Course Structure
&
Detailed Syllabus

M. Tech.
Power Systems

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

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

AVANTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
(Autonomous)

Vision and Mission of the Institute

Vision: To develop highly skilled professionals with ethics and human values.

Mission:

- To impart quality education with industrial exposure and professional training
- To produce competent and highly knowledgeable engineers with positive approach
- To induce self confidence among students which is an imperative pre-requisite to face the challenges of life

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

AVANTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
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Vision and Mission of the Department

Vision:

To emerge as a Center of Excellence for disseminating knowledge and research in the area of Electrical and Electronics Engineering.

Mission:

The Mission of the Department of Electrical & Electronics Engineering is to:

M1:

Impart quality education for addressing the needs of present & emerging technological world.

M2:

Interact with industry and research organizations to provide a unique set of well- rounded learning skills.

M3:

To enable graduates to take on the mantle of higher responsibilities in the domain of Electrical Engineering.

M4:

To produce competent and highly knowledgeable engineers with positive approach and self-confidence to face the challenges of life.

Program Educational Objectives (PEOs)

PEO1:

To impart education and train graduate engineers in the field of power Electronics to meet the emerging needs of society.

PEO2:

To provide knowledge and skill in the development of controls and drives to meet varied applications.

Program Outcomes (POs)

PO1: Demonstrate knowledge with ability to select, learn and apply appropriate techniques, skills and modern engineering tools to solve engineering problems appropriate to the relevant discipline.

PO2: Analyze engineering problems critically, conceptualize, design, implement and evaluate potential solutions to contribute to the development of scientific/technological solutions in the context of relevant discipline.

PO3: Independently carry out research /investigation and development work to solve practical problems.

PO4: Function effectively as an individual and in a team to possess knowledge and recognize opportunities for career progression and research.

PO5: Communicate effectively in professional practice through verbal and written formats.

PO6: Recognize the need for self-motivated pursuit of knowledge to show commitment and competence in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO 1:

Apply technical knowledge, skill and analytical ability to design, develop and test power electronic converters and drives using modern tools and technologies.

PSO 2:

Solve the real world problems in the emerging fields like smart grid, renewable energy interfaces, and electric vehicles and to develop innovative technologies relevant to social, ethical, economic and environmental issues.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Structure **Program: M.Tech-Power Systems**

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

I Year I Semester- Course Structure **Regulation: R24**

S.No	Category	Course Code	Course Name	L	T	P	C
1	PC	MTPS1101	**Professional Core-1** Power System Operation & Control	3	0	0	3
2	PC	MTPS1102	**Professional Core-2** Analysis of Power Electronic Converters	3	0	0	3
3	PE	MTPS11031 MTPS11032 MTPS11033	**Professional Elective-1** 1. Electrical Distribution Automation 2. Control and Integration of Renewable Energy sources 3. Power System Deregulation	3	0	0	3
4	PE	MTPS11041 MTPS11042 MTPS11043	**Professional Elective-2** 1. HVDC Transmission 2. Digital Power Systems Protection 3. Power System Reliability	3	0	0	3
5	CC	MTCC1105	Research Methodology and IPR	2	0	0	2
6	LB	MTPS1106	**Laboratory-1** Power System Simulation Laboratory -1	0	0	4	2
7	LB	MTPS1107	**Laboratory-2** Power Systems Laboratory	0	0	4	2
8	AC	MTAC1108 MTAC1109	**Audit Course-1** 1. English for Research Paper Writing 2. Disaster Management	2	0	0	0
			Total	16	0	8	18

Category	Courses	Credits
PC: Professional Core Course	2	6
PE: Professional Elective Course	2	6
CC: Compulsory Course	1	2
LB: Laboratory Course	2	4
AC: Audit Course	1	0
Total	8	18

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Structure **Program: M.Tech-Power Systems**

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

I Year II Semester- Course Structure **Regulation: R24**

S.No	Category	Course Code	Course Name	L	T	P	C
1	PC	MTPS1201	**Professional Core-3** Power System Dynamics and Stability	3	0	0	3
2	PC	MTPS1202	**Professional Core-4** Real Time Control of Power Systems	3	0	0	3
3	PE	MTPS12031 MTPS12032 MTPS12033	**Professional Elective-3** 1. EHVAC Transmission 2. Flexible AC Transmission Systems 3. Electric Vehicles & Design	3	0	0	3
4	PE	MTPS12041 MTPS12042 MTPS12043	**Professional Elective-4** 1. Generation & Measurement of High Voltages 2. Evolutionary Algorithms and Applications 3. Programmable Logic Controllers & Applications	3	0	0	3
5	CC	MTCC1205	**Laboratory-3** Power System Simulation Laboratory-2	0	0	4	2
6	LB	MTPS1206	**Laboratory-4** Power Converters Laboratory	0	0	4	2
7	PR	MTPS1207	Technical Seminar/Mini Project	0	0	4	2
8	AC	MTAC1208 MTAC1209	**Audit Course-2** 1. Constitution of India 2. Pedagogy Studies	2	0	0	0
			Total	14	0	12	18

Category	Courses	Credits
PC: Professional Core	2	6
PE: Professional Elective	2	6
LB: Laboratory	2	4
PR: Project	1	2
AC-Audit Course	1	0
Total	8	18

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Structure- Program: M.Tech-Power Systems

(Applicable from the academic year 2024-25 onwards)

II Year I Semester- Course Structure **Regulation: R24**

S.No	Category	Course Code	Course Name	L	T	P	C
1	PE	MTPS21051 MTPS21052 MTPS21053	**Professional Elective - V** 1. Energy Audit Conservation & Management 2. Smart Grid Technologies 3. Power Quality and Custom Power Devices	3	0	0	3
2	OE	MTPS2104	**Open Elective** 1. MOOCs-2 (NPTEL/SWAYAM)-Any 12 Week Course on Engineering/ Management/ Mathematics offered by other than parent department) 2. Course offered by other departments in the college	3	0	0	3
3	PJ	MTPS2105	**Dissertation-I / Industrial Project #**	0	0	20	10
			Total	**6**	**0**	**20**	**16**

Category	Courses	Credits
PC-Professional Core Course	1	3
OE-Open Elective Course	1	3
PJ- Project	1	10
Total	3	16

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

Course Structure- Program: M.Tech-Power Systems

(Applicable from the academic year 2024-25 onwards)

II Year II Semester- Course Structure **Regulation: R24**

S.No	Category	Course Code	Course Name	L	T	P	C
1	PJ	MTPS2201	Dissertation-II	0	0	32	16
			Total	0	0	32	16

Category	Courses	Credits
PR-Project	1	16
Total	**1**	**16**

Open Electives offered by the Department of EEE

1. Renewable Energy Sources
2. Battery Management Systems and Charging Stations
3. Concepts of Power System Engineering
4. Applications of Power Converters

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MTPS1101 POWER SYSTEM OPERATION & CONTROL 3 0 0 3

Course Objectives:

1. To study the unit commitment problem for economic load dispatch.
2. To study the load frequency control of single area and two area systems with and without control.
3. To analyze two –area load frequency control in controlled and uncontrolled cases
4. To study the effect of generation with limited energy supply.
5. To study the effectiveness of interchange evaluation in interconnected power systems.

Course Code	Course Outcomes	Mapping with POs and PSOs					Dok
		PO1	PO2	PO3	PS01	PS02	
MTPS1101.1	Determine the unit commitment problem for economic load dispatch	2	3	-	2	2	L2,L5
MTPS1101.2	Explain the need of keeping frequency constant and design the block diagram for single area control	1	2	2	3	1	L3,L4
MTPS1101.3	Analyze two –area load frequency control in controlled and uncontrolled cases	2	-	2	1	2	L3,L5
MTPS1101.4	Analyze the generation with limited energy supply	3	2	1	2	2	L2,L3
MTPS1101.5	Determine the interchange evaluation in interconnected power systems	1	2	2	2	1	L4,L5

SYLLABUS

UNIT – I: Unit commitment problem and optimal power flow solution **12 hours**

Unit commitment: Constraints in UCP, UC solution methods. Priority list method, Introduction to Dynamic programming Approach. Optimal power flow: OPF without inequality constraints, inequality constraints on controlvariables and dependent variables. **COs – CO1**

Self-Learning Topics: Shut Down Rule

UNIT – II: Single area Load Frequency Control **12 hours**

Necessity of keeping frequency constant, Definition of control area, single area control, Block diagram representation of an isolated Power System, Steady State analysis, Dynamic response-Uncontrolled case. Proportional plus Integral control of single area and its block diagram representation, steady state response. **COs – CO2**

Self-Learning Topics: Mathematical Modelling of LFC

UNIT – III: Two areas Load Frequency Control **12 hours**

Load frequency control of two-area system, uncontrolled case and controlled case, tie-line bias control, steady state representation. Optimal two-area Load Frequency control- performance Index and optimal parameter adjustment. Load frequency control and Economic dispatch control.

Self-Learning Topics: Two Area Block Diagram **COs– CO3**

UNIT- IV: Generation with limited Energy supply **10 hours**

Take-or-pay fuel supply contract, composite generation production cost function. Solution by gradient search techniques, hard limits and slack variables,Fuel scheduling by linear programming.

COs– CO4

Self-Learning Topics: Cost Function for Power Generation

UNIT-V: Interchange Evaluation and Power Pools Economy Interchange **10 hours**

Economy interchange Evaluation, Interchange Evaluation with unit commitment, Multiple Interchange transactions, other types of Interchange, power pools, transmission effects and issues.

COs – CO5

Self-Learning Topics: Power Pools

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Approved in ACM No: 01

Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Power system Operation and Control	CO1–CO5	PO1, PO2,PO3,PSO1, PSO2
2. SCADA in Power systems	CO1–CO5	PO1, PO2,PO3,PSO1, PSO2

Text Books:

1. Power Generation, Operation and Control - by A.J.Wood and F.Wollenberg, John wiley& sonsInc. 1984.
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 operation and control PSR Murthy B.S publication.
2. Electrical Energy Systems Theory - by O.I.Elgerd, Tata McGraw-Hill Publishing Company Ltd, 2nd edition.
3. Reactive Power Control in Electric Systems - by TJE Miller, John Wiley & sons.

Web References:

1. https://archive.nptel.ac.in/courses/108/104/108104052/
2. https://archive.nptel.ac.in/courses/108/101/108101040/#

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Why you have to study the Unit Commitment problem for power system operation?
2. Justify the need of Unit Commitment solution methods. List the methods.
3. Using dynamic programming method to determine the most economical units to be committed to supply a load of 6 MW. There are three units with the following data. C1=0.8 P1 2 +22 P1, C2=0.85P2 2 +21P2 and C3=0.8P3 2 +20P3 . The maximum and minimum capacities of each unit are 5 MW and 1 MW respectively.
4. Why you have to maintain constant frequency of a given power system? Justify with

suitable example for each reason.

