – Scan design: full scan, partial scan – Built-In Self-Test (BIST): LFSR-based test pattern generation, MISR for response analysis – Boundary Scan (IEEE 1149.1 JTAG standard) – ATPG tools and industrial DFT flow.

Self-Learning Topics: Machine Learning-Aided Test Generation and Defect Prediction in VLSI Manufacturing **CO's: CO4**

Unit –V: Advanced CMOS and Emerging Technologies **12 Hours**

Nano-scale CMOS challenges: gate leakage, subthreshold leakage, band-to-band tunnelling – Process variability and statistical design – Design for manufacturability (DFM) – Multi-gate transistors: FinFET, tri-gate, GAA nanowire FET – High-k dielectrics and metal gates – Strained silicon – 3D integrated circuits and through-silicon vias (TSV) – Silicon photonics for on-chip communication – Carbon nanotube FETs and graphene transistors – Neuromorphic computing and memristive devices.

Self-Learning Topics: Post-CMOS Devices: Tunnel FETs, Negative Capacitance FETs **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. CMOS VLSI Design: A Circuits and Systems Perspective – Neil H.E. Weste and David Harris, Addison Wesley, 4th Edition, 2011.
2. VLSI Design – Debaprasad Das, Oxford University Press, 2nd Edition, 2015.

Reference Books:

1. Digital Integrated Circuits: A Design Perspective – Jan M. Rabaey, AnanthaChandrakasan, BorivojeNikolic, Prentice Hall, 2nd Edition, 2003.
2. CMOS Digital Integrated Circuits – Sung-Mo Kang and Yusuf Leblebici, Tata McGraw Hill, 3rd Edition, 2003.
3. Principles of CMOS VLSI Design – N. Weste and K. Eshraghian, Addison Wesley, 2nd Edition.
4. Analysis and Design of Analog Integrated Circuits – Paul R. Gray et al., Wiley, 5th Edition, 2009.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee110
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee85
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_cs12

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define threshold voltage and body effect in MOSFET.
2. List the main steps in a CMOS twin-tub fabrication process.
3. State the fault models used in VLSI testing.
4. Define latch-up and list methods to prevent it in CMOS circuits.

L2: Understand

1. Explain channel length modulation and its effect on MOSFET output characteristics.
2. Describe the operation of a 6T SRAM cell during read and write cycles.
3. Explain the principle of domino logic and its advantages over static CMOS.
4. Discuss the significance of constant field scaling on power dissipation and performance.
5. Explain the need and mechanism of refresh in DRAM and its impact on performance

L3: Apply

1. Compute the drain current of an NMOSFET in the saturation region for given device parameters and applied voltages.
2. Design a CMOS full adder using complementary static CMOS logic and estimate its propagation delay.
3. Determine the transistor sizing for a 6T SRAM cell to ensure read stability using the static noise margin criterion.
4. Apply the D-algorithm to generate test vectors for a stuck-at fault in a combinational circuit.
5. Design a scan chain for a sequential circuit with four flip-flops and explain the test procedure.

L4: Analyse

1. Analyse the impact of short channel effects (SCE and DIBL) on MOSFET I-V characteristics at nano-scale.
2. Compare the power-delay product of static CMOS, pseudo-NMOS, and dynamic CMOS logic families.
3. Examine the trade-offs between NOR flash and NAND flash memory in terms of speed, density, and endurance.
4. Evaluate the fault coverage improvement achieved by adding scan design to a given circuit.

L5: Evaluate

1. Evaluate the effectiveness of MTCMOS in reducing leakage power for a digital circuit block.
2. Justify the adoption of FinFET over planar MOSFET for 16 nm and below technology nodes.
3. Assess the suitability of BIST versus external test for testing embedded memory arrays in SoC designs.
4. Evaluate adiabatic CMOS logic for ultra-low power IoT applications

L6: Create

1. Design a low-power 4-bit ALU using dynamic CMOS logic with clock gating and estimate the power savings compared to a static CMOS implementation.
2. Develop a complete DFT strategy for a complex SoC including scan chain insertion, BIST for embedded SRAM, and boundary scan for I/O, and estimate the area overhead.

3. Formulate a layout design for a CMOS inverter at 28 nm technology node, applying DFM rules and estimate the parametric yield under process variability.

Chairperson
Board of Studies (EEE)

R24EEPE16 **Special Electrical Machines** **3 0 0 3**
(Professional Elective-IV)

Course Objectives:

The main objectives of the course is to

1. Properties of magnetic materials and the operation of PMDC motors
2. Performance and control of stepper motors and their applications
3. Theory of operation and control of switched reluctance motor
4. Characteristics and performance of PM BLDC motors
5. Principle of operation of linear induction motor

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE16.1	Acquire knowledge on the characteristics and application of PMDC motors.	3	2	1	–	1	1	–	–	1	–	1	3	2	L1,L2
R24EEPE16.2	Explore different types construction and principle of operation of different types of stepper motors and their applications	3	2	1	–	1	1	–	–	1	–	1	3	2	L2,L3
R24EEPE16.3	Explain theory of operation of switched reluctance motor and its control	3	2	2	1	2	1	–	–	1	–	1	3	2	L3,L4
R24EEPE16.4	Analyse the performance of PMBLDC motors	3	3	2	2	2	1	–	–	1	–	2	3	3	L4,L5
R24EEPE16.5	Explain the operation of linear induction motor drive for traction purpose.	3	2	1	1	1	2	–	–	1	–	1	2	3	L4,L6

SYLLABUS

Unit –I: Permanent magnet materials and PMDC motors **14 Hours**

Introduction-classification of permanent magnet materials used in electrical machines-minor hysteresis loop and recoil line-Stator frames of conventional dc machines-Development of electronically commutated dc motor from conventional dc motor-Permanent-magnet materials and characteristics-B-H loop and demagnetization characteristics-Temperature effects: reversible and irreversible losses-high temperature effects-reversible losses-Irreversible losses recoverable by magnetization-Mechanical properties, handling and magnetization Application of permanent magnets in motors-power density-operating temperature range-severity of operation duty

Self-Learning Topics: B–H curve and hysteresis loop, Power density in PM motors

CO's: CO1

Unit –II: Stepper Motors **14 Hours**

Classification of stepper motors – Hybrid and Variable Reluctance Motor (VRM) - Construction and principle of hybrid type synchronous stepper motor – Different configuration for switching the phase windings control circuits for stepper motors – Open loop and closed loop control of 2-phase hybrid stepping motor. Construction and principle of operation of Variable Reluctance Motor (VRM) – Single stack and multiple stack – Open loop control of 3- phase VR Stepper Motor-Applications.

Self-Learning Topics: Types of stepper motors**,** Torque characteristics **CO's: CO2**

Unit –III: Switched Reluctance Motors **12 Hours**

Construction – Comparison of conventional and switched reluctance motors – Design of stator and rotor pole arcs – Torque producing principle and torque expression – Different converter configurations for SRM – Drive and power circuits for SRM – Position sensing of rotor – Applications of SRM.

Self-Learning Topics: Torque–speed characteristics, Control techniques **CO's: CO3**

Unit –IV: Permanent Magnet Brushless DC Motor **12 Hours**

Types of constructions – Surface mounted and interior type permanent magnet – Principle of operation of BLDC motor – Torque and EMF equations of square permanent magnet brushless motor – Torque speed characteristics – Performance and efficiency- Square wave brushless motors with 1200 and 1800 magnetic areas commutation. Torque and EMF equations of sine wave permanent magnet brushless motor – Phasor Diagram – Circle diagram – Torque/speed characteristics – Comparison between square wave and sine wave permanent magnet motors - Applications.

Self-Learning Topics: Hall sensors **CO's: CO4**

Unit –V: Linear Induction Motors (LIM) **10 Hours**

Construction– principle of operation–Double sided LIM from rotating type Induction Motor – Schematic of LIM drive for traction – Development of one-sided LIM with back iron- equivalent circuit of LIM.

Self-Learning Topics: Performance characteristics **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Brushless Permanent magnet and reluctance motor drives, Clarenden press, T.J.E. Miller, 1989, Oxford
2. Special electrical Machines, K.VenkataRatnam, University press, 2009, New Delhi

Reference Books:

1. Special electrical machines, E.G. Janardhanan, PHI learning private limited, 2014.

Web References:

1. https://www.scribd.com/document/378009087/Special-Electrical-Machines
2. https://www.youtube.com/watch?t=23&v=LPcQYXjPdIQ

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	50	---
L2	50	---
L3	---	---
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. List types of permanent magnet materials?
2. Define step angle
3. What is reluctance torque
4. Explain construction and working of stepper motor

5. Explain construction and working of switched reluctance motor

L2: Understand

1. State advantages of PMDC motors
2. Define resolution of stepper motor
3. What is rotor position sensing?
4. Define thrust in LIM

L4: Analyzing

1. Derive torque equation and explain characteristics of PMDC motor
2. Analyze control strategies of SRM
3. Compare BLDC motor with PMSM
4. Explain micro stepping and its advantages
5. Analyze performance characteristics of LIM

L5: Evaluating

1. Evaluate applications of PMDC motors in industry
2. Evaluate advantages and limitations of SRM
3. Explain construction and working of linear induction motor

L6: Create

1. Design a basic traction system using LIM

Chairperson
Board of Studies (EEE)

R24EEPE17 Soft Computing Techniques in Electrical Engineering 3 0 0 3
(Professional Elective-IV)

Course Objectives:

The main objectives of the course is to

1. Introduce soft computing concepts for solving real-world engineering problems
2. Understand fuzzy logic, neural networks, and genetic algorithms
3. Apply soft computing techniques in electrical engineering applications like control systems, power systems, and optimization
4. Understand machine learning concepts and approach
5. the basics of machine learning, data clustering algorithms and support vector machines.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE17.1	Student can be able to build intelligent systems through soft computing techniques	3	2	3	2	3	1	–	1	1	–	2	2	3	L1,L2
R24EEPE17.2	Student should be able to understand the concept of artificial neural networks, fuzzy arithmetic, and fuzzy logic with their day-to-day applications.	3	2	1	1	2	–	–	–	1	–	1	1	2	L2, L3
R24EEPE17.3	Understand fuzzy logic and reasoning to handle and solve engineering problems.	3	3	2	2	2	1	–	–	1	–	2	2	3	L2, L3
R24EEPE17.4	Utilize genetic algorithm techniques to find	3	3	3	2	3	1	–	1	1	1	2	2	3	L4,L5

	the optimal solution of a given problem.														
R24EEPE17.5	Explain the basics of machine learning, data clustering algorithms and support vector machines	3	2	1	2	2	–	–	–	1	–	2	1	2	L4,L5

SYLLABUS

Unit –I: Introduction to Soft Computing **14 Hours**

What is Soft Computing? Soft and Hard Computing, Difference between Hard and Soft computing Evolution of soft computing, Soft computing constituents., Requirement of Soft computing, Major Areas of Soft Computing, Applications of Soft Computing.

Self-Learning Topics: Need and scope of Soft Computing **CO's: CO1**

Unit –II: Neural Networks **10 Hours**

What is Neural Network, Learning rules and various activation functions, Single layer Perceptrons , Back Propagation networks, Architecture of Back propagation(BP) Networks, Back propagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications

Self-Learning Topics: Biological foundations **CO's: CO2**

Unit –III: Fuzzy Systems **12 Hours**

Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Predicate logic, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification

Self-Learning Topics: Membership functions **CO's: CO3**

Unit –IV: Genetic Algorithm: **10 Hours**

Introduction - basic concepts of Genetic Algorithm, encoding, fitness function, reproduction, cross over, mutation operator, bit-wise operators, generational cycle.

Hybrid Systems: Adaptive Neuro Fuzzy Inference System (ANFIS), Genetic algorithm based back propagation networks, fuzzy back propagation networks.

Self-Learning Topics: Multi-level Optimization **CO's: CO4**

Unit –V: Machine Learning **10 Hours**

Machine learning model-Approaches to machine learning- Machine learning architecture- Data Clustering Algorithms -Hierarchical clustering, K-Means Clustering Support Vector Machines for Learning – Support Vector Classification – Support Vector Regression - Applications.

Self-Learning Topics: Linear Learning Machines **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. S.Rajasekharan, G.A.Vijayalakshmi Pai, Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications, Prentice Hall India, 2003.
2. Principles of Soft Computing- S N Sivanandam, S N Deepa, Wiley India, 3rd edition, 2018.
3. Soft Computing and Intelligent System Design -Fakhreddine 0 Karray, Clarence D Silva, Pearson, 1 st Edition, 2004
4. Tom Mitchell, Machine Learning, McGraw Hill, 1997

Reference Books:

1. Genetic Algorithms: Search and Optimization, E. Goldberg, 1 st Edition, 1998
2. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, 1 st Edition, 1996, PHI
3. Hassoun Mohammed H, Fundamentals of Artificial Neural Networks, Prentice Hall of India, 2002.J.-S.R.Jang, C.-T.Sun,E.Mizutani, Neuro-Fuzzy and Soft Computing, Prentice Hall, 1997.
4. Simon Haykin, Neural Networks a Comprehensive foundation, Pearson Education, 1999

Web References:

1. https://www.sciencedirect.com/science/chapter/edited-volume/abs/pii/B9781845696634500012?utm_

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	---
L2	30	---
L3	40	
L4	---	40
L5	---	40

L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. List the components of soft computing techniques
2. What is membership function
3. Define crossover operation.
4. What is data clustering
5. Define K-means clustering algorithm.

L2: Understand

1. Differentiate biological neuron and artificial neuron
2. Mention applications of fuzzy logic..
3. State the importance of fuzzy controllers.
4. List applications of genetic algorithms.

L3: Apply

1. Describe the structure and operation of an artificial neural network.
2. Discuss applications of fuzzy logic in electrical engineering problems..
3. Discuss the role of fuzzy logic in solving electrical engineering problem
4. Discuss selection, crossover, and mutation operations in GA..

L4: Analyzing

1. Compare conventional optimization methods with genetic algorithms.
2. Discuss machine learning techniques for electrical engineering applications
3. Analyze and compare different neural network training algorithms for fault diagnosis in electrical machines..

L5: Evaluating

1. Evaluate the performance of fuzzy logic controllers and conventional PID controllers for industrial process control applications
2. Evaluate the effectiveness of Support Vector Machines in classification of power quality disturbances.

L6: Create

1. Develop a fuzzy inference system for voltage stability enhancement in power systems.
2. Design a predictive maintenance model for transformers using machine learning techniques.

Chairperson
Board of Studies (EEE)

R24EEPE18 **Electric Mobility Systems** **3 0 0 3**
(Professional Elective-IV)

Course Objectives:

The main objectives of the course are to

1. To understand the fundamentals, types, and architecture of electric mobility systems including EVs, HEVs, PHEVs, and FCEVs.
2. To analyze traction motor drives, power electronics, and advanced control strategies for electric mobility propulsion systems.
3. To understand energy storage technologies, battery management systems, and charging infrastructure for electric mobility.
4. To evaluate energy management strategies, vehicle connectivity, and smart mobility ecosystems including V2G and autonomous driving.
5. To assess the sustainability, safety standards, lifecycle assessment, and emerging trends in electric mobility systems.

Course Code	Course Outcomes	Mapping with POs and PSOs													Do K
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	
R24EEPE18.1	Explain the classification, architecture, and operating principles of BEV, HEV, PHEV, and FCEV electric mobility systems.	2	2	-	-	1	3	1	-	1	-	2	1	3	L1, L2
R24EEPE18.2	Analyze traction motor types, power electronic drives, and advanced control strategies for electric mobility propulsion.	2	3	3	2	2	2	-	-	-	-	2	3	2	L3, L4
R24EEPE18.3	Evaluate energy storage	2	3	-	2	2	2	1	-	-	-	2	2	3	L3, L4

	technologies, battery management systems, and charging infrastructure for electric mobility.														
R24EEPE18.4	Analyze vehicle connectivity, smart mobility ecosystems, V2G integration, and autonomous driving technologies.	2	3	2	2	2	2	1	-	-	1	2	2	3	L4, L5
R24EEPE18.5	Evaluate sustainability, safety standards, lifecycle assessment, and emerging trends in electric mobility systems.	2	3	3	2	2	3	-	-	-	2	3	2	3	L5, L6

SYLLABUS

Unit I – Introduction to Electric Mobility **12 Hours**

Overview of electric mobility ecosystem, evolution of electric vehicles, EV market trends in India and globally, types of electric vehicles (BEV, HEV, PHEV, FCEV), vehicle dynamics, road load analysis, tractive force, comparison with conventional ICE vehicles, environmental and economic drivers for electric mobility adoption.

Self-Learning Topics:

India's EV30@30 Campaign and FAME-II Policy **CO's: CO1**

Unit II – Power Electronics and Drive Systems **12 Hours**

Traction motor characteristics and requirements, types of motors for EV (IM, PMSM, BLDC, SRM) – construction and working, power converters for EV drives, DC-DC converters (bidirectional), voltage

source inverters, PWM techniques, regenerative braking systems, motor controller architectures.

Self-Learning Topics: SiC and GaN Power Devices **CO's: CO2**

Unit III – Energy Storage and Charging Systems **12 Hours**

Battery technologies for EVs (Li-ion, LFP, NMC, NCA, Solid-state), battery comparison, Battery Management System (BMS) – cell balancing, SoC, SoH estimation, EV charging infrastructure – Level 1/2/3 charging, charging standards (CCS, CHAdeMO, BharatAC-001, BharatDC-001), wireless charging, ultra-capacitors and flywheel energy storage.

Self-Learning Topics:

Solid-State Batteries: Commercialization Challenges for Future Electric Mobility **CO's: CO3**

Unit IV – Smart Mobility and Connected EVs **10 Hours**

Vehicle-to-Grid (V2G) and Vehicle-to-Everything (V2X) technology, smart charging and demand response, IoT-enabled fleet management, telematics and OTA updates, vehicle connectivity standards (OCPP, ISO 15118), introduction to autonomous and semi-autonomous electric vehicles, ADAS for EVs, mobility-as-a-service (MaaS).

Self-Learning Topics: Enabling Seamless Authentication and Smart Charging for EVs **CO's: CO4**

Uni V – Sustainability and Future Trends **12 Hours**

Energy management strategies (rule-based, optimization-based, AI-based), thermal management of batteries and motors, lifecycle assessment (LCA) of EVs, end-of-life battery reuse and recycling, EV safety standards (AIS-038, ISO 26262, UN ECE R100), carbon footprint analysis, green manufacturing, emerging trends: hydrogen fuel cell vehicles, solar EVs, electric aviation.

Self-Learning Topics: Second-Life EV Batteries: Grid-Scale Energy Storage Applications and Business Models **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles – Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, CRC Press, 3rd Edition, 2018.
2. Electric Vehicle Technology Explained – James Larminie and John Lowry, Wiley, 2nd Edition, 2012.

Reference Books:

1. Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles – John G. Hayes and G.A. Goodarzi, Wiley, 2018.
2. Battery Management Systems – Volumes I and II – Gregory L. Plett, Artech House, 2015.
3. Plug-in Electric Vehicles in Smart Grids – S. Rajakaruna, F. Shahnia, A. Ghosh, Springer, 2015.
4. Power Electronics and Motor Drives – B.K. Bose, Academic Press/Elsevier, 2006.

Web References:

1. https://nptel.ac.in/courses/108106182
2. https://nptel.ac.in/courses/108102121

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Classify electric vehicles and state the key differences between BEV, HEV, PHEV, and FCEV.
2. List the major components of a Battery Electric Vehicle (BEV) powertrain.
3. State the three levels of EV charging and their respective power ratings.
4. Define State of Charge (SoC) and State of Health (SoH) of a traction battery.

L2: Understand

1. Explain the series and parallel hybrid powertrain architectures and compare their energy flow paths.

2. Describe the Field Oriented Control (FOC) strategy for PMSM in an EV and explain the role of MTPA control.
3. Explain the working principle of a lithium-ion battery cell and describe the charge/discharge mechanism.
4. Discuss the Vehicle-to-Grid (V2G) concept and explain how it provides grid ancillary services.

L3: Apply

1. Calculate the tractive effort, gradeability, and maximum speed of an EV given motor rating and vehicle parameters.
2. Design a battery pack configuration (series-parallel) for a 400 V, 60 kWh EV battery system using a given Li-ion cell.
3. Compute the SoC of an EV battery using Coulomb counting for a given current profile and initial SoC.
4. Determine the charging time for an EV battery from 20% to 80% SoC using Level 2 and DC fast charging.
5. Implement a thermostat energy management strategy for a parallel HEV and calculate the fuel consumption improvement.

L4: Analyse

1. Analyse the impact of regenerative braking on energy recovery and range extension for an EV under urban drive cycles.
2. Compare SiC MOSFET and Si IGBT for EV traction inverter applications in terms of efficiency and switching frequency.
3. Examine passive and active cell balancing methods in a BMS and compare their efficiency and complexity.
4. Analyse the impact of 50 kW DC fast charging stations on distribution transformer loading in a residential area.

L5: Evaluate

1. Evaluate the total cost of ownership (TCO) of a BEV versus an equivalent ICE vehicle over a 10-year period.
2. Justify the selection of LFP chemistry over NMC for a commercial electric bus considering safety, cycle life, and cost.
3. Assess the environmental benefits of EVs under the current Indian electricity generation mix versus a future 50% renewable scenario.

L6: Create

1. Design a complete electric mobility powertrain for a 5-seater passenger car specifying traction motor rating, inverter, battery pack, OBC, BMS, and thermal management for a 300 km range target.
2. Develop a smart V2G management system for a 100-EV fleet integrating ToU pricing, grid capacity constraints, and renewable energy availability to minimise charging cost.
3. Formulate a connected EV ecosystem architecture integrating IoT telematics, predictive energy management, and autonomous driving features for a smart city mobility solution.

Chairperson
Board of Studies (EEE)

R24EEPE19 **Power Quality** **3 0 0 3**

(Professional Elective-IV)

Course Objectives:

The main objectives of the course is to

1. Different types of power quality phenomena and identify sources for voltage sag, voltage swell, interruptions, transients, long duration over voltages and harmonics in a power system
2. Power quality terms and study power quality standards
3. The principle of voltage regulation, power factor improvement methods and study the effect the harmonic distortion and its solutions
4. The relationship between distributed generation and power quality
5. The power quality monitoring concepts and the usage of measuring instruments.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE19.1	Know the different types of power quality problems and analyze power quality terms and power quality standards	3	2	1	–	1	1	–	–	1	–	1	3	2	L1,L2
R24EEPE19.2	Explain the principle of voltage regulation and power factor improvement methods.	3	2	2	1	1	1	–	–	1	–	1	3	2	L2, L3
R24EEPE19.3	Analyze the effect the harmonic distortion and its solutions.	3	3	2	2	2	2	–	–	1	–	2	3	3	L3,L4
R24EEPE19.4	Demonstrate the relationship between distributed	3	2	2	2	2	3	–	1	1	–	2	2	3	L3, L4

	generation and power quality.														
R24EEPE19.5	Know the power quality monitoring concepts and the usage of measuring instruments.	3	2	1	3	3	1	–	1	1	–	2	2	2	L3,,L4

SYLLABUS

Unit –I: Introduction and Voltage imperfections in power systems **14 Hours**

Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power frequency variations- Power quality terms – Voltage sags, Voltage swells, harmonics interruptions, voltage flicker and voltage spikes – Sources of voltage sag, swell and interruptions – Nonlinear loads. Source of transient over voltages – Principles of over voltage protection – Devices for over voltage protection – Utility capacitor switching transients.

Self-Learning Topics: Smart grid power quality challenges **CO's: CO1**

Unit –II: Voltage Regulation and power factor improvement: **12 Hours**

Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation – End–user capacitor application – Regulating utility voltage with distributed resources – Flicker – Power factor penalty – Static VAR compensations for power factor improvement.

Self-Learning Topics: Automatic voltage regulators (AVR) **CO's: CO2**

Unit –III: Harmonic distortion and solutions **10 Hours**

Voltage distortion vs. Current distortion – Harmonics vs. Transients – Harmonic indices – Sources of harmonics – Effect of harmonic distortion – Impact of capacitors, transformers, motors and meters – Point of common coupling – Passive and active filtering – Numerical problems

Self-Learning Topics: Design of passive and active filters **CO's: CO3**

Unit –IV: Distributed Generation and Power Quality **10 Hours**

Resurgence of distributed generation – DG technologies – Interface to the utility system – Power quality issues and operating conflicts – DG on low voltage distribution networks.

Self-Learning Topics: Microgrids and distributed generation **CO's: CO4**

Unit –V: Monitoring and Instrumentation **12 Hours**

Power quality monitoring and considerations – Historical perspective of PQ measuring instruments – PQ measurement equipment – Assessment of PQ measuring data – Application of intelligent systems – PQ monitoring standards.

Self-Learning Topics: IoT - based power quality monitoring systems **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw–Hill, 2012, 3rd edition.
2. Electric power quality problems –M.H.J.Bollen IEEE series-Wiley India publications,2011

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw–Hill, 2000.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M HJ, First Edition, IEEE Press; 2000.
3. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley& Sons, 2003
4. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, VanNostrad Reinhold, New York.
5. Power Quality C.Shankaran, CRC Press, 2001
6. Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor &Francis)

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee64
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ee65

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	30
L3	30	40
L4	---	30
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. problems List different power quality
2. List instruments used for power quality measurement
3. List methods of power factor correction
4. Define voltage regulation
5. Define waveform distortion

L2: Understand

1. Mention power quality issues caused by DG
2. Discuss various power factor improvement methods
3. What is a power quality analyzer
4. State the importance of monitoring instruments
5. Discuss harmonic mitigation techniques in detail

L3: Apply

1. Describe islanding detection methods in distributed generation systems
2. Explain static VAR compensators and their application
3. Explain monitoring and data acquisition techniques for power quality assessment

L4: Analyzing

1. Analyze the impact of harmonics on electrical equipment
2. Analyze causes and effects of voltage sag and interruptions
3. Analyze the impact of harmonics on electrical equipment
4. Compare passive and active harmonic filters
5. Explain power quality issues associated with renewable energy integration

Chairperson
Board of Studies (EEE)

R24EEOE11 **Energy Auditing and Management** **3 0 0 3**

(Open Elective-III)

Course Objectives:

The main objectives of the course is to

1. To understand modern energy auditing methodologies, smart energy management systems, and sustainable energy conservation practices in industrial applications.
2. To analyze and design energy-efficient lighting systems using advanced LED, smart lighting, and automated control technologies.
3. To develop skills in power factor correction, harmonic mitigation, and utilization of modern digital energy measurement instruments.
4. To apply energy conservation techniques in electrical equipment, HVAC systems, smart transformers, and variable speed drive applications for industrial optimization.
5. To perform techno-economic analysis, life cycle costing, and financial evaluation of energy-efficient and sustainable energy projects using modern analytical tools.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE11.1	Understand the principles of energy auditing and energy management systems in industrial applications	3	2	1	1	1	2	-	-	1	-	2	2	3	L1,L2
R24EEOE11.2	Analyze modern lighting systems and implement energy-efficient lighting techniques.	3	3	2	2	2	2	-	1	1	1	2	2	3	L3, L5
R24EEOE11.3	Evaluate power factor improvement methods and utilize modern energy measuring	3	3	2	2	3	2	-	1	1	1	2	3	3	L4, L6

	instruments.														
R24EEOE11.4	Apply energy conservation techniques in electrical equipment and industrial systems.	3	2	3	2	2	3	1	1	1	1	2	3	3	L3,L4
R24EEOE11.5	Perform economic analysis and financial evaluation of energy management projects.	2	3	2	2	2	3	1	1	1	3	3	2	3	L3,L4

SYLLABUS

Unit –I: Basic Principles of Energy Audit and Management **14 Hours**

Energy audit – Scope, methodology and digital auditing techniques - Energy performance indicators and benchmarking - Advanced visualization using Sankey software and smart load profiling - Green energy conservation practices and carbon reduction strategies - ISO 50001 based energy management systems -Roles of certified energy managers and auditors

Self-Learning Topics: Smart energy monitoring systems **CO's: CO1**

Unit –II: Lighting **10 Hours**

Modern lighting terminology and standards - Efficiency comparison of LED and OLED lighting - Computer aided illumination calculations - Smart lighting systems and sensor-based lighting - Advanced luminaires and architectural lighting - Energy optimization using automated lighting control

Self-Learning Topics: Motion sensor and IoT-based lighting control **CO's: CO2**

Unit –III: Power Factor and Energy Instruments **12 Hours**

Reactive power management and APFC systems - Optimal capacitor placement using software tools - Harmonic mitigation using filters - Digital smart energy meters and IoT data loggers - Advanced power quality analyzers and wireless instruments

Self-Learning Topics: Automatic Power Factor Correction (APFC) panels **CO's: CO3**

Unit –IV: Energy Conservation in Electrical Equipment **12 Hours**

IE3 and IE4 super-efficient motors - Thermal analysis and predictive maintenance - Modern vector-controlled variable frequency drives - Amorphous core transformers and smart transformers - AI-based energy management in HVAC systems

Self-Learning Topics: Variable Frequency Drive (VFD) applications **CO's: CO4**

Unit –V: Economic Aspects and Costing **12 Hours**

Techno-economic analysis for sustainable systems - Modern depreciation and taxation concepts - Financial modeling using spreadsheet tools - Equipment replacement based on energy analytics - Life cycle assessment and carbon costing - Advanced investment appraisal techniques

Self-Learning Topics: Carbon credit and green energy economics **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. Dr. G. Srinivasulu Reddy et al. – A Text Book on Energy Auditing and Demand Side Management, Authors Click Publishing, 2024.
2. W.R. Murphy & G. McKay – Energy Management, Butterworth-Heinemann / Elsevier Publications, 2012.
3. John C. Andreas – Energy Efficient Electric Motors, Marcel Dekker Inc., 2nd Edition, 1995.