5. Define the control area concept. Give example for Indian Power system scenario.
6. Prove that the change in frequency is zero under steady state condition with neat block diagram.
7. A 300MVA synchronous generator is operating at 1500 rpm, 50Hz. A load of 70MW is suddenly applied to the machine and the station valve to the turbine opens only after 0.37 sec due to the time lag in the generator action. Calculate the frequency to which the generated voltage drops before the steam flow commences to increase to meet the new load. Given that the valve of H of the generator is 3.7 kW sec per kVA of the generator energy. Comment on the results.
8. What are the basic principles of pool operation for interconnected power system?
9. Derive the expression for change in tie line power for interconnected power system and draw its block diagram?
10. Define tie line bias control and write its expression
11. The two control areas of capacity 2,000 and 8,000 MW are interconnected through a tie line. The parameters of each area based on its own capacity base are R = 1 Hz/p.u. MW and B = 0.02 p.u. MW/Hz. If the Control area-2 experiences an increment in load of 180 MW, determine the static frequency drop and the tie-line power. Comment on the result.
12. When the take or pay fuel of agreement is needed of a given power system?
13. What is meant by hard limits and slack variable and write its necessary expressions?
14. Explain the procedure for interchange evaluation with unit commitment approach.
15. What is meant by power pool and list out its merits and demerits?

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MTPS1102 ANALYSIS OF POWER ELECTRONIC CONVERTERS 3 0 0 3

Course Objectives:

1. To understand the control principle of ac to ac conversion with suitable power semi - Conductor devices.
2. To have the knowledge of ac to dc conversion and different ac to dc converter topologies.
3. To understand the effect of operation of controlled rectifiers on p.f. and improvement of p.f. with PFC converters
4. To acquire the knowledge on dc-ac converters and to know the different control Techniques of dc-ac converters.
5. To know multilevel inverter configuration to improve the quality of the inverter output Voltage.

Course Code	Course Outcomes	Mapping with POs and PSOs					DoK
		PO1	PO2	PO3	PSO1	PSO2	
MTPS1102.1	Describe and analyze the operation of AC-DC converters	2	1	2	2	2	L2,L4
MTPS1102.2	Analyze the operation of power factor correction converters.	-	3	1	2	1	L3,L5
MTPS1102.3	Analyze the operation of three phase inverters with PWM control	3	2	2	1	1	L4,L5
MTPS1102.4	Study the principles of operation of multi- level inverters and their applications.	2	2	-	3	2	L2,L3
MTPS1102.5	Analyze the quality of the inverter output Voltage.	2	-	2	1	2	L3,L5

SYLLABUS

UNIT– I

Overview of Switching Devices: **8 Hours**

Power MOSFET, IGBT, GTO, GaN devices-static and dynamic characteristics, gate drive circuits for switching devices. **COs – CO1**

Self-Learning Topics: Thyristor Protection

UNIT– II **12 Hours**

AC-DC converters: Single phase fully controlled converters with RL load– Evaluation of input power Factor and harmonic factor- Continuous and Discontinuous load current, Power factor improvements, Extinction angle control, symmetrical angle control, PWM control. Three Phase AC-DC Converters, fully Controlled converters feeding RL load with continuous and discontinuous load current, Evaluation of input power factor and harmonic factor-three phase dual converters.

COs – CO2

Self-Learning Topics: Speed control of AC motors

UNIT– III **12 Hours**

Power Factor Correction Converters: Single-phase single stage boost power factor corrected rectifier, Power circuit principle of operation, and steady state- analysis, three phase boost PFC converter. **COs – CO3**

Self-Learning Topics: Reactive power

UNIT– IV **12 Hours**

PWM Inverters: Principle of operation-Voltage control of single phase inverters - sinusoidal PWM –Modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and Delta modulation. Voltage Control of Three-Phase Inverters- Sinusoidal PWM-600PWM- Third Harmonic PWM- Space Vector Modulation- Comparison of PWM Techniques-Three phase current source inverters-Variable dc link inverter. **COs – CO4**

Self-Learning Topics: Filters

UNIT– V **12 Hours**

Multi level inverters: Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying-Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation-Features of Cascaded Inverter-Switching Device Currents-DC-Link Capacitor Voltage Balancing-Features of Multilevel Inverters-Comparisons of Multilevel Converters. **COs – CO5**

Self-Learning Topics: CSI, VSI

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

Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Three Phase AC-DC Converters	CO1–CO5	PO1,PO2,PO3, PSO1 PSO2
2. Types of Multilevel Inverters	CO1–CO5	PO1,PO2,PO3, PSO1 PSO2

Text Books:

1 Power Electronics: Converters, Applications, and Design- Ned Mohan, Tore M.
2 Undeland, William P. Robbins, John Wiley& Sons, 2nd Edition, 2003.
3 Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First IndianReprint-2008.

Reference Books:

1. Power Electronics Daniel W. Hart - McGraw-Hill, 2011
2. Elements of Power Electronics – Philip T. Krein, Oxford University press, 2014.
3. Power Converter Circuits – William Shepherd & Li Zhang-Yes Dee CRC Press, 2004.

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

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)

L1 L2	20	20
L3 L4	40	40
L5 L6	40	40
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

1. Draw the load current waveforms PWM control based1_ phase ac voltage controller with R and R-L loads.
2. Explain the operation of a three-phase full-wave bidirectional connected to star connected resistive load. Draw necessary voltage and current waveforms with $\alpha = 600$.
3. Discuss extinction angle control method for power factor improvement of a single phase full-converter
4. Discuss the operation of ac voltage controller with PWM control.
5. Give examples for resistive –inductive loads.
6. A three phase ac voltage controller feeds a balanced star connected R-L load. The Value of resistance is 10 _ and inductance is 6.5mH. The controller is fed from a 3-Phase supply of 400V, 50Hz. Determine for a firing angle of 300, the values of i) rms load current ii) rms load voltage iii) Power factor.
7. A single-phase full-wave ac voltage controller controls power flow from a 230V, 60Hz ac source into a resistive load. The maximum desired output power is 10kW. Calculate i) The maximum rms current rating of thyristors ii) The peak current of thyristors iii) the peak value of thyristor voltage.
8. What are full converters? With a neat diagram and waveforms, explain the operation of a single phase full converter with RL load.
9. Single phase full converter connected to a 120 V, 60 Hz supply. The load current Ia is continuous and its ripple content is negligible. The turn's ratio of the transformer is unity. a) Express the input current in a Fourier series; also determine the harmonic factor of the input current, Displacement factor, and input power factor
10. With a neat schematic diagram, discuss the operation of a Single-phase single stage boost power factor corrected rectifier.
11. Describe the working of single phase half bridge inverter with RL load. What is its main drawback?
12. With an appropriate power diagram discuss the principle of working of a three phase inverter. Draw the waveforms on the each thyristor conduct for 1800 and the resistive load is star connected.

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MTPS11031 **ELECTRICAL DISTRIBUTION AUTOMATION** **3 0 0 3**

Course Objectives:

1. To learn the importance of economic distribution of electrical energy.
2. To analyze the distribution networks for V-drops, P_{Loss}calculations and reactive power.
3. To understand the co-ordination of protection devices.
4. To impart knowledge of capacitive compensation/voltage control.
5. To understand the principles of voltage control.

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO5	PS01	PS02	
MTPS11031.1	Analyze a type of distribution system.	2	-	3	2	2	2	L3,L4
MTPS11031.2	Design the types of distribution feeders and their loading effects	1	2	2	-	2	3	L3,L5
MTPS11031.3	Identify the protective systems and their co-ordination	3	1	2	-	2	3	L2,L4
MTPS11031.4	Improve power factor by capacitive compensation.	-	2	3	1	3	2	L2,L3
MTPS11031.5	Understand about the Distribution automation	2	-	2	3	2	3	L3,L5

SYLLABUS

UNIT– 1 General: Introduction to Distribution systems **12 Hours**

An overview of the role of computers in distribution system planning-Load modeling and characteristics - definition of basic terms like demand factor, utilization factor, load factor, plant factor, diversity factor, coincidence factor, contribution factor and loss factor-Relationship between the load factor and loss factor - Classification of loads (Residential, Commercial, Agricultural and Industrial) and their characteristics. **COs – CO1**

Self-Learning Topics: Classification of Loads

UNIT– 2 Distribution Feeders and Substations **12 Hours**

Design consideration of Distribution feeders: Radial and loop types of primary feeders, voltage levels, and feeder-loading. Design practice of the secondary distribution system. Location of Substations: Rating of a Distribution Substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations. **COs – CO2**

Self-Learning Topics: Substation types

UNIT – III: Protective devices and coordination **12 Hours**

Objectives of distribution system protection, types of common faults and procedure for fault calculation. Protective Devices: Principle of operation of fuses, circuit reclosers, line sectionalizer and circuit breakers. Coordination of protective devices: General coordination procedure; types of coordination. **COs– CO3**

Self-Learning Topics: Different Types of Protection systems in Power system

UNIT- IV: Capacitive compensation for power factor control **12 Hours**

Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched), power factor correction, capacitor location. Economic justification. Procedure to determine the best capacitor location. Voltage control: Equipment for voltage control, effect of series capacitors, effect of AVB/AVR, line drop compensation. **COs– CO4**

Self-Learning Topics: Reactive Power compensation

UNIT-V: Distribution automation functions **12 Hours**

Electrical system automation, EMS functional scope, DMS functional scope functionality of DMS-Steady state and dynamic performance improvement; Geographic information systems- AM/FM functions and Database management; communication options, supervisory control and data acquisition: SCADA functions and system architecture; Synchro phasors and its application in power systems. **COs – CO5**

Self-Learning Topics: Automation systems

Board of Studies: Electrical and Electronics Engineering
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Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. SCADA	CO1–CO5	PO1, PO2,PO3,PSO1, PSO2
2. Substation operation and design	CO1–CO5	PO1, PO2,PO5,PSO1, PSO2

Text Books:

1. Electric Power Distribution System Engineering by Turan Gonen, McGraw-Hill Book Company, 1986.
2. Distribution System Analysis and Automation, by Juan M. Gers, The Institution of Engineering and Technology, UK 2014.

Reference Books:

1. Electric Power Distribution-by A.S.Pabla, Tata McGraw-Hill Publishing Company, 4thedition, 1997.
2. Electrical Distribution V.Kamaraju-McGraw Hill
3. Handbook of Electrical Power Distribution – Gorti Ramamurthy-Universities press

Web References:

1. https://archive.nptel.ac.in/courses/108/107/108107112/
2. https://onlinecourses.nptel.ac.in/noc22_ee35/preview

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Explain briefly about the different types of distribution sub transmission system

2. Write briefly about factors affecting the primary feeder loading.
3. Explain the following terms:

a. Utilization Factor (ii) Contribution factor (iii) Diversity Factor

4. Write briefly about factors effecting the primary feeder rating
5. Explain detail description of the distribution transformer loading.
6. Explain the forward sweep distribution load flow algorithm.
7. Explain the approximate line segment modelling in distribution system.
8. Derive an expression for voltage drop and power loss for uniformly radial type distribution load.
9. Consider a three phase, 3 wire 240V secondary system with balanced loads at A, B and C as shown in Figure (1) Determine: (i) The voltage drop in one phase of lateral (ii) The real power per phase for each load (iii) The reactive power per phase for each load.