Reference Books:

1. S.C. Tripathy – Electric Energy Utilization and Conservation, Tata McGraw Hill Publishing Company, New Delhi.
2. Paul O' Callaghan – Energy Management, McGraw Hill Book Company, 1st Edition, 1998.
3. W.C. Turner – Energy Management Handbook, John Wiley & Sons.
4. K.V. Sharma & P. Venkata Seshaiah – Energy Management and Conservation, I.K. International Publishing House Pvt. Ltd., 2011.
5. L. Ashok Kumar & Gokul Ganesan – Energy Audit and Management: Concepts, Methodologies, Procedures and Case Studies, CRC Press, 2023.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_hs77
2. https://nptel.ac.in/courses/124105552?utm_source

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	30	---
L2	20	30

L3	30	20
L4	10	10
L5	10	20
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define energy audit and list its types.
2. State the principle of energy management.
3. List different types of lighting systems used in industries.
4. Define power factor and mention its importance.
5. List various instruments used in energy auditing.

L2: Understand

1. Explain the role of an energy manager in industries.
2. Explain the working principle of LED lighting systems.
3. Describe the methods of power factor improvement.
4. Explain the operation of variable frequency drives.
5. Discuss the concept of life cycle costing analysis.

L3: Apply

1. Calculate energy savings using an efficient lighting system.
2. Apply Sankey diagram representation for industrial energy flow.
3. Determine capacitor rating required for power factor correction.
4. Demonstrate the use of power analyzer in energy auditing.
5. Apply payback period method for an energy conservation project.

L4: Analyzing

1. Analyze the energy losses in electrical motors.
2. Compare conventional lighting systems with smart lighting systems.
3. Analyze the effects of harmonics on power factor.
4. Compare energy-efficient transformers with conventional transformers.
5. Analyze economic feasibility of energy conservation measures.

L5: Evaluating

1. Evaluate the effectiveness of ISO 50001 energy management system.

2. Assess the performance of LED lighting in industrial applications.
3. Evaluate different power factor correction techniques.
4. Justify the use of VFDs for energy conservation.
5. Evaluate ROI and life cycle costing methods for energy projects.

L6: Create

1. Design an energy audit procedure for a manufacturing industry.
2. Develop a smart lighting model for an educational institution.
3. Create an energy monitoring system using IoT-based instruments.
4. Design an energy-efficient HVAC system for commercial buildings.
5. Propose a techno-economic energy conservation plan for an industrial plant.

Chairperson
Board of Studies (EEE)

R24EEOE12 **Fundamentals of Power Electronics** **3 0 0 3**
(Open Elective-III)

Course Objectives:

The main objectives of the course is to

1. To know the characteristics of various power semiconductor devices.
2. To learn the operation of single phase full–wave converters and perform harmonic analysis of input current.
3. To learn the operation of three phase full–wave converters and AC/AC converters.
4. To learn the operation of different types of DC-DC converters.
5. To learn the operation of PWM inverters for voltage control and harmonic mitigation.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO5	PO11	PSO1	PSO2	
R24EEOE12.1	Illustrate the static and dynamic characteristics SCR - Power MOSFET and Power IGBT.	3	2	1	1	2	1	1	–	–	–	1	3	1	L1, L2
R24EEOE12.2	Analyse the operation of phase controlled rectifiers.	3	3	2	2	2	1	–	–	–	–	1	3	1	L2, L3
R24EEOE12.3	Analyse the operation of Three-phase full–wave converters - AC Voltage Controllers and Cycloconverters .	3	3	2	2	2	2	–	–	–	–	1	3	2	L3, L4
R24EEOE12.4	Examine the operation and design of different types of DC-DC	3	3	3	2	3	2	–	–	–	1	2	3	3	L4, L5

	converters.														
R24EEOE12.5	Analyse the operation of PWM inverters for voltage control and harmonic mitigation.	3	3	3	2	3	2	–	–	1	1	2	3	3	L5,L6

SYLLABUS

Unit –I: Power Semi-Conductor Devices **14 Hours**

Silicon controlled rectifier (SCR) – Two transistor analogy - Static and Dynamic characteristics Static and Dynamic Characteristics of Power MOSFET and Power IGBT– Gate Driver Circuits for Power MOSFET and IGBT - Numerical problems - Thermal Management of Power Devices

Self-Learning Topics: Wide Band gap Semiconductor Devices Systems **CO's: CO1**

Unit –II: Single-phase AC-DC Converters **10 Hours**

Single-phase half wave controlled rectifiers - R load and RL load with and without freewheeling diode - Single-phase fully controlled bridge converter with R load - RL load and RLE load - Continuous and Discontinuous conduction - Expression for output voltages – Single-phase Semi-Converter with R load - RL load and RLE load – Continuous and Discontinuous conduction - Harmonic Analysis - Numerical Problems.

Self-Learning Topics: Power Factor Improvement in AC–DC Converters **CO's: CO2**

Unit –III: Three-phase AC-DC Converters & AC – AC Converters **12 Hours**

Three-phase fully controlled rectifier with R and RL load - Three-phase semi converter with R and RL load - Expression for Output Voltage - Matrix Converters (Basic Concept) - Modern AC Voltage Controllers using PWM-AC-AC power control by phase control with R and RL loads - Expression for rms output voltage Numerical problems.

Self-Learning Topics: Cycloconverters and Their Industrial Applications **CO's: CO3**

Unit –IV: DC–DC Converters **12 Hours**

Analysis of Buck - Boost and Buck-Boost converters in Continuous Conduction Mode (CCM) and Discontinuous Conduction Modes (DCM) – Expressions for output voltage ripple and inductor current ripple- Numerical Problems. Synchronous Buck Converter - Isolated DC–DC Converters (Flyback, Forward – basic idea)

Self-Learning Topics: SMPS Design and Applications **CO's: CO4**

Unit –V: DC–AC Converters **12 Hours**

Introduction - Single-phase half bridge and full bridge inverters with R and RL loads – Three-phase square wave inverters – 120^o conduction and 180^o conduction modes of operation - PWM inverters - Sinusoidal Pulse Width Modulation - Numerical Problems - Multilevel Inverters: Diode-clamped, Cascaded H-bridge

Self-Learning Topics: Multilevel Inverters **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. Power Electronics: Converters - Applications and Design by Ned Mohan - Tore M Undeland - William P Robbins - John Wiley & Sons.
2. Power Electronics: Circuits - Devices and Applications – by M. H. Rashid - Prentice Hall of India - 2 nd edition – 1998.
3. Power Electronics: Essentials & Applications by L. Umanand - Wiley - Pvt. Limited - India - 2009.

Reference Books:

1. Power Electronics–Philip T.Krein. Oxford University Press; Second edition
2. Power Electronics – by P.S.Bhimbra - Khanna Publishers.
3. Power Electronics: by Daniel W.Hart - Mc Graw Hill.

Web References:

1. https://nptel.ac.in/courses/108102145
2. https://nptel.ac.in/courses/108105066

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	20	20
L2	30	30
L3	20	10
L4	20	10
L5	10	20
L6	--	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define latching current and holding current of an SCR.
2. List different types of single-phase AC–DC converters.
3. Define duty cycle in DC–DC converters.
4. What is a freewheeling diode? State its purpose.
5. List different PWM techniques used in inverters.

L2: Understand

1. Explain the two-transistor analogy of an SCR with neat diagram.
2. Describe the operation of a single-phase half-wave controlled rectifier with R load.
3. Explain continuous and discontinuous conduction modes in converters.
4. Describe the working of a boost converter.
5. Explain the operation of a single-phase full bridge inverter with RL load.

L3: Apply

1. A single-phase half-wave controlled rectifier with R load is supplied with 230 V, 50 Hz. For a firing angle of 60°, calculate the average output voltage.
2. Determine the output voltage of a single-phase fully controlled bridge converter feeding an RL load for a given firing angle.
3. A buck converter operates with a duty cycle of 0.6 and input voltage of 100 V. Calculate the output voltage.
4. Calculate RMS output voltage of an AC voltage controller for a given firing angle.
5. For a PWM inverter, calculate the fundamental output voltage for given modulation index.

L4: Analyzing

1. Analyze the static and dynamic characteristics of a Power MOSFET.
2. Compare the performance of single-phase full converter and semi-converter.
3. Analyze the operation of a three-phase fully controlled rectifier with RL load.
4. Compare CCM and DCM operation of DC–DC converters with waveforms.
5. Analyze harmonic content in the output of a square wave inverter

L5: Evaluating

1. Evaluate the advantages and limitations of IGBT over MOSFET in power applications.
2. Compare half-wave and full-wave controlled rectifiers based on performance.
3. Evaluate the effect of source inductance on converter performance.
4. Compare buck, boost, and buck-boost converters for practical applications.
5. Evaluate different PWM techniques used in inverters.

L6: Create

1. Design a gate driver circuit for an SCR or IGBT with necessary protection features.
2. Design a single-phase controlled rectifier circuit for a DC motor load.
3. Design a DC–DC buck converter for a specified output voltage and load.
4. Propose a three-phase converter system for industrial power supply applications.
5. Design a PWM inverter for speed control of an induction motor.

Chairperson
Board of Studies (EEE)

R24EEOE13 **Optimization Techniques** **3 0 0 3**
(Open Elective-III)

Course Objectives:

The main objectives of the course is to

1. To know the importance of adopting optimization techniques in day to day life.
2. To analyse the importance of various types of constraints at various stages.
3. To learn more on linear & nonlinear programming concepts.
4. To analyse the significance of transportation problem.
5. To learn the concepts of dynamic programming.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE13.1	State and formulate the optimization problem without and with constraints	3	2	1	1	1	–	–	–	–	–	1	1	–	L1, L2,
R24EEOE13.2	Formulate a mathematical model and apply linear programming technique by using Simplex method.	3	3	2	2	2	1	–	–	–	1	1	2	1	L2 ,L3
R24EEOE13.3	Formulate a mathematical model and apply non-linear programming techniques for unconstrained and constrained case studies.	3	3	2	3	2	1	–	–	–	1	2	2	1	L3, L4
R24EEOE13.4	Solve transportation and assignment	3	3	2	2	2	1	–	–	–	2	1	2	1	L5, L6

	problem by using Linear programming Simplex method.														
R24EEOE13.5	Formulate and apply Dynamic programming technique to inventory control, production planning, engineering design problems etc.	3	3	3	3	3	2	–	1	1	2	2	2	2	L5, L6

SYLLABUS

Unit –I: Introduction to Optimization Techniques **14 Hours**

Statement of an Optimization problem – design vector – design constraints – objective function – classification of Optimization problems. Classical Optimization Techniques Single variable Optimization – multi variable Optimization without constraints – multivariable Optimization with equality constraints.- - Introduction to Optimization using MATLAB/Python tools -Convex vs Non-convex optimization (basic concept). Solution by method of Lagrange multipliers

Self-Learning Topics: Applications in Electrical Systems **CO's: CO1**

Unit –II: Linear Programming **10 Hours**

Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method – simplex algorithm. - Applications in power system optimization (economic dispatch, scheduling)

Self-Learning Topics: Linear Programming Applications in Power System **CO's: CO2**

Unit –III: Nonlinear Programming **12 Hours**

Unconstrained cases - One – dimensional minimization methods: Classification - Fibonacci method and Quadratic interpolation method - Univariate method - Powell's method.

Constrained cases - Characteristics of a constrained problem - Classification - Basic approach of Penalty Function method.

Self-Learning Topics: Nonlinear Optimization in Economic Load Dispatch **CO's: CO3**

Unit –IV: Transportation Problem **10 Hours**

Finding initial basic feasible solution by north – west corner rule - least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems – Special cases

in transportation problem - Real-time logistics optimization using software tools - Power system applications (economic power distribution)

Self-Learning Topics: Optimal Power Distribution using Transportation Models **CO's: CO4**

Unit –V: Dynamic Programming **10 Hours**

Dynamic programming - Multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming - Bellman equation- Applications in Unit Commitment and optimal scheduling

Self-Learning Topics: Unit Commitment Problem using Dynamic Programming **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No:

Approved in ACM No:

Text Books:

1. "Engineering optimization: Theory and practice"-by S. S.Rao- New Age International (P) Limited - 3rd edition - 1998.
2. "Introductory Operations Research" by H.S. Kasene& K.D. Kumar - Springer (India) 2013.

Reference Books:

1. "Optimization Methods in Operations Research and systems Analysis" – by K.V. Mital and C. Mohan - New Age International (P) Limited - Publishers - 3 rd edition - 1996.
2. Operations Research – by Dr. S.D.Sharma- Kedarnath - Ramnath& Co - 2012.
3. "Operations Research: An Introduction" – by H.A.Taha - PHI pvt. Ltd. - 6th edition
4. Linear Programming–by G.Hadley.

Web References:

1. https://onlinecourses.nptel.ac.in/noc22_me44/preview?utm_source=chatgpt.com
2. https://onlinecourses.nptel.ac.in/noc25_ee137/preview?utm_source=chatgpt.com

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	20	20
L2	30	30
L3	10	10
L4	20	10
L5	10	20

L6	10	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define optimization problem, objective function, and constraints.
2. List different types of optimization problems.
3. State necessary and sufficient conditions for extrema in single-variable optimization.
4. Define feasible solution, basic feasible solution, and optimal solution in Linear Programming.
5. What is the principle of optimality in Dynamic Programming?

L2: Understand

1. Explain classification of optimization problems with examples.
2. Describe the method of Lagrange multipliers for solving constrained problems.
3. Explain the geometric interpretation of Linear Programming problems.
4. Describe the working of Fibonacci search method.
5. Explain the concept of multistage decision process in Dynamic Programming.

L3: Apply

1. Find the optimum value of a single-variable function using necessary conditions.
2. Solve a multivariable optimization problem with equality constraints using Lagrange multipliers.
3. Solve a Linear Programming problem using the simplex method.
4. Obtain an initial basic feasible solution of a transportation problem using Vogel's Approximation Method.
5. Solve a multistage problem using Dynamic Programming.

L4: Analyzing

1. Analyze the difference between constrained and unconstrained optimization problems.
2. Compare Fibonacci method and Quadratic interpolation method.
3. Analyze the steps involved in the simplex algorithm.
4. Compare North-West Corner Rule, Least Cost Method, and Vogel's Approximation Method.
5. Analyze the computational procedure of Dynamic Programming with an example.

L5: Evaluating

1. Evaluate the effectiveness of classical optimization techniques in engineering problems.
2. Compare graphical method and simplex method for solving Linear Programming problems.
3. Evaluate the performance of penalty function methods in nonlinear programming.

4. Compare different methods for solving transportation problems in terms of optimality.
5. Evaluate advantages and limitations of Dynamic Programming.

L6: Create

1. Formulate an optimization problem for minimizing power loss in an electrical system.
2. Develop a Linear Programming model for resource allocation in power generation.
3. Design a nonlinear optimization model for economic load dispatch.
4. Formulate a transportation model for optimal distribution of electrical energy.
5. Develop a Dynamic Programming model for unit commitment problem.