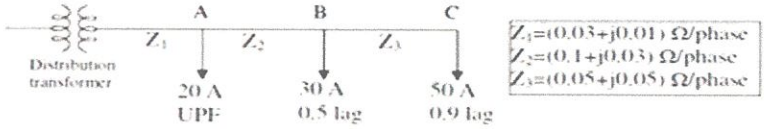


Figure (1)

10. Derive equations for the K constants in distribution load systems.
11. Write briefly about radial feeder uniformly distributed loads.
12. Explain different types of three phase capacitor bank connections.
13. Write briefly about the distribution feeder cost calculation methods.
14. Explain about SCADA functions and system architecture
15. Explain about Synchro phasors and its application in power systems

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MTPS11032 Control and Integration of Renewable Energy Sources 3 0 0 3

Course Objectives:

1. Understand different renewable energy sources and storage devices.
2. Model and simulate renewable energy sources.
3. Analyze and simulate control strategies for grid connected and off-grid systems
4. Develop converters to comply with grid standards to obtain grid integration.
5. Understand operation & control of hybrid energy Systems

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO4	PSO1	PSO2	
MTPS11032.1	Understand state estimation, security and contingency evaluation	2	-	2	3	2	1	L2,L5
MTPS11032.2	Analyze the performance characteristics of various dynamic energy conversion technologies, including their efficiency, power output, and operational limits.	2	3	1	-	3	2	L3,L4
MTPS11032.3	Utilize simulation software and modelling tools to predict the behaviour and performance of static energy conversion systems under various conditions.	3	1	-	2	1	3	L3,L5
MTPS11032.4	Design control systems for various applications, considering constraints such as noise, delays, and nonlinearity.	2	2	3	-	2	2	L2,L3
MTPS11032.5	Understand operation & control of hybrid energy systems and various standards , codes.	2	1	-	2	2	1	L4,L5

SYLLABUS

UNIT– I **10 Hours**

Introduction: Renewable Sources of Energy; Distributed Generation; Renewable Energy Economics - Calculation of Electricity Generation Costs; Demand-Side Management Options; Supply-Side Management Options; Control of renewable energy based power Systems.**COs – CO1**

Self-Learning Topics: Renewable Energy Sources

UNIT– II **10 Hours**

Induction Generators: Principles of Operation; Representation of Steady-State Operation; Power and Losses Generated - Self-Excited Induction Generator; Magnetizing Curves and Self-Excitation - Mathematical Description of the Self-Excitation Process; Interconnected and Stand-alone operation - Speed and Voltage Control. **COs – CO2**

Self-Learning Topics: Types of Turbines

UNIT – III: **10 Hours**

Wind Power Plants: Site Selection; Evaluation of Wind Intensity; Topography; Purpose of the Energy Generation- General Classification of Wind Turbines; Rotor Turbines; Multiple-Blade Turbines; Drag Turbines; Lifting Turbines - Generators and Speed Control Used in Wind Power

Energy; Analysis of Small wind energy conversion system-Doubly fed induction generator(DFIG)-Permanent magnet synchronous generator (PMSG). **COs– CO3**

Self-Learning Topics: Solar modules

UNIT- IV: 10 Hours

Photovoltaic Power Plants: Solar Energy; Generation of Electricity by Photovoltaic Effect; Dependence of a PV Cell on Temperature and irradiance input-output Characteristics - Equivalent Models and Parameters for Photovoltaic Panels; MPPT schemes: P&O, INC, effect of partial shaded condition. Applications of Photovoltaic Solar Energy-Economical Analysis of Solar Energy **COs– CO4**

Self-Learning Topics: basics of control systems

UNIT-V: 10 Hours

Fuel Cells: The Fuel Cell; Low- and High-Temperature Fuel Cells; Commercial and Manufacturing Issues - Constructional Features of Proton Exchange-Membrane Fuel Cells; Reformers; Electrolyser Systems; Advantages and Disadvantages of Fuel Cells - Fuel Cell Equivalent Circuit; Practical Determination of the Equivalent Model Parameters; Aspects of Hydrogen for storage **COs – CO5**

Self-Learning Topics: ON-Grid & Off-Grid solar systems

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

Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Energy control centers	CO1–CO5	PO1, PO2,PO3,PSO1, PSO2
2. Communication options for PMUs	CO1–CO5	PO1, PO2,PO3,PSO1, PSO2

Text Books:

1. Renewable and Efficient Electric Power Systems, G. Masters, IEEE-John Wiley and Sons Ltd. Publishers, 2013,2nd Edition.
2. Microgrids and Active Distribution Networks, S. Chowdhury, S. P. Chowdhury, P. Crossley,IET Power Electronics Series, 2012.
3. Integration and Control of Renewable Energy in Electric Power System, Ali Keyhani Mohammad Marwali, Min Dai, John Wiley publishing company, 2010, 2nd Edition.

Reference Books:

1. Solar Photovoltaic: Fundamentals, technologies & Applications, Chetan Singh Solanki, PHI Publishers, 2019, 3rd Edition.
2. Solar PV Power: Design, Manufacturing and Applications from Sand to Systems, Rabindra Kumar Satpathy, Venkateswarlu Parmuru, Academic Press, 2020.
3. Control of Power Inverters in Renewable Energy and Smart Grid Integration, Quing-Chang Zhong, IEEE-John Wiley and Sons Ltd. Publishers, 2013,1st Edition.
4. Power Conversion and Control of Wind Energy Systems, Bin Wu, Yongqiang Lang, NavidZargari, IEEE- John Wiley and Sons Ltd. Publishers,2011,1st Edition.
5. Report on "Large Scale Grid Integration of Renewable Energy Sources - Way Forward" Central Electricity Authority, GoI, 2013.

Web References:

1. https://nptel.ac.in/courses/108/102/108102145/

2. https://nptel.ac.in/courses/103/103/103103206/

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. What are the primary types of renewable energy sources?
2. Name three common control systems used in the integration of renewable energy sources into the grid
3. List the main components involved in a typical solar photovoltaic (PV) system
4. Explain how a grid-tie inverter functions in a solar power system.
5. Describe the role of energy storage systems in the integration of renewable energy sources.
6. How does a demand response program help in managing the variability of renewable energy sources?
7. Given a scenario with fluctuating wind speeds, how would you adjust the control parameters of a wind turbine to optimize energy output?
8. If you are designing a micro grid with a mix of solar and wind power, how would you configure the control system to ensure stable power supply?
9. Apply the principles of power factor correction to improve the efficiency of integrating renewable energy sources into a conventional power grid.
10. Compare the advantages and limitations of different energy storage technologies (e.g., batteries, pumped hydro, flywheels) in the context of renewable energy integration.
11. Analyze the impact of intermittent renewable energy sources on grid stability and suggest strategies to mitigate these impacts.
12. Assess the effectiveness of a hybrid energy storage system (e.g., combining batteries with flywheels) in improving the reliability of a renewable energy system.
13. Evaluate the economic and environmental benefits of integrating large-scale renewable energy sources into an existing grid infrastructure.
14. Design an innovative control strategy for a hybrid renewable energy system that includes solar, wind, and battery storage. Describe how your strategy addresses issues of energy storage, grid stability, and efficiency.
15. Develop a proposal for a new algorithm that improves the forecasting and integration of renewable energy sources into the grid. Include considerations for data collection, processing, and application.

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MTPS11033 **POWER SYSTEM DEREGULATION** **3 0 0 3**

Course Objectives:

1. To provide in-depth understanding of operation of deregulated electricity market systems.
2. To examine typical issues in electricity markets and how these are handled world –wide in various markets.
3. To enable students to analyse various types of electricity market operational and control issues using new mathematical models.
4. To understand trading and Congestion management in deregulated power system
5. To understand ancillary services and Technical, economic & regulatory issues involved in deregulated power system

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO6	PS01	PS02	
MTPS11033.1	Understand of operation of deregulated electricity market systems	2	3	-	2	2	3	L2,L4
MTPS11033.2	To analyze typical issues in electricity markets	-	1	3	2	1	2	L3,L5
MTPS11033.3	To analyze various types of electricity market operational and control issues using new mathematical models.	2	-	3	1	2	1	L4,L5
MTPS11033.4	Understand trading and Congestion management in deregulated power system	2	2	1	-	3	2	L2,L3
MTPS11033.5	Understand ancillary services and Technical, economic & regulatory issues involved in deregulated power system	3	2	-	2	1	2	L3,L5

SYLLABUS

UNIT– I Need and conditions for deregulation: **12 Hours**

Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts: marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation. **COs – CO1**

Self-Learning Topics: Compilation and Interpretation

UNIT– II Electricity sector structures: **12 Hours**

Electricity sector structures and Ownership /management, the forms of Ownership and management. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model. **COs – CO2**

Self-Learning Topics: Power sector structure

UNIT – III: Framework and methods: **12 Hours**

Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based unit commitment, country practices. **COs– CO3**

Self-Learning Topics: Power System Market structure

UNIT- IV: Transmission network and market power: **12 Hours**

Power wheeling transactions and marginal costing, transmission costing. Congestion management methods- market splitting, counter-trading; Effectof congestion on LMPs- country practices.

COs– CO4

Self-Learning Topics: Power Transmission Network

UNIT-V: Ancillary Services and System Security in Deregulation: **12 Hours**

Classifications and definitions, AS management in various markets- country practices. Technical, economic, & regulatory issues involved in the deregulation of the power industry. **COs – CO5**

Self-Learning Topics: Power system deregulation

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

Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Power system Deregulation	CO1–CO5	PO1, PO2, PO6, PSO1, PSO2
2. Power system Congestion	CO1–CO5	PO1, PO2, PO3, PSO1, PSO2

Text Books:

1. Power System Economics: Designing markets for electricity - S. Stoft, wiley.
2. Operation of restructured power systems -K. Bhattacharya,M.H.J. Bollen and J.E. Daalder, Springer.

Reference Books:

1. Power generation, operation and control, -J. Wood and B. F. Wollenberg, Wiley.
2. Market operations in electric power systems - M. Shahidehpour, H. Yaminand Z. Li,Wiley.
3. Fundamentals of power system economics - S. Kirschen and G. Strbac, Wiley.
4. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau, IEEE Press series on Power Engineering.
5. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth

Web References:

https://archive.nptel.ac.in/courses/108/101/108101005/

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. What is deregulation? Explain the need and conditions required for a deregulated market.
2. Explain in detail the concepts of marginal cost of generation, least cost operation and incremental cost of generation.

3. What are different structures and the forms of ownership and management?
4. Explain deregulated models of power systems based on energy trading
5. What are bilateral and pool markets? Analyse and explain them in brief.
6. Discuss and list out the history of power system deregulation in India?
7. What is market power and discuss various transmissions pricing in power systems.
8. What is the effect of congestion on LMPS country practices?
9. Explain i) Purchasing agency model. ii) Wholesale competition model. iii) Retail completion model.
10. What meant by market structure, market architecture spot market, forward markets and settlements.
11. Explain in detail the synchronous generator as ancillary service providers.
12. What is meant by ancillary service management?
13. What are various, technical, economic & regulatory issues involved in the deregulation of the power industry.
14. Explain in detail power wheeling transactions and marginal costing, transmission costing?
15. Explain in detail different congestion management methods?