Chairperson
Board of Studies (EEE)

R24EEOE14 **Electrical Wiring Estimation and Costing** **3 0 0 3**
(Open Elective-III)

Course Objectives:

The main objectives of the course is to

1. To introduce the electrical symbols and simple electrical circuits
2. To Able to learn the design of electrical installations.
3. To Able to learn the design of electrical installation for different types of buildings and small industries.
4. To Learn the basic components of electrical substations.
5. To Familiarize with the motor control circuits

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE14.1	Demonstrate the various electrical apparatus and their interconnections	3	1	–	–	1	–	–	–	–	–	1	2	1	L1,L2
R24EEOE14.2	Examine various components of electrical installations.	3	2	1	1	2	1	–	–	–	–	1	2	1	L2, L3
R24EEOE14.3	Estimate the cost for installation of wiring for different types of building and small industries.	3	2	2	1	2	2	–	–	1	3	1	2	1	L3, L4
R24EEOE14.4	Illustrate the components of electrical substations.	3	1	1	–	1	1	–	–	–	–	1	2	2	L4,L5
R24EEOE14.5	Design suitable control circuit for starting of three phase induction motor and	3	3	3	2	3	2	1	1	1	2	2	3	3	L5,L6

	synchronous motor.														

SYLLABUS

Unit –I: Electrical Symbols and Simple Electrical Circuits **14 Hours**

Identification of electrical symbols - Electrical wiring Diagrams - Methods of representation of wiring diagrams - Basics of smart electrical wiring systems - Introduction to home automation and sensor-based lighting control

Self-Learning Topics: Applications in Electrical Systems **CO's: CO1**

Unit –II: Design Considerations of Electrical Installations **12 Hours**

Electric supply system - Three-phase four wire distribution system - protection of electric installation against overload - short circuit and earth fault - earthing - neutral and earth wire - Energy efficient electrical installation practices - systems of wiring - Electrical safety standards and modern protection techniques - estimating and costing of electrical installations.

Self-Learning Topics: Basics of electrical safety standards and regulations **CO's: CO2**

Unit –III:Electrical Installation for Different Types of Buildings & Small Industries 12Hours

Electrical installations for electrical buildings - estimating and costing of material - simple examples on electrical installation for residential buildings - Solar rooftop electrical installation for residential buildings - Smart building electrical infrastructure and automation

Self-Learning Topics: Load calculation and energy auditing techniques **CO's: CO3**

Unit –IV: Substations **12 Hours**

Introduction - types of substations - Digital substations and SCADA monitoring - indoor substations floor mounted type - Gas Insulated Substations (GIS) and modern substation -case studies.

Self-Learning Topics: Substation grounding and lightning protection **CO's: CO4**

Unit –V: Motor control circuits **14 Hours**

Motor control circuits Introduction to AC motors - starting of three phase squirrel cage induction motors - PLC based motor control systems - starting of synchronous motors - Variable Frequency Drive (VFD) based speed control of induction motors - basic control circuits - motor protection – Schematic and wiring diagrams for motor control circuits.

Self-Learning Topics: Industrial motor protection techniques **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. Electrical Design and Estimation Costing - K. B. Raina and S.K.Bhattacharya – New Age International Publishers - 2007.

Reference Books:

1. Electrical wiring estimating and costing – S.L.Uppal and G.C.Garg – Khanna publishers - 6 th edition - 1987.
2. A course in electrical installation estimating and costing – J.B.Gupta –Kataria SK & Sons - 2013.

Web References:

1. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou25_ec07

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	20	20
L2	30	30
L3	20	10
L4	20	10
L5	10	20
L6	--	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. List the standard electrical symbols used in wiring diagrams.
2. Define earthing and state its purpose in electrical installations.
3. List different types of substations.
4. Name various types of AC motors.
5. List components used in motor control circuits.

L2: Understand

1. Explain the methods of representing electrical wiring diagrams.
2. Describe the three-phase four-wire distribution system.
3. Explain the procedure for estimating electrical installation in buildings.
4. Discuss the working of indoor and outdoor substations.

5. Explain the working of a squirrel cage induction motor starter.

L3: Apply

1. Draw a wiring diagram for a simple light and fan circuit.
2. Calculate the appropriate wire size for a given load condition.
3. Estimate the cost of wiring for a small residential building.
4. Determine the material requirements for a pole-mounted substation.
5. Draw a basic motor control circuit using a contactor and overload relay.

L4: Analyzing

1. Differentiate between various wiring systems used in electrical installations.
2. Analyze protection methods against overload, short circuit, and earth faults.
3. Compare electrical installations in residential, commercial, and industrial buildings.
4. Distinguish between indoor and outdoor substations with suitable examples.
5. Analyze different motor protection techniques used in industries.

L5: Evaluating

1. Evaluate the suitability of different wiring methods for domestic applications.
2. Justify the need for earthing and protective devices in installations.
3. Evaluate cost factors involved in electrical installation projects.
4. Assess the advantages and limitations of different types of substations.
5. Evaluate different starting methods of three-phase induction motors.

L6: Create

1. Design a complete wiring layout for a small residential building.
2. Develop an electrical installation plan with proper protection for a commercial building.
3. Design a cost estimation sheet for an electrical installation project.
4. Create a layout for a simple substation with required components.
5. Design a motor control circuit with safety and protection features.

Chairperson
Board of Studies (EEE)

R24EEOE15 **Instrumentation** **3 0 0 3**
(Open Elective-III)

Course Objectives:

The main objectives of the course is to

1. To understand basic concepts of measurement systems and instrumentation.
2. To analyze the characteristics and performance of measuring instruments.
3. To Gain knowledge of sensors and transducers used in industrial applications
4. To Understand signal conditioning and data acquisition systems.
5. To apply instrumentation concepts in real-time industrial and engineering problems.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE15.1	Explain fundamentals of instrumentation and measurement systems.	2	2	2	1			-					2	1	L1, L2
R24EEOE15.2	Analyze static and dynamic characteristics of instruments.	2	1	-	2			1					2	1	L2 ,L3
R24EEOE15.3	Identify and select appropriate sensors and transducers for applications.	3	2	2	2			-					1	1	L3,L4
R24EEOE15.4	Demonstrate knowledge of signal conditioning and data acquisition systems.	2	3	-	2			1					1	1	L4,L5
R24EEOE15.5	Apply instrumentation techniques in practical engineering systems.	3	2	2	1			1					-	2	L5,L6

SYLLABUS

Unit –I: Fundamentals of Measurement Systems **14 Hours**

Introduction to instrumentation - Generalized measurement system - Types of instruments (analog, digital) - Static characteristics: accuracy, precision, sensitivity, linearity - Errors in measurement and their analysis

Self-Learning Topics: Case study on measurement standards (ISO, BIS) **CO's: CO1**

Unit –II: Analog Indicating Instruments **12 Hours**

DC galvanometer, PMMC and Moving Iron instruments, Voltmeter, Ammeter, RMS and True RMS concept, Extension of range of ammeter, design of multi range ammeter, extension of range of voltmeter, design of multi range voltmeter, series and shunt type ohmmeter, Single phase wattmeter: construction and working.

Self-Learning Topics: Study of damping effects in measuring instruments **CO's: CO2**

Unit –III: Sensors and Transducers **12 Hours**

Classification of transducers - Resistive, inductive, capacitive transducers - Temperature sensors (RTD, Thermistor, Thermocouple) - Pressure and displacement sensors - Selection criteria of transducers

Self-Learning Topics: IoT-based sensor applications in smart homes **CO's: CO3**

Unit –IV: Digital Instruments **12 Hours**

Introduction to digital instruments, Advantages of Digital instruments over Analog instruments, Block diagram, principle of operation, Accuracy of digital instruments, Need of ADC, ADC types like Flash, Counter, SAR and Dual-Slope, ADC Specifications, ADC Numerical, Need of DAC, DAC types like Weighted-Resistor and R-2R ladder, DAC Specifications, Its applications in digital instruments like Digital Multimeter, Digital Kilo Watt Hour meter, Digital Clamp meter.

Self-Learning Topics: Noise reduction techniques in signal processing **CO's: CO4**

Unit –V: Industrial Instrumentation Applications **12 Hours**

Measurement of temperature, pressure, flow, and level - Industrial process control basics - Smart sensors and IoT in instrumentation - Safety and standards in instrumentation - Case studies of industrial instrumentation systems

Self-Learning Topics: Safety standards in industrial instrumentation (IEC standards) **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. W. D. Cooper & A. D. Helfrick, 'Electronic Instrumentation and Measurement

Techniques', PHI, 4th e/d, 1987.

2. Sawhney A. K., Electrical and Electronics Measurements and Instruments, Dhanpat Rai & Co. 02nd Ed..

Reference Books:

1. Anand M. M. S., 'Electronic Instruments and Instrumentation Technology', PHI, 2004, 02nd Ed.
2. Bouwens A. J., 'Digital Instrumentation, McGraw-Hill, second edition
3. Kalsi H. S., 'Electronic Instrumentation', TMH, 2nd or 3rd e/d, 2004/2010.

Web References:

1. https://onlinecourses.nptel.ac.in/noc26_ee01/preview
2. https://onlinecourses.nptel.ac.in/noc25_ee123/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	20	20
L2	30	30
L3	10	20
L4	20	10
L5	10	20
L6	10	--
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define accuracy, precision, and sensitivity.
2. List different types of transducers.
3. Define time constant and damping ratio.
4. State the function of signal conditioning circuits.
5. List methods used for measurement of temperature and pressure.

L2: Understand

1. Explain the generalized measurement system with a neat diagram.
2. Describe the dynamic response of first-order instruments.
3. Explain the working principle of RTD and thermocouple.

4. Explain the operation of Analog to Digital Converter (ADC).
5. Describe the working of PLC in industrial applications.

L3: Apply

1. Calculate percentage error for a given measurement system.
2. Determine the step response of a first-order system.
3. Select a suitable sensor for measuring pressure in a boiler.
4. Design a basic signal conditioning circuit using an op-amp.
5. Apply instrumentation techniques to measure flow rate in pipelines.

L4: Analyzing

1. Analyze different types of measurement errors and their sources.
2. Compare first-order and second-order system responses.
3. Analyze the performance of resistive and inductive transducers.
4. Examine the role of filters in signal conditioning.
5. Analyze an industrial process control system using instrumentation.

L5: Evaluating

1. Evaluate the performance of analog versus digital instruments.
2. Assess the importance of calibration in measurement systems.
3. Justify the selection of a temperature sensor for industrial use.
4. Evaluate different data acquisition systems based on efficiency.
5. Assess the impact of IoT on modern industrial instrumentation.

L6: Create

1. Design a complete measurement system for temperature monitoring in an industrial furnace, including sensor selection, signal conditioning, and display unit.
2. Develop a mathematical model and simulate the dynamic response of a second-order instrumentation system for a given input.
3. Design a smart sensor-based system using IoT for real-time monitoring of pressure and flow in pipelines.
4. Construct a data acquisition system using suitable ADC, signal conditioning circuits, and microcontroller for industrial applications.
5. Propose an instrumentation scheme for a process industry (such as a thermal power plant) including measurement, control, and safety systems.

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R24EEPC22 **Power Systems Simulation Lab** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course are:

1. To develop the ability to perform power system studies such as load flow, fault analysis, and economic load dispatch using simulation tools and numerical techniques
2. To analyze the performance and stability of power systems under various operating and fault conditions through computer-based simulations..
3. To evaluate transient stability and load frequency control of single-area and multi-area power systems and interpret the simulation results for practical applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPC22.1	Apply load flow analysis, fault analysis, and economic load dispatch techniques using simulation tools for solving power system operational problems	3	3	2	2	3	-	-	-	-	-	2	3	1	L2, L3
R24EEPC22.2	Analyze power system performance under different operating conditions, fault conditions, and stability studies using advanced numerical methods and simulation techniques.	3	3	2	3	3	-	-	-	-	-	2	3	2	L2, L3

R24EEPC22.3	Evaluate transient and dynamic behavior of power systems through stability studies and load frequency control analysis using simulation software.	3	3	3	3	3	-	-	-	-	-	2	3	3	L2, L3

List of Experiments

1. Load Flow Solution using Gauss-Seidel Method. **CO's:** CO1
2. Load Flow Solution using Newton-Raphson Method. **CO's:** CO1
3. Load flow analysis by fast decoupled method. **CO's:** CO2
4. Symmetrical fault analysis by using Z-bus. **CO's:** CO1
5. Unsymmetrical fault analysis by using Z-bus. **CO's:** CO2
6. Economic Load Dispatch with transmission losses **CO's:** CO1
7. Economic Load Dispatch without transmission losses. **CO's:** CO2
8. Transient stability analysis using modified Euler's method **CO's:** CO2
9. Transient stability analysis using modified R-K method. **CO's:** CO2
10. Transient stability analysis using point by point method. **CO's:** CO3
11. Load frequency control of single area control with and without controllers. **CO's:** CO3
12. Load frequency control of two area control with and without controllers **CO's:** CO3

Any 10 experiments are to be conducted

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,
Approved in ACM No: 03

Online Learning Resources:

1. https://nptel.ac.in
2. https://virtual-labs.ac.in

References:

1. C.L. Wadhwa, Electrical Power Systems, New Age International.

2. Hadi Saadat, Power System Analysis, McGraw Hill.
3. I.J. Nagrath & D.P. Kothari, Modern Power System Analysis, McGraw Hill.
4. Power system operation and control by Dr. Sivanagaraju

L1: Remember

1. Define slack, PV, and PQ buses.
2. State the assumptions of the Fast Decoupled Load Flow method
3. List different types of unsymmetrical faults.
4. What is the swing equation?
5. Define tie-line power.

L2: Understand

1. Explain the steps involved in the Gauss-Seidel load flow method.
2. Explain how real and reactive power equations are decoupled.
3. Explain the concept of penalty factor.
4. Explain the operation of a two-area load frequency control system.

L3: Apply

1. Compare Newton-Raphson and Gauss-Seidel methods in terms of convergence and accuracy.
2. Analyze the effect of transmission losses on optimal generation scheduling.
3. Analyze the performance of the system with and without controllers.
4. Evaluate system stability for different fault clearing times

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Board of Studies (EEE)

R24EESC03 **Electric Mobility Systems Lab** **0 0 3 1.5**

(Electrical and Electronics Engineering)

Course Objectives:

The main objectives of the course is to

1. To understand and simulate the operation of DC-DC converters, electric motor drives, and control techniques used in electric vehicle propulsion systems.
2. To develop practical skills in the operation, control, charging, and performance analysis of EV propulsion motors and lithium-ion battery systems.
3. To analyze the dynamic performance and four-quadrant operation of electric vehicle drive systems using modern simulation and hardware platforms.