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MTPS11041 **HVDC Transmission** **3 0 0 3**

Course Objectives:

1. To learn various schemes of HVDC transmission.
2. To learn about the basic HVDC transmission equipment.
3. To learn the control of HVDC systems.
4. To be exposed to the interaction between HVAC and HVDC system.
5. To be exposed to the various protection schemes of HVDC engineering.

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO3	PO5	PO6	PSO1	PSO2	
MTPS11041.1	Understand the various schemes of HVDC transmission.	2	2	-	3	2	1	L3,L4
MTPS11041.2	Understand the basic HVDC transmission equipment.	1	3	2	-	1	2	L3,L5
MTPS11041.3	Understand the control of HVDC systems.	3	1	2	-	2	1	L2,L4
MTPS11041.3	Understand the interaction between HVAC and HVDC system.	2	2	-	2	3	2	L2,L3
MTPS11041.4	Understand the various protection schemes of HVDC engineering.	2	-	3	1	2	2	L3,L5

SYLLABUS

UNIT– I **12 Hours**

Limitation of EHV AC Transmission, Advantages of HVDC: Technical economical and reliability aspects. HVDC Transmission: General considerations, Power Handling Capabilities of HVDC Lines, Basic Conversion principles, static converter configuration. Types of HVDC links-Apparatus and its purpose. **COs – CO1**

Self-Learning Topics: Basic Conversion principles

UNIT– II **12 Hours**

Static Power Converters: 6-pulse bridge circuit and 12-pulse converters, converter station and Terminal equipment, commutation process, Rectifier and inverter operation, equivalent circuit for converter – special features of converter transformers. Comparison of the performance of diametrical connection with 6-pulse bridge circuit. **COs – CO2**

Self-Learning Topics: Rectifier and inverter operation

UNIT – III: **12 Hours**

Control of HVDC Converters and Systems: constant current, constant extinction angle and constant Ignition angle control. Individual phase control and equidistant firing angle control, DC power flow control. Factors responsible for generation of Harmonics voltage and current, harmonics effect of variation of α and μ. Filters, Harmonic elimination. **COs– CO3**

Self-Learning Topics: constant current, constant extinction angle and constant Ignition angle control

UNIT- IV: **12 Hours**

Interaction between HV AC and DC systems – Voltage interaction, Harmonic instability problems and DC power modulation. Development of DC circuit Breakers, Multi-terminal DC links

and systems; series, parallel and series parallel systems, their operation and control.**COs– CO4**
Self-Learning Topics: Circuit Breakers

UNIT-V: **12 Hours**

Transient over voltages in HV DC systems: Over voltages due to disturbances on DC side, over voltages due to DC and AC side line faults. Converter faults and protection in HVDC Systems: Converter faults, over current protection - valve group, and DC line protection, circuit breakers. Over voltage protection of converters, surge arresters. **COs – CO5**
Self-Learning Topics: Protection

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

Text Books:

1. S Kamakshaih and V Kamaraju: HVDC Transmission- MG hill.
2. K.R.Padiyar : High Voltage Direct current Transmission, Wiley Eastern Ltd., New Delhi 1992.

Reference Books:

1. E.W. Kimbark : Direct current Transmission, Wiley Inter Science – New York.
2. .J.Arillaga : H.V.D.C.Transmission Peter Peregrinus ltd., London UK 1983
3. Vijay K Sood: HVDC and FACTS controllers: Applications of static converters in power systems by, Kluwer Academic Press.

Web References:

a. https://testbook.com/electrical-engineering/hvdc-transmission
b. https://archive.nptel.ac.in/courses/108/104/108104013
c. https://www.slideshare.net/slideshow/hvdc-transmission-77363658/77363658
d. https://www.tutorialspoint.com/difference-between-hvac-and-hvdc-transmission-systems

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1L2	20	20
L3 L4	40	40
L5 L6	40	40
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

1. Write the advantages and disadvantages of HVDC Transmission Advantages
2. List the types of power devices for HVDC transmission.
3. What are the types of DC link
4. List out two merits of AC and DC transmission
5. Mention the some of HVDC projects from abroad?
6. State at least four HVDC projects in India
7. What is firing angle
8. Draw the circuit of Graetz circuit.
9. Define value rating

10. What is the principal of control in DC link
11. What is meant by an Asynchronous tie
12. How can the converter configuration defined?
13. Write the assumptions for analysis of 6 pulse converter?
14. What is meant by firing angle control?
15. How power is reversed in HVDC link?
16. What are the parameters to change current and power transfer in DC link?
17. Differentiate characteristic and non-characteristic harmonics.
18. What are the effects of trouble caused by harmonics?
19. What are the factors depends on commutation failure?
20. Give the comparison between AC and DC Transmission and explain the factors in detail?
21. What are the applications of DC Transmission and also mention the modern trends in
22. HVDC technology.
23. Write the special features of converter transformers?
24. Why circuit turn off time should be greater than the thyristor turn-off time?(
25. Why the necessity of control in a DC link?
26. Differentiate between Multi-Terminal and Multi-Infeed Systems?
27. Explain the interaction between HVAC & DC systems?
28. What are the major types of AC-DC systems interaction and also explain about the
29. Harmonic interactions in details?

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MTPS11042 **Digital Power Systems Protection** **3 0 0 3**

Course Objectives:

1. To learn about classification and operation of static relays.
2. To understand the basic principles and application of comparators.
3. To learn about static version of different types of relays.
4. To understand about Pilot Relaying Scheme.
5. To understand about numerical protection techniques.

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO6	PS01	PS02	
MTPS11042.1	Know the classifications and applications of static relays.	2	-	3	2	2	-	L2,L4
MTPS11042.2	Understand the application of comparators.	2	1	2	-	1	2	L3,L5
MTPS11042.3	Understand the static version of different types of relays.	3	-	1	2	1	2	L4,L5
MTPS11042.4	Understand the Pilot Relaying Scheme	1	3	2	-	2	1	L2,L3
MTPS11042.5	Understand the numerical protection techniques.	2	1	-	3	1	2	L3,L5

SYLLABUS

UNIT–I: **10 Hours**

Static Relays classification and Tools : Comparison of Static with Electromagnetic Relays, Basic classification, Level detectors and Amplitude and phase Comparators – Duality – Basic Tools – Schmitt Trigger Circuit, Multivibrators, Square wave Generation – Polarity detector – Zero crossing detector – Thyristor and UJT Triggering Circuits. Phase sequence Filters – Speed and reliability of static relays. **COs – CO1**

Self-Learning Topics: Multi vibrators, Square wave Generation

UNIT– II: **10 Hours**

Amplitude and Phase Comparators (2 Input) : Generalized equations for Amplitude and Phase comparison – Derivation of different characteristics of relays – Rectifier Bridge circulating and opposed voltage type amplitude comparators – Averaging & phase splitting type amplitude comparators – Principle of sampling comparators.

Phase Comparison : Block Spike and phase Splitting Techniques – Transistor Integrating type, phase comparison, Rectifier Bridge Type Comparison – Vector product devices. **COs – CO2**

Self-Learning Topics: Derivation of different characteristics of relays

UNIT – III: **10 Hours**

Static over current (OC) relays – Instantaneous, Definite time, Inverse time OC Relays, static distance relays, static directional relays, static differential relays, measurement of sequence impedances in distance relays, multi input comparators, elliptic & hyperbolic characteristics, switched distance schemes, Impedance characteristics during Faults and Power Swings.**COs– CO3**

Self-Learning Topics: Instantaneous, Definite time, Inverse time OC Relays

UNIT- IV: **10 Hours**

PILOT Relaying schemes: Wire pilot protection: circulating current scheme – balanced voltage scheme – translay scheme – half wave comparison scheme - carrier current protection: phase comparison type – carrier aided distance protection – operational comparison of transfer trip and blocking schemes – optical fiber channels. **COs– CO4**

Self-Learning Topics: Wire pilot protection: circulating current scheme

UNIT-V: **10 Hours**

Microprocessor based relays and Numerical Protection: Introduction – over current relays –impedance relay – directional relay – reactance relay.

Numerical Protection: Introduction - numerical relay - numerical relaying algorithms - mann-Morrison technique - Differential equation technique and discrete Fourier transform technique Numerical over current protection - numerical distance protection. **COs – CO5**

Self-Learning Topics: numerical relay

Board of Studies:	Electrical and Electronics Engineering
Approved in BoS No:	01,1st August, 2024
Approved in ACM No:	01

Text Books:

1. Power System Protection with Static Relays – by TSM Rao, TMH.
2. Power system protection & switchgear by Badri Ram & D N viswakarma, TMH.

Reference Books:

1. Protective Relaying Vol-II Warrington, Springer.
2. Art & Science of Protective Relaying - C R Mason, Willey.
3. Power System Stability KimbarkVol-II, Willey.
4. Electrical Power System Protection –C.Christopoulos and A.Wright- Springer
5. Protection & Switchgear –Bhavesh Bhalaja, R.PMaheshwari, NileshG.Chothani-Oxfordpublisher

Web References:

1. https://archive.nptel.ac.in/courses/108/105/108105167/

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Outline the necessity of protection for power system
2. What do you understand from quadrature connection
3. Define static over current relay
4. Discuss various zones of Protection
5. Explain the process of development of new numerical relay using flowchart
6. Explain construction of Different types of over current protection Relays and its

characteristics

7. Discuss about reclosure
8. Explain construction of Different types of over current protection Relays and its characteristics
9. Briefly explain Phase fault protective scheme
10. Define least error squared technique
11. Describe the concept of Numerical Over current protection
12. Demonstrate with a neat diagram of Mho relay
13. Outline the concept of wavelet analysis and how it will be used for numerical protection
14. Draw the block diagram of the numerical relay
15. Demonstrate with a neat diagram of Unit type carrier aided directional comparison Relaying

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MTPS11043 **POWER SYSTEM RELIABILITY** **3 0 0 3**

Course Objectives:

1. To get the basic understanding of network modeling and reliability.
2. To get the basic understanding of Network Modeling and Reliability.
3. To get the basic understanding of Markov chains.
4. To get the basic understanding of Reliability analysis of generation systems.
5. To get the basic understanding of Decomposition techniques

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO5	PS01	PS02	
MTPS11043.1	Understand reliability analysis applied to power systems.	1	2	3	-	1	1	L2, L3
MTPS11043.2	Understand Network Modeling and Reliability applied to power systems.	1	-	1	2	-	2	L3,L4
MTPS11043.3	Understand Markov Chains and application to power systems.	3	2	-	1	1	1	L3,L4
MTPS11043.4	Perform stability analysis of generation systems.	1	1	2	-	2	-	L4,L5
MTPS11043.5	Understand decomposition techniques applied to power system.	2	1	-	2	1	2	L3,L4

SYLLABUS

UNIT– I: **10 Hours**

Basic probability theory – rules for combining probabilities of events – Bernoulli`s trials – probability density and distribution functions – binomial- distributions – expected value and standard deviation of binomial distribution. **COs – CO1**

Self-Learning Topics: Probability Concepts

UNIT– II: **10 Hours**

Network Modeling and Reliability Analysis of Series, Parallel, Series-Parallel networks – complex networks – decomposition method

Reliability functions F(t), R(t), h(t) and their relationship – exponential distributions – Expected value and standard deviation of exponential distribution – Bath tub curve – reliability analysis of series parallel networks using exponential distribution – reliability measures MTTF, MTTR,MTBF **COs – CO2**

Self-Learning Topics: Series Parallel Networks

UNIT – III: **10 Hours**

Markov chains – concept of stochastic transitional probability Matrix, Evaluation of limiting state Probabilities – Markov processes one component repairable system – time dependent probability evaluation using Laplace transform approach – evaluation of limiting state probabilities using STPM – two component repairable models – Frequency and duration concept – Evaluation of frequency of encountering state, mean cycle time, for one, two component repairable models – evaluation of cumulative probability and cumulative frequency of encountering merged states **COs– CO3**

Self-Learning Topics: Concept of stochastic transitional probability

UNIT- IV: **10 Hours**

Generation system reliability analysis – reliability model of a generation system – recursive relation for unit addition and removal – load modelling – merging of generation load model evaluation of transition rates for merged state model – cumulative Probability, cumulative frequency of failure evaluation – LOLP, LOLE. **COs– CO4**

Self-Learning Topics: Generation system

UNIT-V: **10 Hours**

Composite system reliability analysis decomposition method – distribution system reliability analysis – radial networks – weather effects on transmission lines – Evaluation of load and energy indices. **COs – CO5**

Self-Learning Topics: Radial networks

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

Reference Books:

1. Reliability Evaluation of Engg. System – R.Billinton, R.N.Allan, Plenum Press, New York.
2. Reliability Modeling in Electric Power Systems - J. Endrenyi, John Wiley, 1978, Neewyork.
3. An Introduction to Realiability and Maintainability Engineering. Sharies E Ebeling, TATA McGraw Hill – Edition.

Web References:

1. https://www.intechopen.com/chapters/57936
2. https://link.springer.com/chapter/10.1007/978-1-84996-232-2_8

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Give a definition for power system reliability.
2. Define the term reliability? Explain the reliability function
3. Explain the term MTTF. Also derive it with respect to reliability and CDF
4. S4.tate k-out-of-m system redundancy?
5. What is mixed redundancy?
6. Define Maintainability and availability and compare it with reliability
7. Explain memory lessness with a example
8. Explain the static model for constant strength and load?
9. Find out the system reliability for a serial and parallel configuration with 2 components.
10. Find out the reliability using markov analysis for load sharing units?

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MTCS1105 **Research Methodology and IPR** **3 0 0 3**

Course Objectives:

1. To give an overview of the research methodology and explain the technique of defining a research problem.
2. To explain the functions of the literature review in research and guide the process of conducting a literature search, reviewing it, and writing a review.
3. To explain various research designs, their characteristics, and the details of sampling designs, measurement and scaling techniques, along with different methods of data collection.
4. To explain several parametric tests of hypotheses, including the Chi-square test, and their application in research.
5. To explain various forms of intellectual property, its relevance, business impact, and leading international instruments concerning Intellectual Property Rights in the global business environment.

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

Course Code	Course Outcomes	Mapping with POs			Dok
		PO1	PO2	PO12	
MTCS1105.1	Analyze the intensity variation of light due to interference, diffraction and classify various types of lasers.	3	2	1	L1,L4
MTCS1105.2	Identify various crystal systems and analyze the crystalline structure.	3	2	1	L1,L4
MTCS1105.3	Summarize various types of polarization of dielectrics and classify the magnetic materials.	2	2	1	L1,L3
MTCS1105.4	Explain fundamentals of quantum mechanics and apply to one dimensional motion of particles.	3	2	2	L1,L3
MTCS1105.5	Outline the properties of charge carriers in semiconductors	3	2	1	L1,L4

SYLLABUS

UNIT-I: Research Methodology **10 Hours**

Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India.

Technique Involved in Defining a Problem, an Illustration. **COS-CO1**

UNIT-II: Reviewing the literature **8 Hours**

Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected Literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. **COS-CO2**

UNIT-III: Design of Sample Surveys **12 Hours**

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, Techniques of Developing Measurement Tools, · Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data, Selection of Appropriate Method for Data Collection, Case Study Method. **COS-CO3**

UNIT-IV: Testing of Hypotheses **12 Hours**

Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Goodness of Fit, Cautions in Using ChiSquare Tests. Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. **COS-CO4**

UNIT-V: Interpretation and Report Writing: **12 Hours**

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999, The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act 1999, Copyright Act, 1957, The Protection of Plant Varieties and Farmers' Rights Act, 2001, The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organisation (WIPO), WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Undisclosed Information, Enforcement of Intellectual Property Rights, UNSECO. **COS-CO5**

Board of Studies : Management Science
Approved in BOS No: 05, August, 2024
Approved in ACM No: 01,

Textbooks:

1. Research Methodology: Methods and Techniques - C.R. Kothari, Gaurav Garg, New Age International, 4th Edition, 2018.
2. Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module2)- Ranjit Kumar SAGE Publications Ltd, 3rdEdition, 2011
3. Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice,The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

Reference Books:

1. Research Methods: The concise knowledge base- Trochim, Atomic Dog Publishing, 2005
2. Conducting Research Literature Reviews: From the Internet to Paper–Fink, Sage Publications, 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	30	30
L2	30	30
L3	20	20
L4	20	20
Total (%)	**100**	**100**

Sample Short and Long Answers questions of Various Cognitive Levels

Module-1: Research Methodology

1. What is the primary objective of research?
2. Describe the difference between basic and applied research.
3. Explain the significance of using the scientific method in research.
4. Differentiate between research methods and research methodology.
5. Outline the steps in the research process.
6. What are the criteria for good research?
7. Identify common problems encountered by researchers in India.
8. What are the main research approaches, and how do they differ from one another?
9. Discuss the significance of defining a research problem clearly.
10. Provide an example of how to define a research problem, including the steps involved.

Module-2: Reviewing the Literature & Research Design

1. What is the role of a literature review in a research study?
2. How does reviewing literature help in clarifying the research problem?
3. What is the difference between a theoretical framework and a conceptual framework?
4. List and describe the key features of a good research design.
5. Why is research design crucial for the validity of a study?

6. Explain the different types of research designs and their applications.
7. What are the basic principles of experimental designs?
8. How can a literature review improve research methodology?
9. Describe the process of searching and reviewing existing literature.
10. Illustrate how a well-developed theoretical framework can guide a research study.

Module-3: Design of Sample Surveys, Measurement, and Scaling

1. What is the difference between sampling errors and non-sampling errors?
2. Discuss the advantages and disadvantages of sample surveys compared to census surveys.
3. Explain the concept of sample design and its importance in research.
4. What are the classifications of measurement scales, and how are they used?
5. Describe the sources of error in measurement and techniques to minimize them.
6. Differentiate between qualitative and quantitative data.
7. What is multidimensional scaling, and how is it applied in research?
8. Explain the process of developing a measurement tool.
9. How does scaling affect data collection and analysis?
10. Discuss the role of the case study method in data collection.

Module-4: Testing of Hypotheses

1. Define hypothesis and its role in research.
2. What is the procedure for hypothesis testing?
3. Differentiate between Type I and Type II errors in hypothesis testing.
4. Explain the concept of the critical value and its role in decision-making.
5. How do you test hypotheses for differences between two means or proportions?
6. Describe the P-value approach and its significance in hypothesis testing.
7. What is the power of a test, and why is it important?
8. Discuss the limitations of hypothesis testing.
9. Explain how the chi-square test is used for goodness of fit and its cautions.
10. Describe the different test statistics used in hypothesis testing for variances.

Module-5: Interpretation, Report Writing, and Intellectual Property

1. What is the meaning of interpretation in research, and why is it important?
2. Discuss the techniques used for interpreting research data.
3. What are the key steps in writing a research report?
4. How should a research report be structured?
5. What precautions should be taken while writing a research report?
6. Explain the concept of intellectual property and its types.
7. Discuss the TRIPS Agreement and its impact on intellectual property laws.
8. What is the role of the World Intellectual Property Organisation (WIPO)?
9. How do national and international IP laws intersect?
10. Describe the protection mechanisms for patents and copyrights under Indian law.

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MTPS1106 **Power System Simulation Lab–I** **0 0 4 2**

Course Objectives:

1. To understand the modeling of different transmission lines
2. To understand the mathematical formulation of distribution system load flow
3. To understand the configurations of transmission lines

Course Code	Course Outcomes	Mapping with POs and PSOs						DoK
		PO1	PO2	PO3	PO4	PS01	PS02	
MTPS1106.1	Analyze different transmission line and parameters	2	3	-	2	2	3	L2
MTPS1106.2	Analyze Load flow analysis	2	-	2	3	1	2	L3
MTPS1106.3	Analyze Load dispatch	3	1	2	-	3	1	L3

List of Experiments

1. Performance analysis of short and medium transmission lines.
2. Performance analysis of long transmission lines.
3. Computation of sag of transmission lines for equal and unequal heights of towers.
4. Distribution load flow analysis.
5. Computation of B- co-efficient in economic load dispatch problem.
6. Computation of line parameters (R, L, C) for different configuration of 3-ϕ symmetrical transmission lines.
7. Computation of line parameters (R, L, C) for different configuration of 3-ϕ unsymmetrical transmission lines with and without transposition.
8. Computation reflection and refraction co-efficient of voltages and currents of transmission line form different conditions.
9. Formation of Y-bus by direct inspection method.
10. Formations of Z-bus by building algorithm.

Exercise Problems

1. Draw the equivalent circuit and phasor diagram for short, medium and long transmission lines
2. Determine the sag of transmission lines for equal and unequal heights of towers.
3. Give the comparison between Load flow techniques
4. Give the B loss coefficients for Two Generator system
5. Explain about symmetrical components
6. Draw the symmetrical network for Transformers
7. Determine the reflection and refraction coefficients when transmission line open circuited and short circuited
8. Determine Y bus for the Power system network
9. Determine Z bus for the Power system network

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MTPS1107 **POWER SYSTEM LAB** **0 0 4 2**

Course Objectives:

1. To understand the sequence impedance of alternator and transformer
2. To understand the experimental determination of various parameters used in power system area and to analyze the performance of transmission line with and without compensation
3. To Design and simulation of the power angle characteristics of a salient pole synchronous machine

Course Code	Course Outcomes	Mapping with POs and PSOs						DoK
		PO1	PO2	PO3	PO4	PS01	PS02	
MTPS1107.1	Determine the sequence impedance of alternator and transformer.	2	3	-	2	2	3	L2
MTPS1107.2	Determine the transmission line parameters, voltage regulation of transmission lines without and with shunt regulation and study the Ferranti effect.	3	1	2	-	1	2	L3
MTPS1107.3	Perform the experiment on 3-winding transformer and calculate the parameters of transformer.	2	-	2	3	2	1	L3

List of Experiments

1. Determination of Sequence Impendence of an Alternator by direct method.
2. Determination of Sequence impedance of an Alternator by fault Analysis.
3. Measurement of sequence impedance of a three phase transformer
4. a) By application of sequence voltage. (b).using fault analysis.
5. Power angle characteristics of a salient pole Synchronous Machine.
6. Poly-phase connection on three single phase transformers and measurement of phase displacement.
7. Determination of equivalent circuit of 3-winding Transformer.
8. Measurement of ABCD parameters on transmission line model.
9. Performance of long transmission line without compensation.
10. Study of Ferranti effect in long transmission line.
11. Performance of long transmission line with shunt compensation.