Course Outcomes

At the end of the course, students will be able to:

Course code	Course outcomes	Mapping with POs and PSOs													Do K
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EESC03.1	Apply simulation tools to model and analyze DC-DC converters, induction motor drives, SRM drives, PMSM drives, and BLDC drives for electric vehicle applications.	3	2	2	2	3	2	–	1	1	–	2	3	3	L1, L2
R24EESC03.2	Demonstrate the operation, charging/discharging characteristics, and performance evaluation of EV propulsion motors and lithium-ion battery systems using hardware experimental setups	3	2	1	3	2	2	1	2	2	1	2	3	3	L2, L3
R24EESC03.3	Analyze the performance of electric vehicle drive systems under different operating modes including speed control, V/F control, and four-quadrant operation based on measured electrical	3	3	2	3	2	2	–	1	1	–	2	3	3	L2, L3

	and mechanical parameters														

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List of Experiments

Software Based Experiments:

1. Simulation of isolated and non-isolated DC-DC converters for EV application. CO's: CO1
2. Simulation of Field oriented /DTC controlled Induction Motor drive for EV application. CO's: CO1
3. Simulation of Closed loop control of SRM drive for electric vehicle application. CO's: CO1
4. Simulation of Field oriented control of PMSM for electric vehicle application. CO's: CO1
5. Simulation of closed loop control of BLDC motor drive for electric vehicle application. CO's: CO1

Hardware Based Experiments

6. Running the propulsion motor by throttle paddle and analyze the speed, voltage, current, power of the system. CO's: CO3
7. Design and fabrication of 48V/72V, 3/5kWh Li-ion battery pack. CO's: CO2
8. Constant current mode of charging /discharging of EV Battery. CO's: CO2
9. V/F Control of Induction motor drive for electric vehicle application. CO's: CO3
10. Study of four quadrant operation of propulsion motor and analyse all the parameters like voltage, current, speed, toque, and power flow. CO's: CO3
    a) Forward motoring mode
    b) Forward braking mode
    c) Reverse motoring mode
    d) Reverse braking mode

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. List the types of DC-DC converters used in EV applications.
2. What is constant current charging?
3. Define regenerative braking.

L2: Understand

1. Define Field Oriented Control (FOC) used in EV drives.
2. Differentiate between isolated and non-isolated DC-DC converters.

3. Define State of Charge (SOC) of a battery.
4. Explain the construction and operation of a 48V/72V Li-ion battery pack.

L3: Apply

1. Develop a MATLAB/Simulink model for Field Oriented Control of PMSM drive and explain its performance.
2. Simulate and analyze the performance of a buck-boost converter for EV battery applications.
3. Calculate the battery pack voltage for a given series-parallel cell configuration.
4. Apply V/F control to regulate induction motor speed.

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R24EE PE21 **Hybrid Electric Vehicles** **3 0 0 3**

(Professional Elective-V)

Course Objectives:

The main objectives of the course is to

1. Understand the fundamentals, architecture, and classifications of Hybrid Electric Vehicles (HEVs), Electric Vehicles (EVs), and electric traction systems
2. Analyze the characteristics and performance of energy storage systems such as batteries, supercapacitors, and fuel cells used in hybrid electric vehicles.
3. Explain the role of power electronics converters, electric propulsion systems, and motor drives in HEV applications.
4. Apply hybrid vehicle control strategies, regenerative braking concepts, and energy management techniques for vehicle performance analysis.
5. Evaluate charging infrastructure, grid integration techniques, environmental impacts, and emerging trends in electric mobility and autonomous electric vehicles.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE21.1	Explain the classifications, architectures, and operating principles of Hybrid Electric Vehicles (HEVs), Electric Vehicles (EVs), and electric traction systems.	3	2	1	-	1	1	-	-	1	-	2	2	2	L1,L2
R24EEPE21.2	Analyze the performance characteristics of batteries, battery management systems, supercapacitors, and fuel cells used in HEVs.	3	3	1	2	2	1	-	-	1	-	2	3	2	L3, L4
R24EEPE21.3	Apply the concepts of power electronic	3	2	3	2	3	1	-	1	1	1	2	3	3	L3,L4

	converters, motor drives, PWM techniques, and regenerative braking systems in electric propulsion applications.														
R24EEPE21.4	Analyze hybrid vehicle control strategies, energy management methods, drive cycles, and vehicle dynamic parameters for HEV performance evaluation.	3	3	2	3	2	2	-	1	1	1	2	3	3	L4,L5
R24EEPE21.5	Evaluate charging methods, V2G concepts, smart charging techniques, environmental impacts, and future trends in electric mobility systems	2	2	2	1	2	3	2	1	1	1	3	2	3	L5,L6

SYLLABUS

Unit –I: Introduction to Hybrid Electric Vehicles **10 Hours**

Introduction to conventional vehicles and environmental impact – Need for Hybrid Electric vehicles (HEVs) – Classification of Electric Vehicles (EVs), Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs), Fuel Cell Electric Vehicles (FCEVs). Architecture of HEVs – Series hybrid, Parallel hybrid, Series-Parallel hybrid configurations. Electric traction systems – Fundamentals of electric drives –Requirements of traction motors – Selection of motors for EV/HEV applications.

Introduction to BLDC, PMSM and Induction Motor drives used in electric vehicles.

Self-Learning Topics: Evolution of electric vehicles, Comparison between conventional vehicles and HEVs. **CO's: CO1**

Unit –II: Energy Storage Systems for HEVs **10 Hours**

Energy storage requirements in HEVs – Battery fundamentals – Types of batteries used in EVs and HEVs: Lead-acid, Nickel Metal Hydride (NiMH), Lithium-ion batteries. Battery characteristics – State of Charge (SOC), Depth of Discharge (DOD), Specific energy, Specific power, charging and

discharging characteristics. Battery management systems (BMS) – Thermal management of batteries. Supercapacitors and fuel cells for hybrid vehicle applications.

Self-Learning Topics: Recent advancements in Lithium-ion battery technologies and battery recycling methods. **CO's: CO2**

Unit –III: Power Electronics and Electric Propulsion Systems **10 Hours**

Role of power electronics in HEVs – DC-DC converters –Buck, Boost and Buck-Boost converters. Inverters for motor drives–PWM techniques for inverter control. Electric propulsion system components –Motor controllers, regenerative braking systems. Power flow control in hybrid vehicles – Energy management strategies.

Self-Learning Topics: Wide band gap semiconductor devices for EV applications. **CO's: CO3**

Unit –IV: Hybrid Vehicle Control and Energy Management **10 Hours**

Hybrid vehicle control strategies – Rule-based and optimization-based energy management techniques. Drive cycles and vehicle performance analysis. Regenerative braking control. Hybrid vehicle simulation concepts. Vehicle dynamics – Tractive effort, rolling resistance, aerodynamic drag and grade resistance calculations.

Self-Learning Topics: Artificial intelligence techniques in energy management of hybrid vehicles. **CO's: CO4**

Unit –V: Charging Infrastructure and Future Trends **10 Hours**

Electric vehicle charging methods –Conductive and wireless charging. Charging standards and charging stations. Grid integration of EVs –Vehicle-to-Grid (V2G) concept. Smart charging techniques. Environmental impacts and economic analysis of HEVs and EVs. Recent trends in electric mobility and autonomous electric vehicles.

Self-Learning Topics: Government policies and incentives for electric vehicles in India.

CO's: CO5

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Text Books:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles by Mehrdad Ehsani, Yimin Gao, Sebastian Gay and Ali Emadi, CRC Press.
2. Electric and Hybrid Vehicles by Tom Denton, Routledge Publications.
3. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives by Chris Mi, M. Abul Masrur and David Wenzhong Gao.

Reference Books:

1. Electric Vehicle Technology Explained by James Larminie and John Lowry.
2. Fundamentals of Electric Vehicles by Sandeep Dhameja.
3. Power Electronics and Motor Drives by Bimal K. Bose

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ee53
2. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou24_ec10

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. List the classifications of electric vehicles.
2. Define specific energy and specific power
3. What is PWM control?
4. Define tractive effort.
5. Define Vehicle-to-Grid (V2G)

L2: Understand

1. Explain the need for Hybrid Electric Vehicles.
2. Describe charging and discharging characteristics of batteries.
3. Describe the operation of Buck and Boost converters
4. Explain regenerative braking control methods.
5. Discuss smart charging techniques.

L3: Apply

1. Apply electric drive fundamentals in EV propulsion systems.

2. Demonstrate BMS operation in HEVs.
3. Apply regenerative braking concepts in hybrid vehicles.
4. Demonstrate grade resistance calculations.
5. Illustrate V2G power flow operation.

L4: Analyzing

1. Analyze the performance of BLDC and induction motor drives
2. Differentiate batteries and supercapacitors for HEV applications
3. Analyze inverter performance for motor drives.
4. Compare rule-based and optimization-based control strategies.
5. Examine autonomous electric vehicle technologies.

L5: Evaluating

1. Assess the suitability of different traction motors for EV applications.
2. Evaluate thermal management methods for battery systems.
3. Evaluate converter performance in HEV applications.
4. Assess the economic benefits of EV adoption.

L6: Create

1. Develop a block diagram for an electric traction system.
2. Design a battery management system for HEVs.
3. Develop a PWM-based inverter control system.

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Board of Studies (EEE)

R24EEPE22 **HVDC Transmission** **3 0 0 3**
(Professional Elective-V)

Course Objectives:

The main objectives of the course is to

1. To understand the fundamentals, development, and operational principles of HVDC transmission systems and analyze the performance of HVDC converters.
2. To study the control strategies of HVDC links and the methods of reactive power management in HVDC systems.
3. To analyze converter faults, protection schemes, over voltages, and protective equipment used in HVDC transmission
4. To understand the generation of harmonics in HVDC systems and design suitable AC/DC filters for harmonic mitigation.
5. To study multi-terminal HVDC systems, DC circuit breakers, insulation coordination, and modern protection techniques in HVDC networks.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE22.1	Understand and explain the evolution, advantages, configurations, and operating principles of HVDC transmission systems, and analyze the performance of 6-pulse and 12-pulse HVDC converters.	3	2	1	1	2	1	-	-	1	-	2	3	2	L1, L2
R24EEPE22.2	Apply HVDC link control principles to analyze converter control characteristics, reactive power requirements, and power control	3	3	2	2	3	1	-	1	1	1	2	3	2	L2, L3

	methods under steady-state and transient conditions.														
R24EEPE22.3	Analyze converter faults, over voltages, and protection schemes in HVDC systems, and evaluate the performance of protective devices such as surge arresters and smoothing reactors.	3	3	2	3	2	2	1	1	1	1	2	3	2	L3, L4
R24EEPE22.4	Analyze harmonic generation in HVDC systems, evaluate their effects on power systems, and design suitable filters for harmonic mitigation.	3	3	3	3	3	2	-	1	1	1	2	3	3	L4,L5
R24EEPE22.5	Understand and evaluate the operation, control, insulation requirements, and protection aspects of multi-terminal HVDC systems and DC circuit breakers.	3	2	2	2	2	2	1	1	1	1	3	3	3	L2,L5

SYLLABUS

Unit –I: DC Power Transmission Technology 14 Hours

Introduction-Historical Development-Comparison of AC and DC transmission- types of DC links Existing HVDC Projects in India. Modern Trends in HVDC Technology.

Analysis of HVDC Converters Three Phase 6-Pulse bridge converter –simplified analysis-waveform with and without overlap - Current and voltage relationship - Equivalent circuits of converters - Analysis of 12 pulse converters.

.**Self-Learning Topics:** Overview of HVDC projects in India, Basic control and protection of HVDC systems **CO's: CO1**

Unit –II: HVDC System and Reactive Power Control **12 Hours**

Principles of DC link control –converter control characteristics-constant current and constant Extinction angle control-constant ignition angle control-starting and stopping of HVDC link-power control & power reversal in HVDC link.

Reactive Power Control in HVDC: Introduction, Reactive Power Requirements in steady state, sources of reactive power- Static VAR Compensators, Reactive power control during transients.

Self-Learning Topics: Commutation failure and its causes, Principle of power reversal without changing current direction **CO's: CO2**

Unit –III: Converter Faults and Protection **12 Hours**

Over voltages in converter station –Surge arrestors –Protection against over voltages and over currents. Converter faults –Protection against faults in voltage source converter – Smoothing Reactor-Transient over voltages for DC line–Protection of DC lines.

Self-Learning Topics: Protection against over voltages and over currents. Surge arresters and their application **CO's: CO3**

Unit –IV: Harmonics and Filters **12 Hours**

Harmonics: Generation of Harmonics, Characteristics harmonics, calculation of AC Harmonics, Non-Characteristics harmonics, adverse effects of harmonics, Calculation of voltage and Current harmonics, Effect of Pulse number on harmonics

Filters: Types of AC filters, Design of Single tuned filters –Design of High pass filters.

Self-Learning Topics: Concept of reactive power and its role in AC power systems, Concept and working of active power filters **CO's: CO4**

Unit –V: Multi Terminal HVDC Systems & DC Circuit Breakers **12 Hours**

Types of MTDC systems – Control and Protection of MTDC system–HVDC insulation–DC line insulators – DC breakers – Characteristics and types of DC breakers.

Self-Learning Topics: Types of Distribution Systems. **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. K.R. Padiyar-"HVDC Power Transmission Systems Technology and System Interactions" New Age International (p) Limited - New Delhi - 2003.
2. Edward Wilson Kimbark - "Direct current Transmission" - Wiley Inter science - Vol. I - New York - 1971.

Reference Books:

1. Vijay K. Sood - "HVDC and FACTS Controller: Application of Static Converters in power systems"-IEEE Power Electronics and Power Systems series-Kluwer Academic publishers-Boston –First edition January 2004.
2. C. Adamson and N.G. Hingorani-"High voltage DC power Transmission"-Garraway Limited - England - 1960.
3. Mohan-Undeland and Robbins-"Power Electronics Converters- Applications and Design-John Wiley & Son - Inc. - 2003.
4. J. Arrialga- "HVDC Transmission" –Peter Peregrinus Ltd. -London-1983.

Web References:

1. https://nptel.ac.in/courses/108104013
2. https://www.classcentral.com/course/youtube-electrical-high-voltage-dc-transmission-47611

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define HVDC transmission system
2. List the types of DC links used in HVDC transmission.
3. What is meant by extinction angle control?
4. Define reactive power in HVDC systems
5. What is a smoothing reactor?
6. List the causes of over voltages in converter stations
7. What are characteristic harmonics?
8. Define DC circuit breaker.

L2: Understand

1. Explain the operation of a three-phase 6-pulse bridge converter.
2. Describe converter control characteristics in HVDC systems
3. Explain the protection methods against over currents in converters.
4. Discuss the adverse effects of harmonics on power systems.
5. Describe the control and protection of MTDC systems.

L3: Apply

1. Calculate the average DC output voltage of a 6-pulse converter for a given firing angle.
2. Apply constant ignition angle control for converter operation analysis.
3. Select appropriate surge arresters for a given HVDC system.
4. Calculate voltage and current harmonics for a converter system
5. Select appropriate DC breakers for HVDC applications.

L4: Analyzing

1. Differentiate between monopolar, bipolar and homopolar DC links.
2. Analyze the converter control characteristics under different operating conditions.
3. Compare different protection techniques used in converter stations.
4. Analyze the impact of harmonics on AC power system performance.
5. Analyze the advantages and challenges of MTDC systems

L5: Evaluating

1. Evaluate the suitability of HVDC transmission for interconnecting asynchronous AC systems.
2. Justify the need for transient reactive power support in HVDC systems.
3. Evaluate the effectiveness of surge arresters in protecting converter stations.
4. Assess the effectiveness of active power filters over passive filters.
5. Evaluate the performance of MTDC systems for modern power networks.

L6: Create

1. Design a basic block diagram of an HVDC transmission system for long-distance bulk power transfer.
2. Develop a reactive power compensation scheme for a converter station.
3. Develop a fault analysis procedure for DC line protection.

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Board of Studies (EEE)

R24EEPE23 **Smart Grid Technologies** **3 0 0 3**
(Professional Elective-V)

Course Objectives:

The main objectives of the course is to

1. Understand the concepts, architecture, functions, and challenges of Smart Grid systems and compare them with conventional power grids.
2. Explain Smart Grid technologies including microgrids, renewable energy integration, load frequency control, and reactive power management in modern power systems.
3. Analyze the operation and applications of smart substations, SCADA systems, IEC 61850 communication, protection, monitoring, and automation techniques.
4. Examine smart transmission technologies such as Energy Management Systems (EMS), Wide Area Monitoring Systems (WAMS), Wide Area Monitoring Protection and Control (WAMPC), and Phasor Measurement Units (PMUs).
5. Apply the concepts of smart distribution systems including Distribution Management Systems (DMS), Distribution SCADA (DSCADA), Volt/VAR control, and Fault Detection Isolation and Service Restoration (FDIR) for efficient power distribution.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE23.1	Understand and explain the fundamentals, architecture, functions, technologies, advantages, and challenges of Smart Grid systems and compare them with conventional power grids.	3	2	1	1	2	1	-	-	1	-	2	3	2	L1,L2
R24EEPE23.2	Analyze Smart Grid technologies including microgrids,	3	3	2	2	3	1	-	1	1	1	2	3	2	L3,L4

	renewable energy integration, load frequency control, and reactive power management in modern electrical networks.														
R24EEPE23.3	Examine and interpret the operation of smart substations, SCADA systems, IEC 61850 standards, protection devices, sensors, and automation techniques used in Smart Grids.	3	3	2	3	2	2	1	1	1	1	2	3	2	L4,L5
R24EEPE23.4	Evaluate smart transmission technologies such as EMS, WAMS, WAMPC, and PMUs for improving monitoring, protection, control, and reliability of transmission systems.	3	3	3	3	3	2	-	1	1	1	2	3	3	L5,L6
R24EEPE23.5	Apply smart distribution system concepts including DMS, DSCADA, Volt/VAR control, and FDIR techniques for efficient, reliable, and automated distribution network operation.	3	2	3	2	3	2			1		2	3	3	L3,L4

SYLLABUS

Unit –I: Introduction to Smart Grid **14 Hours**

Working definitions of Smart Grid and Associated Concepts –Smart Grid Functions –Traditional Power Grid and Smart Grid –New Technologies for Smart Grid –Advantages – Indian Smart Grid – Key Challenges for Smart Grid.

Smart Grid Architecture: Components and Architecture of Smart Grid Design – Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs – Transmission Automation – Distribution Automation – Renewable Integration

.**Self-Learning Topics:** Evolution of Electrical Power Grids, Need for Smart Grid Technology in Modern Power Systems, Comparison between Conventional Grid and Smart Grid. **CO's: CO1**

Unit –II: Smart Grid Technologies **12 Hours**

Characteristics of Smart grid, Micro grids, Definitions, Drives, benefits, types of Micro grid, building blocks, Renewable energy resources, needs in smart grid, integration impact, integration standards, Load frequency control, reactive power control, case studies and test beds.

Self-Learning Topics: Fundamentals and Characteristics of Smart Grid, Concept and Evolution of Micro Grid, Types of Micro Grids (AC, DC, Hybrid, Islanded and Grid Connected). **CO's: CO2**

Unit –III: Smart Substations **14 Hours**

Protection, Monitoring and control devices, sensors, SCADA, Master stations, Remote terminal unit, interoperability and IEC 61850, Process level, Bay level, Station level, Benefits, role of substations in smart grid, Volt/VAR control equipment inside substation.

Self-Learning Topics: Fundamentals of Smart Substations, Conventional Substations vs Smart Substations, Components of Digital and Smart Substations. Protection Relays Used in Smart Substations. **CO's: CO3**

Unit –IV: Smart Transmission **14 Hours**

Energy Management systems, History, current technology, EMS for the smart grid, Wide Area Monitoring Systems (WAMS), protection & Control (WAMPC), needs in smart grid, Role of WAMPC smart grid, Drivers and benefits, Role of transmission systems in smart grid, Synchro Phasor Measurement Units (PMUs).

Self-Learning Topics: Evolution of Transmission System Technologies, Energy Management Systems (EMS) in Power Systems**.** **CO's: CO4**

Unit –V: Smart Distribution Systems **10 Hours**

DMS, DSCADA, trends in DSCADA and control, current and advanced DMSs, Voltage fluctuations, effect of voltage on customer load, Drivers, objectives and benefits, voltage-VAR control, VAR control equipment on distribution feeders, implementation and optimization, FDIR - Fault Detection Isolation and Service restoration (FDIR), faults, objectives and benefits, equipment, implementation.

Self-Learning Topics: Fundamentals of Smart Distribution Systems, Modern Trends in Distribution Automation. **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. Stuart Borlase, Smart Grids - Infrastructure, Technology and Solutions, CRC Press, 1e, 2013.
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley–IEEE Press, 2e, 2013.

Reference Books:

1. A.G. Phadke and J.S. Thorp, Synchronized Phasor Measurements and their Applications, Springer Edition, 2e, 2017.
2. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2e, 2012.

Web References:

1. https://nptel.ac.in/courses/108107113
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee84
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee60

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define Smart Grid.
2. List the functions of a Smart Grid.

3. Mention the types of Micro Grids.
4. What is SCADA?
5. State the role of transmission systems in Smart Grid.

L2: Understand

1. Explain the difference between a traditional grid and a Smart Grid.
2. Discuss the need for renewable energy integration in Smart Grid.
3. Explain the process level, bay level, and station level architecture.
4. Discuss the need for WAMS in Smart Grid.
5. Discuss modern trends in DSCADA.

L3: Apply

1. Apply Smart Grid technologies for reducing transmission losses.
2. Demonstrate the operation of Hybrid Micro Grid systems.
3. Illustrate SCADA operation in Smart Substations.
4. Illustrate PMU applications in transmission systems.
5. Demonstrate DSCADA operation in distribution automation

L4: Analyzing

1. Analyze the advantages of Smart Grid over conventional grids.
2. Analyze the impact of renewable integration on power systems.
3. Differentiate process level and station level operations.
4. Compare conventional and Smart Transmission systems.
5. Analyze the benefits of distribution automation.

L5: Evaluating

1. Evaluate the effectiveness of Smart Grid technologies in India.
2. Justify the need for reactive power compensation
3. Justify the use of SCADA in Smart Substations.
4. Evaluate the effectiveness of EMS in Smart Grid.
5. Evaluate the effectiveness of Voltage-VAR control methods.

L6: Create

1. Design a basic Smart Grid architecture for a smart city.
2. Develop a renewable energy-based Smart Grid model.
3. Develop a SCADA-based monitoring system for substations.

Chairperson
Board of Studies (EEE)

R24EEPE24 **Electrical Distribution Systems** **3 0 0 3**
(Professional Elective-V)

Course Objectives:

The main objectives of the course is to

1. Understand the fundamentals, structure, load characteristics, and operational concepts of electrical distribution systems.
2. Explain and analyze the design considerations of distribution substations and feeders for effective electrical power distribution.
3. Apply system analysis techniques to determine voltage drop and power losses in distribution lines under different loading conditions.
4. Examine the operation and coordination of protective devices used in distribution systems for reliable and safe operation.
5. Analyze and apply compensation techniques for power factor improvement and voltage control in electrical distribution systems.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEPE24.1	Understand and explain the fundamentals of electrical distribution systems, load modeling, load characteristics, and classification of loads in power distribution networks..	3	2	1	-	1	1	-	-	1	-	2	2	2	L1, L2
R24EEPE24.2	Analyze the location, rating, and design considerations of substations and distribution feeders in electrical distribution	3	3	2	2	2	1	-	1	1	1	2	3	2	L3,L4

	systems.														
R24EEPE24.3	Apply voltage drop and power-loss calculations for uniformly and non-uniformly distributed loads in balanced three-phase distribution systems.	3	2	2	2	3	1	-	1	1	1	2	3	2	L2,L3
R24EEPE24.4	Examine and evaluate the operation and coordination of protective devices such as fuses, reclosers, sectionalizers, circuit breakers, and RCCBs used in distribution systems.	3	3	2	3	2	2	1	1	1	1	2	3	2	L4, L5
R24EEPE24.5	Analyze and apply power factor improvement and voltage control techniques using capacitive compensation and voltage regulating equipment in distribution systems.	3	3	3	2	3	2	-	1	1	1	2	3	3	L4,L5

SYLLABUS

Unit –I: General Concepts **12 Hours**

Introduction to distribution systems, Load modeling and characteristics–Coincidence factor – Contribution factor-loss factor–Relationship between the load factor and loss factor–Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics.

.**Self-Learning Topics:** Fundamentals of Electrical Distribution System, Structure and Components of Distribution Systems **CO's: CO1**

Unit –II: Substations & Distribution Feeders **14 Hours**

Location of substations: Rating of distribution substation – Service area with 'n' primary feeders – Benefits and methods of optimal location of substations.

Design Considerations of distribution feeders: Radial and loop types of primary feeders – Voltage levels – Feeder loading – Basic Design practice of the secondary distribution system.

Self-Learning Topics: Types of Distribution Substations, Components of Distribution Substations.

CO's: CO2

Unit –III: System Analysis **12 Hours**

Voltage drop and power–loss calculations: Derivation for voltage drop and power loss in lines – Uniformly distributed loads and non-uniformly distributed loads–Numerical problems-Three phase balanced primary lines.

Self-Learning Topics: Electrical Parameters of Distribution Lines, Resistance, Inductance and Capacitance of Distribution Lines. **CO's: CO3**

Unit –IV: Protective devices and Coordination **14 Hours**

Objectives of distribution system protection – Types of common faults and procedure for fault calculations for distribution system – Protective devices: Principle of operation of fuses – Circuit reclosures – Line sectionalizes and circuit breakers, Coordination of protective devices, General coordination procedures - Various types of coordinated operation of protective devices - Residual Current Circuit Breaker

Self-Learning Topics: Objectives and Requirements of Protection Systems, Types of Faults in Distribution System, Symmetrical and Unsymmetrical Faults. **CO's: CO4**

Unit –V: Compensation for Power Factor Improvement and Voltage Control **14 Hours**

Capacitive compensation for power factor control – Different types of power capacitors – shunt and series capacitors – Effect of shunt capacitors (Fixed and switched) – Power factor correction – Capacitor allocation – Economic justification – Procedure to determine the best capacitor location. Equipment for voltage control – Effect of series capacitors – Effect of AVB/AVR – Line drop compensation – Numerical problems.

Self-Learning Topics: Causes and Effects of Low Power Factor, Advantages of Power Factor Improvement, Reactive Power and Its Role in Power Systems. **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03

Approved in ACM No: 03

Text Books:

1. "Electric Power Distribution system Engineering" – by Turan Gonen, McGraw–hill Book Company.

Reference Books:

1. Electrical Distribution Systems by Dale R.Patrick and Stephen W. Fardo, CRC press
2. Electric Power Distribution–by A.S.Pabla, Tata Mc Graw–hill Publishing company, 4th edition, 1997.
3. Electrical Power Distribution Systems by V. Kamaraju, Right Publishers

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee69
2. https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_ee105
3. https://nptel.ac.in/courses/108107112

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define distribution system.
2. What is load modeling?
3. What is a radial feeder?
4. Define power loss in distribution lines.
5. What is a sectionalizer?

L2: Understand

1. Discuss the relationship between load factor and loss factor.

2. Explain radial and loop type feeders.
3. Explain uniformly distributed loads.
4. Describe coordination of protective devices.
5. Discuss the effects of low power factor.

L3: Apply

1. Calculate loss factor from given load factor values.
2. Apply feeder design principles for a residential area.
3. Determine power losses in distribution lines.
4. Illustrate the operation of RCCB in protection systems.
5. Apply shunt capacitors for voltage improvement

L4: Analyzing

1. Analyze the load characteristics of industrial and agricultural consumers.
2. Compare radial and loop distribution systems.
3. Analyze the causes of power loss in distribution systems.
4. Analyze coordinated protection schemes.
5. Analyze the effects of shunt capacitors on distribution systems.

L5: Evaluating

1. Justify the need for load classification in distribution planning.
2. Evaluate the design practices of secondary distribution systems.
3. Evaluate methods for reducing voltage drop in feeders.
4. Evaluate the performance of protective devices in distribution systems.

L6: Create

1. Design a load model for a residential distribution area.
2. Develop a layout for an optimally located distribution substation.
3. Propose methods to minimize power losses in distribution systems.

Chairperson
Board of Studies (EEE)

R24EEOE16 **Concepts of Smart Grid Technologies** **3 0 0 3**

(Open Elective-IV)

Course Objectives:

The main objectives of the course are to

1. To understand the vision, architecture, and key enabling technologies of the smart grid.
2. To analyze advanced metering infrastructure (AMI) and the role of smart meters in consumer interaction.
3. To understand wide area monitoring, protection, and control using PMUs and synchro phasor technology.
4. To evaluate distribution automation, self-healing grid concepts, and outage management systems.
5. To understand demand side management, grid integration of renewables, and cyber security in smart grids.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													Do K
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	
R24EEOE16.1	Explain the vision, architecture, components, and enabling technologies of the smart grid and compare it with the conventional grid.	2	2	-	-	1	3	1	-	1	-	2	2	3	L1, L2
R24EEOE16.2	Analyze the Advanced Metering Infrastructure (AMI), smart meter functionality, and Home Area Network for consumer energy management.	2	3	2	2	2	2	-	-	-	-	2	2	3	L2, L3
R24EEOE16.3	Evaluate wide area monitoring using PMUs, synchrophasor	2	3	-	2	2	2	-	-	-	-	2	3	2	L3, L4

	-based applications, and WAMPAC for grid stability.														
R24EEOE16.4	Analyze distribution automation, FLISR, Volt-VAR optimization, and self-healing grid features in smart distribution systems.	2	3	3	2	2	2	-	-	-	-	2	3	3	L4, L5
R24EEOE16.5	Evaluate demand response, renewable energy integration, cyber security threats, and smart grid standards for sustainable grid operation.	2	3	3	2	2	3	2	-	-	-	3	2	3	L5, L6

SYLLABUS

Unit I – Smart Grid Architecture **14 Hours**

Challenges in power grid, concept of smart grid, need, components, limitations, grid vision, intelligent architecture, wholesale energy market, stakeholders, interoperability standards

Self-Learning Topics: Digital Twin Technology for Smart Grid Planning and Real-Time Operational Optimization **CO's: CO1**

Unit II – Communications and Measurements **12 Hours**

Latest wired/wireless tech, smart grid communication techniques, switching techniques, Wide Area Monitoring Systems, Phasor Measurement Units, smart metering components, AMI, multi-agent systems

Self-Learning Topics: Blockchain-Enabled Secure and Transparent Peer-to-Peer Energy Trading Using Smart Meters **CO's: CO2**

Unit III – Performance Analysis Tools **12 Hours**

Load flow studies, extended formulations and algorithms, security assessment, contingency studies, voltage stability, energy management

Self-Learning Topics: Machine Learning-Based Power System Event Classification Using PMU Data

Streams **CO's: CO3**

Unit IV – Computational Tools and Security **12 Hours**

Computational tools, optimization techniques for smart grid, evolutionary computation, network security: encryption/decryption, cyber-attacks, authentication, cyber security standards

Self-Learning Topics: Edge Computing and Fog Computing for Low-Latency Distribution Automation Applications **CO's: CO4**

Unit V – Renewable Energy and Storage **12 Hours**

Benefits of renewable generation, microgrid importance, demand response, PHEV technology, energy storage technologies, grid integration issues

Self-Learning Topics: Quantum Cryptography for Future-Proof Security in Critical Smart Grid Infrastructure **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Smart Grid: Technology and Applications – Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley, 2012.
2. Smart Grids: Infrastructure, Technology, and Solutions – Stuart Borlase, CRC Press, 2012.