Exercise Problems

1. Determine of Sequence Networks of an Alternator.
2. Determine the Fault analysis on Alternator
3. Determine the Sequence Impedance of Transformer
4. Explain Ferranti effect
5. Draw the equivalent circuit of long transmission line and its Parameters
6. Explain about Series compensation
7. Explain about Shunt Compensation

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MTPS1201 POWER SYSTEM DYNAMICS AND STABILITY 3 0 0 3

Course Objectives:

1. To study the model of synchronous machines.
2. To study the stability studies of synchronous machines.
3. To study the solution method of transient stability.
4. To know Effect of governor action and excite on power system stability.
5. To study the effect of different excitation systems.

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO4	PSO1	PSO2	
MTPS1201.1	Determine the model of synchronous machines	2	-	2	2	2	2	L2,L3
MTPS1201.2	Know the stability studies of synchronous machines	2	3	-	1	2	1	L3,L4
MTPS1201.3	Get the knowledge of solution methods of transient stability.	1	2	2	-	1	3	L3,L4
MTPS1201.4	To know Effect of governor action and excite on power system stability.	-	2	3	1	3	2	L2,L5
MTPS1201.5	Know the effect of different excitation systems in power systems	3	-	2	3	2	3	L4,L5

SYLLABUS

UNIT–I **10 Hours**

System Dynamics: Synchronous machine model in state space from computer representation for excitation and governor system–modeling of loads and induction machines. **COs – CO1**

Self-Learning Topics: Rotating magnetic fields

UNIT–II **10 Hours**

Steady state stability – steady state stability limit – Dynamics Stability limit – Dynamic stability analysis – State space representation of synchronous machine connected to infinite bus-time response–Stability by eigen value approach. **COs – CO2**

Self-Learning Topics: Time response of different signals

UNIT – III: **10 Hours**

Digital Simulation of Transient Stability: Swing equation machine equations – Representation of loads – Alternate cycle solution method – Direct method of solution – Solution Techniques: Modified Euler method– Runge Kutta method– Concept of multi machine stability. **COs– CO3**

Self-Learning Topics: Types of loads

UNIT- IV: **10 Hours**

Effect of governor action and excite on power system stability effect of saturation, saliency &automatic voltage regulators on stability. **COs– CO4**

Self-Learning Topics: Voltage Regulators

UNIT-V: **10 Hours**

Excitation Systems : Rotating Self-excited Exciter with direct acting Rheostatic type voltage regulator – Rotating main and Pilot Exciters with Indirect Acting Rheostatic Type Voltage

Regulator – Rotating Main Exciter, Rotating Amplifier and Static Voltage Regulator – Static excitation scheme–Brushless excitation system. **COs – CO5**

Self-Learning Topics: Rotating Amplifier

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

Expert Talk (To be Delivered by SMEs from Industries) COs POs / PSOs

1. Stability by eigen value approach CO1-CO5 PO1, PO2,PO4,PSO1, PSO2
2. Rotating Amplifier and Static Voltage Regulator CO1-CO5 PO1, PO3 PO4,PSO1, PSO2

Textbooks:

1. Power systems stability and control by PRABHAKUNDUR,TMH.
2. Power System control and stability by Anderson and Fund, IEEE Press.
3. Computer Applications to Power Systems–M.A.Pai, TMH.

Reference Books:

1. Computer Applications to Power Systems–Glenn.W.Stagg& Ahmed.H.El. Abiad, TMH.
2. Power Systems Analysis &Stability–S.S.Vadhera Khanna Publishers

Web References:

1. http://powerunit-ju.com/wp-content/uploads/2018/01/Power-System-Stability-and-Control-by-Prabha-Kundur.pdf
2. https://nptel.ac.in/courses/108106026
3. https://www.accessengineeringlibrary.com/content/book/9781260473544
4. https://digital-library.theiet.org/content/books/po/pbpo076e

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Define system dynamics
2. Write synchronous machine in state space model
3. Write Swing equation machine equations
4. Define Transient Stability
5. Define power system stability
6. Define Rotating Self-excited
7. Explain about the different subsystems of a power system and associated controls and operating states of power system.
8. Explain about the modelling of Synchronous machine using park's transformation

9. Draw the functional and standard block diagram of excitation system and explain
10. Explain about the small signal stability of system by eigen value approach
11. Explain about the Power system stabilizer with each component in PSS
12. Explain about the concepts of multi machine stability
13. What are different solution techniques for transient stability and explain the modified Euler method for the determination of transient stability

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MTPS1202 **REAL TIME CONTROL OF POWER SYSTEMS** **3 0 0 3**

Course Objectives:

1. To understand the importance of state estimation in power systems.
2. To know the importance of security and contingency analysis.
3. To understand SCADA, its objectives and its importance in power systems.
4. To know the significance of voltage stability analysis.
5. To know the applications of AI to power systems problems.

Course Code	Course Outcomes	Mapping with POs and PSOs					Dok
		PO1	PO2	PO3	PSO1	PSO2	
MTPS1202.1	Understand state estimation, security and contingency evaluation	2	3	2	2	2	L3,L4
MTPS1202.2	Understand about Supervisory control and data acquisition	2	1	3	1	2	L3,L5
MTPS1202.3	Real time software application to state estimation.	1	2	-	2	1	L2,L4
MTPS1202.4	Know the Stability in Power systems	2	-	2	1	3	L2,L3
MTPS1202.5	Understand application of AI in power system.	1	2	2	2	2	L3,L5

SYLLABUS

UNIT– I **10 Hours**

State Estimation: Different types of State Estimations, Theory of WLS state estimation, sequential and non sequential methods to process measurements. Bad data Observability, Bad data detection, identification and elimination. **COs – CO1**

Self-Learning Topics: Power system Optimisation

UNIT–II **10 Hours**

Security and Contingency Evaluation: Security concept, Security Analysis and monitoring, Contingency Analysis for Generator and line out ages by iterative linear power flow method, Fast Decoupled model, and network sensitivity methods. **COs – CO2**

Self-Learning Topics: Types of Generators

UNIT – III: **10 Hours**

Computer Control of Power Systems: Need for real time and computer control of power systems,operating states of a power system, SCADA - Supervisory control and Data Acquisition system simple mentation considerations, energy control centers, software requirements for implementing the above functions. **COs– CO3**

Self-Learning Topics: Operating stages of a power system

UNIT- IV: **10 Hours**

Voltage Stability, voltage collapse, and voltage security, relation of voltage stability to rotor angle stability. Voltage stability analysis Introduction to voltage stability analysis `P-V' curves and `Q-V'curves, voltage stability in mature power systems, long-term voltage stability, power flow analysis for voltage stability, voltage stability static indices. **COs– CO4**

Self-Learning Topics: Reference Bus, Slack Bus

UNIT-V: **10 Hours**

Synchro phasor Measurement units: Introduction, Phasor representation of sinusoids, a generic PMU,GPS, Phasor measurement systems, Communication options for PMUs, Functional requirements of PMU sand PDCs, Phasors for nominal frequency signals, types of frequency excursions in power sytems, DFT estimation at off nominal frequency with a nominal frequency clock. **COs – CO5**

Self-Learning Topics: Phasor measurement systems

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

Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Energy control centers	CO1–CO5	PO1, PO2,PO3,PSO1, PSO2
2. Communication options for PMUs	CO1–CO5	PO1, PO2,PO3,PSO1, PSO2

Textbooks:

1.JohnJ.Grainger and William D.Stevenson, Jr. :Power System Analysis,McGraw-Hill,1994,InternationalEdition

2.Allen J.Wood and BruceF. Wollenberg: Power Generation operation and control, JohnWiley&Sons,1984.

3.A.G.Phadka and J.S.Thorp,"Synchronized Phasor Measurements and Their Applications", Springer,2008

Reference Books:

1.R.N.Dhar: Computer Aided Power Systems Operation and Analysis,TataMcGrawHill,1982

2.L.P.Singh: Advanced Power System Analysis and Dynamics,WileyEasternLtd.1986

3.PrabhaKundur :Power System Stability and Control-,McGrawHill,1994

4.P.D.Wasserman : 'Neural Computing : Theory and Practice' Van Nostrand – Feinhold, NewYork.

Web References:

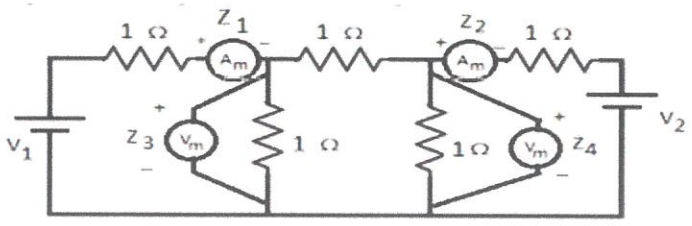
1. https://ieeexplore.ieee.org/abstract/document/1451471
2. https://ijece.iaescore.com/index.php/IJECE/article/view/12530
3. https://npti.gov.in/smart-power-control
4. https://ieeexplore.ieee.org/document/508825

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Explain the need of state estimation in power system
2. Explain about the network observability and pseudo measurements in bad data Collection.
3. Explain how contingency analysis is done using sensitivity factors and also draw flow chart?
4. Describe the operating states of power systems.
5. Explain the structure of control room in SCADA system.
6. Briefly discuss the factors affecting voltage stability.
7. Develop the concept of voltage stability using the method of optimal power flow
8. What is phasor measurement unit? Explain its role in real time environment.
9. In the DC circuit of figure below, the meter readings are z1=9.01 A, z2=3.02A, z3=6.98V and z4=5.01V. Assuming the ammeters are more accurate than the voltmeters, let us assign the measurement weights w1=100, w2=100, w3=50 and w4=50, respectively. Determine the weighted least squares of the voltage sources V1 and V2.