Reference Books:

1. The Smart Grid: Enabling Energy Efficiency and Demand Response – Clark W. Gellings, The Fairmont Press, 2009.
2. Power System SCADA and Smart Grids – Mini S. Thomas and John D. McDonald, CRC Press, 2015.
3. Phasor Measurement Units and Wide Area Monitoring Systems – Arun G. Phadke and James S. Thorp, Elsevier, 2008.
4. Cyber Security for Industrial Control Systems – Celine Marangos, IET, 2014.

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ee84
2. https://www.nsgm.gov.in/en

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---

L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define smart grid and list its key differences from the conventional power grid.
2. List the communication technologies used in Advanced Metering Infrastructure.
3. State the function of a Phasor Measurement Unit (PMU) and the IEEE standard governing its performance.
4. Define FLISR and list the stages involved in automated fault restoration.

L2: Understand

1. Explain the architecture of a smart grid distinguishing the generation, transmission, distribution, and customer domains.
2. Describe the role of AMI in enabling demand response and consumer energy management.
3. Explain the working principle of a PMU and describe how GPS synchronization enables wide area measurements.
4. Discuss the concept of Volt-VAR Optimization (VVO) and explain how it improves distribution system efficiency.

L3: Apply

1. Design an AMI communication network for an urban distribution area of 10,000 consumers specifying HAN, NAN, and WAN technologies.
2. Apply FLISR logic to restore supply to an unfaulted feeder section following a fault isolation sequence.
3. Implement a VVO strategy for a distribution feeder with OLTC transformer and switched capacitor banks to minimise losses.
4. Evaluate the demand response potential of an industrial consumer using real-time pricing (RTP) signals.
5. Assess the cyber attack surface of a SCADA-based distribution management system and

propose mitigation measures.

L4: Analyze

1. Analyze the inter-area oscillation monitoring capability of a WAMS using PMU data and identify the oscillation modes.
2. Compare NB-PLC, RF mesh, and LTE as AMI communication technologies in terms of latency, data rate, and coverage.
3. Examine the role of IEC 61850 GOOSE messaging in speeding up protection and automation in smart substations.
4. Analyze the cyber security vulnerabilities in an SCADA system and evaluate the defence-in-depth approach.

L5: Evaluate

1. Evaluate the business case for deploying smart meters and AMI for an electricity distribution company.
2. Justify the use of WAMPAC over conventional SCADA-based protection for mitigating wide-area blackouts.
3. Assess the role of Virtual Power Plants (VPP) in integrating distributed solar and battery assets into electricity markets.

L6: Create

1. Design a complete smart grid roadmap for an existing urban distribution network specifying AMI deployment, distribution automation, DER integration, demand response programme, and cyber security framework.
2. Develop a WAMS-based inter-area oscillation damping scheme using PMU measurements and supplementary damping signals to FACTS controllers, and evaluate its effectiveness.
3. Formulate a cyber-security framework for a smart grid SCADA system based on IEC 62351 and NERC CIP standards, identifying critical assets, threat vectors, and countermeasures.

Chairperson
Board of Studies (EEE)

R24EEOE17 **Fundamentals Electric Vehicles** **3 0 0 3**

(Open Elective-IV)

Course Objectives:

The main objectives of the course are to

1. To understand the fundamentals, classification, and architecture of electric vehicles and hybrid electric vehicles.
2. To analyze traction motor selection, power electronic drives, and control strategies for electric vehicle propulsion.
3. To understand battery technology, battery management systems, and energy storage for electric vehicles.
4. To understand EV charging infrastructure, charging standards, and grid interaction including V2G technology.
5. To evaluate the energy management strategies, thermal management, and sustainability aspects of electric vehicles.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE17.1	Explain the classification, architecture, and operating principles of BEV, HEV, PHEV, and FCEV electric vehicles.	2	2	-	-	1	3	1	-	1	-	2	1	3	L1, L2
R24EEOE17.2	Analyze traction motor types, power electronic converters, and control strategies for electric vehicle propulsion systems.	2	3	3	2	2	2	-	-	-	-	2	3	2	L3, L4
R24EEOE17.3	Evaluate battery technologies, battery management systems, and energy storage	2	3	-	2	2	2	1	-	-	-	2	2	3	L3, L4

	selection criteria for electric vehicles.														
R24EEOE17.4	Analyze EV charging infrastructure, charging levels and standards, smart charging, and Vehicle-to-Grid (V2G) technology.	2	3	2	2	2	2	1	-	-	1	2	2	3	L4, L5
R24EEOE17.5	Evaluate energy management strategies, thermal management systems, and lifecycle sustainability aspects of electric vehicles.	2	3	3	2	2	3	-	-	-	2	3	2	3	L5, L6

SYLLABUS

Unit I – Introduction **12 Hours**

Fundamentals of vehicles, vehicle model, road load, tractive force, drawbacks of conventional vehicles, need for EVs, advantages, history, EV market in India and outside, types of EVs

Self-Learning Topics: Hydrogen Fuel Cell Vehicles: Technology, Infrastructure, and India's National Hydrogen Mission **CO's: CO1**

Unit II – Components of Electric Vehicles **12 Hours**

Main components, electric traction motor and controller, power converters, rectifiers in EVs, bidirectional DC-DC converters, voltage source inverters, PWM inverters

Self-Learning Topics: Axial Flux PMSM: Compact High-Torque Motor for Next-Generation EV drivetrains **CO's: CO2**

Unit III – Motors for Electric Vehicles **12 Hours**

Characteristics of traction drive, requirements of electric machines for EVs, comparison of motors (IM, Synchronous, PMSM, BLDC, SRM) – construction and working only

Self-Learning Topics: Solid-State Batteries: Next Generation Energy Storage for Safe and High Energy Density EVs **CO's: CO3**

Unit IV – Hybrid Electric Vehicles **10 Hours**

Evolution, advantages, applications, architecture (series/parallel/complex/range-extended HEVs), merits and demerits

Self-Learning Topics: Ultra-Fast Charging at 350 kW and Above: Technology Challenges and Infrastructure Requirements **CO's: CO4**

Unit V – Energy Sources for Electric Vehicles **12 Hours**

Battery types (Li-ion, NiMH, Lead-acid), battery comparison, battery charging, fast charging, Battery Management System (BMS), ultra capacitors, flywheels, compressed air energy storage (CAES), fuel cell

Self-Learning Topics: AI-Based Predictive Energy Management for Extended Range in Electric Autonomous Vehicles **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles – MehrdadEhsani, YiminGao, Sebastien E. Gay, Ali Emadi, CRC Press, 3rd Edition, 2018.
2. Electric Vehicle Technology Explained – James Larminie and John Lowry, Wiley, 2nd Edition, 2012.

Reference Books:

1. Power Electronics and Motor Drives – B.K. Bose, Academic Press/Elsevier, 2006.
2. Battery Management Systems – Volumes I and II – Gregory L. Plett, Artech House, 2015.
3. Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles – John G. Hayes and G.A. Goodarzi, Wiley, 2018.
4. Plug-in Electric Vehicles in Smart Grids – S. Rajakaruna, F. Shahnia, A. Ghosh, Springer, 2015.

Web References:

1. https://nptel.ac.in/courses/108106182
2. https://nptel.ac.in/courses/108102121

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---

L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Classify electric vehicles and state the key difference between BEV, HEV, PHEV, and FCEV.
2. List the major components of a Battery Electric Vehicle (BEV) drivetrain.
3. State the three levels of EV charging and their power ratings.
4. Define State of Charge (SoC) and State of Health (SoH) of a battery.

L2: Understand

1. Explain the series and parallel hybrid powertrain architectures and compare their energy flow paths.
2. Describe the Field Oriented Control (FOC) strategy for PMSM in an EV and explain the role of MTPA control.
3. Explain the working principle of a lithium-ion battery and describe the charge/discharge process.
4. Discuss the Vehicle-to-Grid (V2G) concept and explain how it provides grid frequency regulation services.

L3: Apply

1. Calculate the tractive effort, gradeability, and maximum speed of an EV for given motor rating and vehicle parameters.
2. Design the battery pack configuration (series-parallel) for a 400 V, 60 kWh EV battery system using a given lithium-ion cell.
3. Compute the SoC of an EV battery using Coulomb counting for a given current profile and initial SoC.
4. Determine the charging time for an EV battery from 20% to 80% SoC using Level 2 and DC

fast charging.

5. Implement a thermostat energy management strategy for a parallel HEV and calculate the fuel consumption.

L4: Analyse

1. Analyse the impact of regenerative braking on energy recovery and range extension for an EV in urban drive cycles.
2. Compare SiC MOSFET and Si IGBT for EV traction inverter applications in terms of efficiency and switching frequency.
3. Examine the passive and active cell balancing methods in a BMS and compare their efficiency and complexity.
4. Analyse the impact of 50 kW DC fast charging stations on the distribution transformer loading in a residential area.

L5: Evaluate

1. Evaluate the total cost of ownership (TCO) of a BEV versus an equivalent ICE vehicle over a 10-year period.
2. Justify the selection of LFP chemistry over NMC for a commercial electric bus considering safety, cycle life, and cost.
3. Assess the environmental benefits of EVs under the current Indian electricity generation mix versus a future 50% renewable scenario.

L6: Create

1. Design a complete EV powertrain for a 5-seater passenger car specifying traction motor rating, inverter, battery pack, OBC, BMS, and thermal management for a 300 km range target.
2. Develop a smart charging management system for a 100-EV fleet integrating ToU pricing, grid capacity constraints, and renewable energy availability to minimise charging cost.
3. Formulate a V2G aggregation strategy for a community of 500 EVs to provide frequency regulation services specifying bi-directional charging architecture, communication protocol, and SoC management constraints.

Chairperson
Board of Studies (EEE)

R24EEOE18 **IoT in Energy Systems** **3 0 0 3**

(Open Elective-IV)

Course Objectives:

The main objectives of the course are to

1. To understand the fundamentals of IoT architecture, protocols, and hardware platforms relevant to energy systems.
2. To apply IoT-based sensing and communication techniques for real-time energy monitoring and measurement.
3. To understand IoT-enabled smart metering, demand response, and energy management in smart buildings.
4. To analyse IoT applications in renewable energy systems including solar PV and wind monitoring.
5. To understand cloud platforms, data analytics, cyber security, and emerging trends in IoT-based energy systems.

Course Outcomes

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE18.1	Explain IoT architecture, communication protocols, and hardware platforms used in energy system applications.	2	2	-	-	2	1	-	-	1	-	3	1	2	L1, L2
R24EEOE18.2	Design IoT-based energy monitoring systems to measure voltage, current, power, and energy parameters in real time.	2	2	3	2	3	2	-	-	-	-	2	2	3	L3, L4
R24EEOE18.3	AnalyseIoT applications for smart metering, smart buildings, demand response, and building energy management systems.	2	3	3	2	2	3	-	-	-	1	2	2	3	L3, L4
R24EEOE18.4	Apply IoT techniques for monitoring and control of solar PV systems, wind turbines, and battery energy storage systems.	2	3	3	2	2	3	-	-	-	-	3	2	3	L4, L5
R24EEOE18.5	Evaluate cloud	2	3	3	2	2	2	2	-	-	-	3	2	3	L5,

	platforms, data analytics, cyber security measures, and future trends in IoT-based energy management.														L6

SYLLABUS

Unit I – Fundamentals of IoT for Energy Systems **12 Hours**

IoT definition, characteristics, architecture (perception/network/processing/application layers), hardware (Arduino, ESP8266, ESP32, Raspberry Pi), sensors (ACS712, CT, PZEM-004T, LM35), communication protocols (Wi-Fi, ZigBee, LoRa, NB-IoT, 4G/5G), MQTT, HTTP/REST, CoAP, edge and fog computing

Self-Learning Topics: Role of Next-Generation Wireless Networks in Industrial IoT Energy Applications

CO's: CO1

Unit II – IoT-Based Energy Monitoring and Measurement **12 Hours**

Smart energy metering, IoT energy meter design (ESP32+PZEM-004T+MQTT), RMS calculation, power quality monitoring, NILM, data logging (ThingSpeak, Node-RED, InfluxDB), Grafana dashboards, alert systems, anti-tamper detection

Self-Learning Topics: Non-Intrusive Load Monitoring (NILM) Using AI for Appliance-Level Energy Disaggregation **CO's: CO2**

Unit III – IoT in Smart Buildings and Demand Response **12 Hours**

Smart building concept, IoT lighting control (PIR, LDR, DALI), HVAC control, smart thermostat, BACnet/Modbus, BEMS (ISO 50001), DSM via IoT, OpenADR 2.0, smart plugs, EV charging management via IoT

Self-Learning Topics:

Zero Energy Buildings: IoT Integration for Real-Time Energy Balance and Control **CO's: CO3**

Unit IV – IoT in Renewable Energy and Storage Systems **12 Hours**

Solar PV IoT monitoring (SCADA, fault detection, MPPT monitoring), wind turbine condition monitoring (vibration, bearing fault), IoT for BESS (SoC, SoH, BMS), microgrid monitoring, biogas plant IoT, hybrid RE system cloud monitoring

Self-Learning Topics: Digital Twin for Real-Time IoT-Based Performance Optimisation of Solar PV Plants

CO's: CO4

Unit V – Cloud Platforms, Data Analytics and Cyber Security **12 Hours**

Cloud platforms (AWS IoT Core, Azure IoT Hub, Google Cloud, ThingSpeak), time-series DB (InfluxDB, TimescaleDB), data analytics (descriptive/diagnostic/predictive/prescriptive), ML for load forecasting, pre-

dictive maintenance, cyber security in IoT (IEC 62351, NERC CIP), future trends (AI-IoT, block chain P2P, digital twins, 5G smart grids)

Self-Learning Topics: Block chain-Based Peer-to-Peer Energy Trading Using IoT Smart Meters in Micro grids **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Internet of Things: A Hands-On Approach – Arshdeep Bahga and Vijay Madisetti, VPT, 2014.
2. IoT and Edge Computing for Architects – Perry Lea, Packt Publishing, 2nd Edition, 2020.

Reference Books:

1. Designing the Internet of Things – Adrian McEwen and Hakim Cassimally, Wiley, 2013.
2. Smart Grid: Technology and Applications – Janaka Ekanayake et al., Wiley, 2012.
3. Energy Management Handbook – Wayne C. Turner and Steve Doty, The Fairmont Press, 8th Edition, 2016.
4. Practical Node-RED Programming – TaijiHagino, Packt Publishing, 2021.

Web References:

1. https://thingspeak.mathworks.com
2. https://mqtt.org/
3. https://nodered.org/
4. https://nptel.ac.in/courses/106105166

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. List the four layers of IoT architecture and state the function of each.
2. Name the communication protocols used in IoT for energy applications.
3. Define MQTT and list its three main components.
4. State what a smart meter measures compared to a conventional energy meter.
5. List any four sensors used in IoT-based energy monitoring systems.

L2: Understand

1. Explain the MQTT publish-subscribe protocol and describe how it is used for IoT energy monitoring.
2. Describe the architecture of an IoT-based smart energy meter using ESP32 and PZEM-004T.
3. Explain the concept of Non-Intrusive Load Monitoring (NILM) and describe how it disaggregates individual appliance consumption.
4. Describe the IoT-based solar PV monitoring system and explain the parameters monitored.
5. Explain demand response using Open ADR 2.0 and describe how IoT devices participate in automated demand response.

L3: Apply

1. Design an IoT-based energy monitoring system for a residential building specifying hardware (sensor, microcontroller, communication module), software (MQTT, cloud), and dashboard.
2. Develop an IoT node using ESP32 to measure voltage and current, compute real power and power factor, and publish data to Thing Speak every 10 seconds.
3. Design a smart lighting control system for a classroom using PIR, LDR, and IoT relay, specifying the control logic and communication protocol.
4. Design an IoT monitoring system for a 10 kWp rooftop solar PV plant specifying parameters to monitor, sensors, data logger, and cloud dashboard.
5. Configure an MQTT broker and design a topic structure for an IoT energy management system for a factory with 10 machines.

L4: Analyze

1. Analyze the advantages and limitations of LoRa WAN versus NB-IoT for long-range IoT energy meter communication in a rural utility network.
2. Compare edge computing and cloud computing for real-time fault detection in an IoT-based solar PV monitoring system.
3. Examine the cyber security vulnerabilities of an IoT smart metering system and propose a defence-in-depth security architecture.

4. Analyze the energy saving potential of an IoT-based BEMS in a commercial building by comparing energy consumption before and after implementation.

L5: Evaluate

1. Evaluate the technical and economic benefits of deploying IoT-based smart meters for a distribution utility in an urban area.
2. Justify the use of digital twin technology for performance optimisation of a solar PV plant over conventional SCADA-based monitoring.
3. Assess the feasibility of block chain-based peer-to-peer energy trading using IoT smart meters in a residential microgrid.

L6: Create

1. Design a complete IoT-based energy management system for a 500-student college campus integrating smart metering for all departments, solar PV monitoring, automated demand response, real-time dashboard, and mobile alerts — specifying hardware, software, communication, and expected energy savings.
2. Develop an IoT-based predictive maintenance system for industrial motors using vibration, temperature, and current sensors, cloud-based ML anomaly detection, and automated alert and work-order generation.
3. Formulate a cyber security framework for an IoT-connected smart grid distribution network specifying device authentication, encrypted communication, intrusion detection, and incident response procedures based on IEC 62351 standards.

Chairperson
Board of Studies (EEE)

R24EEOE19 **Concepts of Power Quality** **3 0 0 3**

(Open Elective-IV)

Course Objectives:

The main objectives of the course is to

1. Significance of power quality and power quality parameters
2. Types of transient over voltages and protection of transient voltages
3. Harmonics, their effects, harmonic indices and harmonic minimization techniques
4. Provide knowledge of power quality monitoring, standards, and measurement techniques
5. The power quality monitoring concepts and the usage of measuring instruments

Course Code	Course Outcomes	Mapping with POs and PSOs												DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE19.1	Identify the issues related to power quality in power systems.	3	2	–	–	1	1	–	–	–	–	1	2	1	L1,L2
R24EEOE19.2	Address the problems of transient and long duration voltage variations in power systems	3	3	1	2	2	1	–	–	–	–	1	3	1	L1, L3
R24EEOE19.3	Analyze the effects of harmonics and study of different mitigation techniques.	3	3	2	2	2	1	–	–	–	–	1	3	2	L2,L4
R24EEOE19.4	Evaluate power factor correction methods and reactive power compensation techniques.	3	2	3	2	2	2	–	–	–	1	1	3	2	L2, L4
R24EEOE19.5	Apply power quality standards, monitoring techniques, and mitigation solutions in practical systems.	3	2	2	3	3	2	1	1	2	1	2	3	3	L2,L3

SYLLABUS

Unit –I: Introduction to Power Quality **14 Hours**

Overview of power quality – Concern about the power quality – General classes of power quality and voltage quality problems – Transients – Long–duration voltage variations – Short–duration voltage variations – Voltage unbalance – Waveform distortion – Voltage fluctuation – Power

frequency variations- Power quality terms – Voltage sags, Voltage swells, harmonics interruptions, voltage flicker and voltage spikes – Sources of voltage sag, swell and interruptions – Nonlinear loads.

Self-Learning Topics: Smart grid power quality challenges **CO's: CO1**

Unit –II: Transient and Long Duration Voltage Variations 12 Hours

Source of transient over voltages – Principles of over voltage protection – Devices for over voltage protection – Utility capacitor switching transients. Principles of regulating the voltage – Device for voltage regulation – Utility voltage regulator application – Capacitor for voltage regulation — Regulating utility voltage with distributed resources

Self-Learning Topics: End–user capacitor application **CO's: CO2**

Unit –III: Harmonic distortion and solutions 10 Hours

Voltage distortion vs. Current distortion – Harmonics vs. Transients – Harmonic indices – Sources of harmonics – Effect of harmonic distortion – Impact of capacitors, transformers, motors and meters – Point of common coupling – Passive and active filtering

Self-Learning Topics: Design of passive and active filters **CO's: CO3**

Unit –IV: Power Factor and Reactive Power Compensation 10 Hours

Power factor concepts – Causes of low power factor – Effects of poor power factor – Power factor correction methods – Capacitor banks and synchronous condensers – Reactive power compensation – Economic benefits of power factor improvement

Self-Learning Topics: Voltage regulation techniques **CO's: CO4**

Unit –V: Power Quality Monitoring and Mitigation 10 Hours

Power quality monitoring instruments – Data acquisition and analysis – IEEE and IEC power quality standards – Voltage regulators and UPS systems – Dynamic Voltage Restorer (DVR) – Distribution Static Compensator (DSTATCOM)

Self-Learning Topics: Power quality analyzers **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Electrical Power Systems Quality, Dugan R C, McGranaghan M F, Santoso S, and Beaty H W, Second Edition, McGraw–Hill, 2012, 3rd edition.
2. Electric power quality problems –M.H.J.Bollen IEEE series-Wiley India publications,2011
3. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M H J,

First Edition, IEEE Press; 2000.

Reference Books:

1. Power Quality Primer, Kennedy B W, First Edition, McGraw–Hill, 2000.
2. Understanding Power Quality Problems: Voltage Sags and Interruptions, Bollen M HJ, First Edition, IEEE Press; 2000.
3. Power System Harmonics, Arrillaga J and Watson N R, Second Edition, John Wiley& Sons, 2003
4. Electric Power Quality control Techniques, W. E. Kazibwe and M. H. Sendaula, VanNostrad Reinhold, New York.
5. Power Quality C.Shankaran, CRC Press, 2001
6. Harmonics and Power Systems –Franciso C.DE LA Rosa–CRC Press (Taylor &Francis)

Web References:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee103

https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee56

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	30
L3	30	30
L4	---	40
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. problems List different power quality
2. What are the objectives of power quality improvement?
3. List methods of power factor correction
4. What is Total Harmonic Distortion (THD)?
5. Define waveform distortion

L2: Understand

1. State the importance of power quality standards
2. Explain the causes of poor power quality.
3. Explain the concept of power quality and discuss its importance in modern power systems.
4. State the importance of monitoring instruments
5. Discuss harmonic mitigation techniques in detail

L3: Apply

1. Appply the causes and consequences of poor power quality in industrial systems.
2. Explain static VAR compensators and their application
3. Explain the effects of harmonics on electrical equipment and power system performance.
4. Compare different power factor improvement techniques.

L4: Analyzing

1. Analyze the impact of harmonics on electrical equipment
2. Evaluate the performance of capacitor banks and FACTS devices in improving power quality.
3. Analyze the operation and applications of DVR and DSTATCOM.
4. Evaluate the effectiveness of various harmonic reduction methods in industrial power systems.

Chairperson
Board of Studies (EEE)

R24EEOE20 **Concepts of Programmable Logic Controllers** **3 0 0 3**

(Open Elective-IV)

Course Objectives:

The main objectives of the course are to

1. To understand the architecture, components, and programming concepts of Programmable Logic Controllers.
2. To develop PLC programs using ladder diagram instructions, contacts, coils, and Boolean algebra.
3. To apply timer and counter instructions for industrial automation and sequencing applications.
4. To implement data manipulation, program control, and math instructions in PLC programs.
5. To design PLC-based control solutions for real-world industrial and process control applications.

Course Outcomes:

At the end of the course, students will be able to:

Course Code	Course Outcomes	Mapping with POs and PSOs													DoK
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
R24EEOE20.1	Describe the architecture of PLC systems, I/O modules, CPU, and programming formats and construct basic PLC ladder diagrams.	2	1	-	-	2	-	-	-	-	-	1	3	1	L1, L2
R24EEOE20.2	Develop PLC programs using input/output instructions, contacts, coils, and Boolean algebra to solve digital logic problems.	2	2	-	-	3	-	-	-	-	-	1	3	2	L2, L3
R24EEOE20.3	Apply timer and counter instructions including on-delay, off-delay, retentive timers,	2	2	2	1	3	-	-	-	-	-	1	3	2	L3, L4

	up/down counters and cascading counters for automation tasks.														
R24EEOE20.4	Implement program control instructions including MCR, jump/subroutines, data manipulation, data transfer, comparison and math instructions.	2	2	1	1	3	-	-	-	-	-	1	3	2	L3, L4
R24EEOE20.5	Design PLC-based solutions for real-world applications such as water level control, conveyor systems, parking garages and PID process control.	2	3	3	2	3	2	-	2	1	-	2	3	3	L5, L6

SYLLABUS

Unit –I: Introduction PLC Basics: **10 Hours**

PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules.

Self-Learning Topics: History and Evolution of PLCs: From Relay Logic to Modern PLC Systems

CO's: CO1

Unit –II: PLC Programming: **12 Hours**

Input instructions, outputs, operational procedures, programming examples using contacts and coils. Digital logic gates, programming in the Boolean algebra system, conversion examples. Ladder diagrams and sequence listings, ladder diagram construction.

Self-Learning Topics: IEC 61131-3 Programming Languages: Structured Text and Function Block Diagram

CO's: CO2

Unit –III: Programmable Timers and Counters: **12 Hours**

Timer instructions – On delay timer instruction – Off delay timer instruction – Retentive timer – Counter instructions – Up counter – Down counter – Cascading counters – Incremental encoder – Counter applications – Combining counter and timer functions.

Self-Learning Topics: High-Speed Counters and their Applications in Motion Control Systems

CO's: CO3

Unit –IV: Program Control Instructions: 12 Hours

Master control reset instruction – Jump instructions and subroutines – Immediate input and output instructions. Data manipulation – Data transfer operation – Data compare instruction – Data manipulation programs – Numerical data I/O interfaces – Math instructions – Addition, subtraction, multiplication.

Self-Learning Topics: PLC Communication Protocols: Modbus, Profibus and Industrial Ethernet for SCADA Integration **CO's: CO4**

Unit –V: Applications: 14 Hours

Control of water level indicator – Alarm monitor – Conveyor motor control – Parking garage – Ladder diagram for process control – PID controller.

Self-Learning Topics: Industry 4.0 and PLCs: Integration with IoT, SCADA and Cloud-based Monitoring **CO's: CO5**

Board of Studies: Electrical & Electronics Engineering

Approved in BOS No: 03,

Approved in ACM No: 03

Text Books:

1. Programmable Logic Controllers – Frank D. Petruzella, McGraw Hill, 5th Edition, 2017.
2. Programmable Logic Controllers – W. Bolton, Elsevier Newnes, 5th Edition, 2015.

Reference Books:

1. PLC Programming Using RSLogix 500 – Nathan Clarke, Independently Published, 2018.
2. Industrial Automation and Robotics – A.K. Gupta, S.K. Arora, Laxmi Publications, 2011.
3. Automating Manufacturing Systems with PLCs – Hugh Jack, 2014.
4. Introduction to Programmable Logic Controllers – Gary Dunning, Cengage Learning, 3rd Edition, 2005.

Web References:

1. https://nptel.ac.in/courses/108105088
2. https://nptel.ac.in/courses/108105063

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	40	---
L2	30	---
L3	30	
L4	---	40
L5	---	40
L6	---	20
Total (%)	100	100

Sample Short and Long Answer Questions of Various Cognitive Levels

L1: Remember

1. Define PLC and list its basic components.
2. State the types of timers available in a PLC and list their functions.
3. List the types of counter instructions in PLC programming.
4. Define ladder diagram and identify the basic elements used in it.
5. List the programming formats supported by PLCs.

L2: Understand

1. Explain the working principle of a PLC system with a neat block diagram.
2. Describe the difference between on-delay and off-delay timer instructions with examples.
3. Explain the operation of the Master Control Reset (MCR) instruction.
4. Describe the data transfer and data compare instructions in PLC programming.
5. Explain structured versus unstructured data in IoT and give two examples from electrical engineering.

L3: Apply

1. Develop a PLC ladder diagram for a conveyor belt control system with forward, stop, and reverse functions.
2. Write a PLC program to control a water level indicator using on-delay timer and up-counter instructions.
3. Implement a Boolean algebra expression using PLC contacts and coils and draw its equivalent ladder diagram.
4. Design a PLC ladder diagram for a traffic light control system using timers.

L4: Analyze

1. Analyze the difference between retentive and non-retentive timer instructions with ladder diagram examples.
2. Compare up counter and down counter instructions with respect to count values and reset conditions.
3. Examine the use of jump and subroutine instructions in optimizing PLC program execution.
4. Analyze a PLC-based alarm monitoring system and evaluate its ladder logic implementation.

L5: Evaluate

1. Evaluate the suitability of PID controller implementation in a PLC for a given process control application.
2. Justify the selection of cascading counters over a single counter for high-count industrial applications.
3. Assess the advantages and limitations of using PLCs over relay-based control systems in industry.

L6: Create

1. Design a complete PLC-based parking garage control system with entry/exit counters, indicator lights, and barrier control using timers, counters, and math instructions.
2. Develop a PLC ladder diagram program for a multi-station conveyor system with interlocking, fault detection, and alarm annunciation.
3. Create a PLC program for a process control application using PID instructions, specifying the setpoint, process variable input, and control output interface.

Chairperson
Board of Studies (EEE)