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MTPS12031 **EHVAC TRANSMISSION** **3 0 0 3**

Course Objectives:

1. To calculate the transmission line parameters.
2. To calculate the field affects on EHV and UHVAC lines.
3. To have knowledge of corona, RI and audible noise in EHV and UHV lines.
4. To have knowledge of voltage control and compensation problems in EHV and UHV transmission systems.
5. Understand reactive power compensation using SVC and TCR

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO4	PSO1	PSO2	
MTPS12031.1	Calculate the transmission line parameters.	2	3	-	1	2	1	L2,L4
MTPS12031.2	Calculate the field effects on EHV and UHV AC lines.	3	2	2	-	-	2	L3,L5
MTPS12031.3	Determine the corona, RI and audible noise in EHV and UHV lines.	-	2	1	2	1	2	L4,L5
MTPS12031.4	Analyse voltage control and compensation problems in EHV and UHV transmission systems.	3	2	-	2	2	2	L2,L3
MTPS12031.5	Understand reactive power compensation using SVC and TCR	2	-	3	1	1	-	L3,L5

SYLLABUS

UNIT– I: **12 Hours**

E.H.V. A.C. Transmission, line trends and preliminary aspects, standard transmission voltages – power handling capacities and line losses– mechanical aspects. Calculation of line resistance and inductance: resistance of conductors, temperature rise of conductor and current carrying capacity. Properties of bundled conductors and geometric mean radius of bundle, inductance of two conductor lines and multi conductor lines, Maxwell's coefficient matrix. Line capacitance calculation. Capacitance of two conductor line, and capacitance of multi conductor lines, potential coefficients for bundled conductor lines, sequence inductances and capacitances and diagonalization. **COs – CO1**

Self-Learning Topics: Properties of bundled conductors

UNIT–II **12 Hours**

Calculation of electro static field of AC lines - Effect of high electrostatic field on biological organisms and human beings. Surface voltage Gradient on conductors, surface gradient on two conductor bundle and cosine law, maximum surface voltage gradient of bundle with more than 3sub conductors, Mangolt formula. **COs – CO2**

Self-Learning Topics: Electrostatic fields

UNIT – III: **10 Hours**

Corona : Corona in EHV lines – corona loss formulae – attenuation of traveling waves due to corona – Audio noise due to corona, its generation, characteristics and limits, measurement of audio noise. **COs– CO3**

Self-Learning Topics: Factors effecting Carona

UNIT- IV: **10 Hours**

Power Frequency voltage control: Problems at power frequency, generalized constants, No-load voltage conditions and charging currents, voltage control using synchronous condenser, cascade connection of components: Shunt and series compensation, sub synchronous resonance in series Capacitor compensated lines **COs– CO4**

Self-Learning Topics: charging currents

UNIT-V: **08 Hours**

Reactive power compensating systems: Introduction, SVC schemes, Harmonics injected in to network by TCR, design of filters for suppressing harmonics injected into the system. **COs – CO5**

Self-Learning Topics: Harmonics

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

Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Surface voltage Gradient on conductors	CO1–CO5	PO1,PO2,PO3,PO4,PSO1, PSO2
2. Corona in EHV lines	CO1–CO5	PO1,PO2,PO3,PO4,PSO1, PSO2

Textbooks:

1. Extra High Voltage AC Transmission Engineering –Rakesh Das Begamudre,Wiley Easternltd.,NewDelhi–1987.
2. EHV Transmission line reference book–Edison Electric Institute(GEC)1986.

Web References:

1. https://electengmaterials.com/ehvac-transmission/#google_vignette
2. https://www.e-cigre.org/publications/detail/c4-305-2012-a-review-on-ehvac-transmission-line-lightning-performance.html
3. https://www.e-cigre.org/publications/detail/c1-302-2018-converting-regional-ehv-ac-transmission-to-hvdc.html
4. https://nptel.ac.in/courses/108108099

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Explain the power handling capability and line losses in EHV lines and discuss the useful conclusions from it
2. Derive the expression for inductance of a Multi conductor line used in EHV AC transmission line

3. What are the effects of high electrostatic fields on biological organisms and human beings
4. Explain surface voltage gradient on conductors in a bundle.
5. List t different corona loss formulae and explain each one
6. Explain the generation and measurement of audio noise due to corona in EHV lines. And also Explain in detail the measurement of Audible Noise
7. Explain cascade connection of components in shunt and series compensation.
8. Explain the sub synchronous resonance in a series capacitor and Compare series and shunt compensation for EHV AC transmission.
9. Explain how the harmonics are injected in to network by TCR.
10. A 100MVA 230KV 50Hz transformer has x t = 12% and is connected to a line 200km long which has an inductance of 1mH/km. The filter, connected to the L.V 33kv side of the transformer, is required to suppress the 5th harmonic generated by the TCR to 1% of I n. Calculate the value of filter capacitor if the filter inductance used in 2mH.

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MTPS12032 **FLEXIBLE AC TRANSMISSION SYSTEMS** **3 0 0 3**

Course Objectives:

1. To study the performance improvements of transmission system with FACTS.
2. To study the effect of static shunt compensation.
3. To study the effect of static series compensation.
4. To study the effect of UPFC.
5. To studyFACTS device for different types of applications

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO4	PSO1	PSO2	
MTPS12032.1	Know the performance improvement of transmission system with FACTS.	2	2	3	-	2	1	L3,L4
MTPS12032.2	Get the knowledge of effect of static shunt and series compensation.	1	-	2	3	-	2	L3,L5
MTPS12032.3	Know transfer function and dynamic performance SVC and STATCOM	2	2	-	1	2	1	L2,L4
MTPS12032.4	Know the principle of operation and various controls of UPFC	1	3	2	-	2	-	L2,L3
MTPS12032.5	Determine an appropriate FACTS device for different types of applications	2	1	-	2	1	2	L3,L5

SYLLABUS

UNIT– I: **10 Hours**

FACTS concepts, Transmission interconnections, power flow in an AC System, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers. **COs – CO1**

Self-Learning Topics: Dynamic stability

UNIT–II: **10 Hours**

Basic concept of voltage and current source converters, comparison of current source converters with voltage source converters.

Static shunt compensation: Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, methods of controllable VAr generation, variable impedance type static VAr generation, switching converter type VAr generation, hybrid VAr generation. **COs – CO2**

Self-Learning Topics: voltage and current source converters

UNIT – III: **10 Hours**

SVC and STATCOM: The regulation slope, transfer function and dynamic performance, transient stability enhancement and power oscillation damping, operating point control and summary of compensation control. **COs– CO3**

Self-Learning Topics: Power oscillation damping

UNIT- IV: **10 Hours**

Static series compensators: Concept of series capacitive compensation, improvement of transient stability, power oscillation damping, functional requirements. GTO thyristor controlled series capacitor (GSC), thyristors switched series capacitor (TSSC),and thyristors controlled series capacitor (TCSC), control schemes for GSC,TSSC and TCSC. **COs– CO4**

Self-Learning Topics: Thyristor family devices

UNIT-V: **10 Hours**

Unified Power Flow Controller: Basic operating principle, conventional transmission control capabilities, independent real and reactive power flow control, comparison of the UPFC to series compensators and phase angle regulators. Introduction to Interline Power Flow Controller (IPFC).

COs – CO5

Self-Learning Topics: real and reactive power flow control

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

Expert Talk (To be Delivered by SMEs from Industries)	COs	POs / PSOs
1. Static shunt compensation	CO1–CO5	PO1,PO3,PO4,PSO1,PSO2
2. Unified Power Flow Controller	CO1–CO5	PO1, PO2,PO4,PSO1,PSO2

Textbooks:

1."Understanding FACTS Devices" N.G.Hingorani and L.Guygi, IEEE Press. Indian Edition is available:--Standard Publications

Reference Books:

1.Sang.Y.HandJohn.A.T,"Flexible AC Transmission systems" IEEE Press (2006).
2.HVDC& FACTS Controllers: applications of static converters in power systems-Vijay K.Sood-Springer publishers

Web References:

https://www.siemens-energy.com/global/en/home/products-services/product-offerings/flexible-ac-transmission-systems.html
https://www.infineon.com/cms/en/applications/industrial/power-transmission-and-distribution/flexible-ac-transmission-systems-facts/
https://www.sciencedirect.com/topics/engineering/flexible-ac-transmission-systems
https://nptel.ac.in/courses/108107114

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Discuss various FACTS controllers and their control attributes.
2. Explain the power flow and dynamic stability considerations of a transmission interconnection.
3. Explain the working of a voltage source three level converters.
4. What are the objectives of static shunt compensators?
5. Explain the functions of ideal midpoint reactive compensator in a two-machine power system.
6. Explain the working of TSC with relevant waveforms
7. Discuss the basic operating principle of switching type var generators.
8. Explain with the help of a block diagram representation, how the STATCOM is implemented for the transient stability enhancement during a disturbance.
9. What are the main components of complete control operation of a static compensators? Explain them.
10. Explain the basic operating principles of voltage source converters.

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MTPS12033 **ELECTRIC VEHICLES AND DESIGN** **3 0 0 3**

Course Objectives:

1. To understand the fundamental concepts of hybrid and electric vehicles.
2. To understand the fundamental principles of hybrid and electric vehicles
3. To understand the fundamental analysis and design of hybrid and electric vehicles.
4. To know the various aspects of hybrid and electric drive train such as their configuration,
5. To know the types of electric machines that can be used energy storage devices, etc.

Course Code	Course Outcomes	Mapping with POs and PSOs					DoK
		PO1	PO2	PO3	PS01	PS02	
MTPS12033.1	Understand the fundamental concepts of hybrid and electric vehicles.	2	1	2	3	2	L2,L5
MTPS12033.2	Understand the models to describe hybrid vehicles and their performance	3	1	1	2	1	L3,L4
MTPS12033.3	Understand the different possible ways of energy storage.	1	3	2	-	2	L3,L5
MTPS12033.4	Understand the different strategies related to energy storage systems.	1	2	2	1	-	L2,L3
MTPS12033.5	Know different batteries and other energy storage systems	2	1	3	2	2	L4,L5

SYLLABUS

UNIT– I: **08 Hours**

Conventional Vehicles: Basics of vehicle performance, Vehicle power source characterization, Transmission characteristics, Mathematical models to describe vehicle performance. **COs – CO1**

Self-Learning Topics: vehicle performance

UNIT– II : **10 Hours**

Introduction to Hybrid Electric Vehicles

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies.

Hybrid Electric Drive-Trains: Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis **COs – CO2**

Self-Learning Topics: electric vehicles

UNIT– III: **10 Hours**

ELECTRIC TRAINS

Electric Drive-Trains: Basic concept of electric traction, introduction to various electric drive train topologies, Power flow control in electric drive-train topologies, Fuel efficiency analysis.

Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, Configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, Drive system efficiency. **COs – CO3**

Self-Learning Topics: Power grid

UNIT– IV: **10 Hours**

Energy Storage: Introduction to Energy Storage, Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, Sizing the power electronics, selecting the energy storage technology, Communications, Supporting subsystems. **COs – CO4**

Self-Learning Topics: power electronics

UNIT– V: **10 Hours**

Energy Management Strategies: Introduction to energy management strategies used in hybrid and Electric vehicles, Classification of different energy management strategies, Comparison of different energy Management strategies, Implementation issues of energy management strategies.

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV). **COs – CO5**

Self-Learning Topics: power generation

Board of Studies:	Electrical and Electronics Engineering
Approved in BOS No:	01, 1st Aug, 2024
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Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1.Battery and Storage Systems	CO1–CO5	PO1,PO2,PO3,PSO1 PSO2
2.Plug-in Hybrid Electric Vehicle	CO1–CO5	PO1,PO2,PO3,PSO1 PSO2

Text Books:

1. 1.C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. 2.S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

References:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

Web Resources:

(PDF) Control of Renewable Energy Systems (researchgate.net)

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Explain briefly Effects non-isolated bidirectional DC-DC converter,?
2. What are the different types Effects of renewable energy penetration into the grid
3. Describe briefly about Buck converter used in HEVs
4. Explain briefly about regenerative braking.
5. Explain about PWM rectifier in HEVs?
6. Explain Pumped Hydroelectric Energy Storage
7. Explain the term rolling resistance and aerodynamic drag in vehicles and derive the expression for vehicle translational speed from fundamentals.
8. Obtain the mathematical modeling of electric vehicle to describe its performance.
9. Explain the impact of different transportation technologies on environment and energy supply.
10. What are the basic techniques to improve Vehicle Fuel Economy? Explain.
11. Illustrate the power flow control in hybrid electric drive train.
12. Write short notes on fuel efficiency analysis in hybrid electric drive-trains.
13. Draw and explain the block diagram of switched reluctance motor drive system.
14. Discuss various electric drive train topologies.
15. Explain the super capacitor based energy storage and also state its limitations.
16. 16 Write a short note on sizing the power electronics to hybrid vehicles.
17. Explain the design of a Hybrid Electric Vehicle (HEV) as a case study

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MTPS12041 GENERATION AND MEASUREMENT OF HIGH VOLTAGES 3 0 0 3

Course Objectives:

1. To study the numerical methods for analyzing electrostatic field problems.
2. To study the fundamental principles of generation of high voltage for testing.
3. To study the methods for measurement of high AC, DC and transient voltages.
4. To Study the measurement techniques for high AC, DC and impulse currents.
5. To Study the measurement techniques for high AC, DC and impulse Voltage

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO4	PSO1	PSO2	
MTPS12041.1	Understand numerical computation of electrostatic problems.	3	2	-	2	2	3	L2,L5
MTPS12041.2	Understand the techniques of generation of high AC, DC and transient voltages.	-	1	3	1	1	2	L3,L4
MTPS12041.3	Know the Generation of Impulse Voltages	1	-	3	2	2	1	L3,L5
MTPS12041.4	Measure high AC, DC and transient voltages.	2	2	1	-	3	2	L2,L3
MTPS12041.5	Measurement of Impulse Voltages, Impulse Currents	3	2	-	2	1	2	L4,L5

SYLLABUS

UNIT– I: **10 Hours**

Electro static fields and field stress control: Electric fields in homogeneous Isotropic materials and in multi dielectric media-Simple configurations-field stress control. Methods of computing electrostatic fields-conductive analogues-Impedance networks Numerical techniques-finite difference method-finite element method and charge simulation method. **COs – CO1**

Self-Learning Topics: Electric fields

UNIT–II: **10 Hours**

Generation of High AC&DC Voltages:

Direct Voltages: AC to DC conversion methods, electro static generators, Cascaded Voltage Multipliers. Alternating Voltages: Cascading transformers-Resonant circuits and their applications, Tesla coil. **COs – CO2**

Self-Learning Topics: AC to DC conversion methods

UNIT – III: **10 Hours**

Generation of Impulse Voltages:

Impulse voltage specifications-Impulse generation circuits-Operation, construction and design of Impulse generators-Generation of switching and long duration impulses. Impulse Currents: Generation of high impulse currents and high current pulses. **COs– CO3**

Self-Learning Topics: Impulse Currents

UNIT- IV: **10 Hours**

Measurement of High AC& DC Voltages:

Measurement of High D.C. Voltages: Series resistance meters, voltage dividers and generating voltmeters. Measurement of High A.C. Voltages: Series impedance meters electro static voltmeters potential transformers and CVTS-voltage dividers and their applications. **COs– CO4**

Self-Learning Topics: Series resistance meters

UNIT-V: **10 Hours**

Measurement of Peak Voltages:

Sphere gaps, uniform field gaps, rod gaps. Chubb-Fortesque method, passive and active rectifier circuits for voltage dividers. Measurement of Impulse Voltages: Voltage dividers and impulse measuring systems-generalized voltage measuring circuits-transfer characteristics of measuring circuits-L.V. Arms for voltage dividers- compensated dividers. Measurement of Impulse Currents: Resistive shunts-current transformers-Hall Generators and Faraday generators and their applications-Impulse Oscilloscopes. **COs – CO5**

Self-Learning Topics: Compensated dividers

Board of Studies:	Electrical and Electronics Engineering
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Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Cascading transformers	CO1–CO5	PO2,PO3,PO4,PSO1,PSO2
2. Measurement of Impulse Currents	CO1–CO5	PO1,PO2,PO4,PSO1,PSO2

Textbooks:

1.High Voltage Engineering–byE.KuffelandW.S.Zaengl.Pergamanpress Oxford,1984.

2.High Voltage Engineering–byM.S.Naidu and V.Kamaraju, Mc.Graw-Hill Books Co.,New Delhi,2nd edition,1995.

Reference Books:

1.HighVoltageTechnology– LLAlston,OxfordUniversityPress1968.

2.HighVoltageMeasuring Techniques –A. Schwab MITPress, Cambridge,USA,1972.

3.Relevant I.S.andIECSpecifications

Web References:

1. https://uom.lk/sites/default/files/elect/files/HV_Chap6.pdf
2. https://www.sciencedirect.com/science/article/abs/pii/S1386276699800061
3. https://archive.nptel.ac.in/courses/108/104/108104048/
4. https://biet.ac.in/pdfs/IV-HVE.pdf

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Explain with neat diagrams the procedure to control electric field intensity in high voltage equipment
2. Explain the principle of operation of electrostatic generators with a neat diagram.
3. Define ripple voltage. Show that the ripple voltage in a rectifier circuit depends upon the load current and the circuit parameters.
4. Draw a typical impulse current generator circuit and explain its operation and application.
5. An impulse generator has eight stages, each stage having a capacitor rated 0.16 μF; and 125 kV. The load capacitor is l nF. Find the values of the wave shaping resistors needed to generate a 1.2/50 μs lightning impulse wave. What is the maximum output voltage of the generator if the charging voltage is120kV? What is the energy rating of the generator?
6. Draw a neat schematic diagram of a generating voltmeter and explain its principle of operation. Discuss its application and limitations
7. Explain with neat diagram how rod gaps can be used for measurement of high voltages. Compare its performance with a sphere gap.
8. Give the schematic arrangement of an impulse potential divider with an oscilloscope connected for measuring impulse voltages. Explain the arrangement used to minimize errors.
9. What are the problems associated with measurement of very high impulse voltages? Explain how these can be taken care of during measurements.
10. Draw Chubb-Fortescue Circuit for measurement of peak value of AC voltages discuss its advantages over other methods

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MTPS12042 EVOLUTIONARY ALGORITHMS AND APPLICATIONS 3 0 0 3

Course Objectives:

1. To distinguish between conventional optimization algorithms and evolutionary optimization algorithms.
2. To apply genetic algorithm and particle swarm optimization algorithm to power system optimization problems.
3. To analyse and apply Ant colony optimization algorithm and artificial Bee colony algorithm to optimize the control parameters. Power system optimization problems.
4. To apply shuffled frog leaping algorithm and bat optimization algorithm to power system optimization problem.
5. To apply multi-objective optimization algorithm to power system multi-objective problems.

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO4	PSO 1	PSO 2	
MTPS12042.1	State and formulate the optimization problem, without and with constraints, by using design variables from an engineering design problem.	2	-	1	2	3	2	L3,L4
MTPS12042.2	Apply classical optimization techniques to minimize or maximize a multi-variable objective function, without or with constraints, and arrive at an optimal solution.	2	1	-	2	2	1	L3,L5
MTPS12042.3	Formulate a mathematical model and apply linear programming technique by using Simplex method. Also extend the concept of dual Simplex method for optimal solutions.	1	3	2	-	1	3	L2,L4
MTPS12042.4	Apply gradient and non-gradient methods to nonlinear optimization problems and use interior or exterior penalty functions for the constraints to derive the optimal solutions.	-	2	3	1	3	2	L2,L3
MTPS12042.5	Apply Genetic algorithms for simple electrical problems and able to solve practical problems using PSO.	3	-	2	3	2	1	L3,L5

SYLLABUS

UNIT– I: **10 Hours**

Fundamentals of Soft Computing Techniques

Definition-Classification of optimization problems-Un constrained and Constrained optimization

Optimality conditions-Introduction to intelligent systems-Soft computing techniques-Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Single solution based and population based algorithms–Exploitation and exploration in population based algorithms-Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems – Single objective and multi-objective problems. **COs – CO1**

Self-Learning Topics: Power system optimization

UNIT–II: **10 Hours**

Genetic Algorithm and Particle Swarm Optimization

Genetic algorithms-Genetic Algorithm versus Conventional Optimization Techniques-Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters – GA and PSO algorithms for solving ELD problem without loss, Selective Harmonic Elimination in inverters and PI controller tuning. **COs – CO2**

Self-Learning Topics: Genetic operators

UNIT – III: **10 Hours**

Ant Colony Optimization and Artificial Bee Colony Algorithms

Biological ant colony system - Artificial ants and assumptions - Stigmergic communications – Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models-Touring ant colony system-max min ant system - Concept of Elitist Ants-Task partitioning in honey bees - Balancing foragers and receivers-Artificial bee colony (ABC) algorithms-binary ABC algorithms–ACO and ABC algorithms for solving Economic Dispatch without loss and PI controller tuning. **COs– CO3**

Self-Learning Topics: Stigmergic communication.

UNIT- IV: **10 Hours**

Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm

Bat Algorithm- Echolocation of bats- Behavior of micro bats- Acoustics of Echolocation-Movement of Virtual Bats-Loudness and Pulse Emission-Shuffled frog algorithm-virtual population of frogs comparison of memes and genes-memeplex formation-memeplex updation-BA and SFL A algorithms for solving ELD without loss and PI controller tuning. **COs– CO4**

Self-Learning Topics: Echolocation of bats

UNIT-V: **10 Hours**

Multi Objective Optimization

Multi-Objective optimization Introduction-Concept of Pareto optimality-Non-dominant sorting technique-Pareto fronts-best compromise solution-min-max method-NSGA-II algorithm and application to general two objective optimization problem. **COs – CO5**

Self-Learning Topics: Optimization Techniques

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Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Bird flocking and Fish Schooling	CO1–CO5	PO1,PO2,PO4,PSO1,PSO2

2. Non-dominant sorting technique CO1–CO5 PO1,PO3,PO4,PSO1,PSO2

Textbooks:

1. XinSheYang,,, Recent Advances in Swarm Intelligence and Evolutionary Computation", Springer International Publishing, Switzerland,2015.
2. Kalyanmoy Deb,,Multi-Objective Optimization using Evolutionary Algorithms", John Wiley &Sons,2001.
3. James Kennedy and Russel EEberheart,,,Swarm Intelligence ", The Morgan Kaufmann Series in EvolutionaryComputation,2001.

Reference Books:

1. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, „Swarm Intelligence-From natural to ArtificialSystems",Oxford universityPress,1999.
2. DavidGoldberg,,,GeneticAlgorithmsinSearch,OptimizationandMachineLearning",PearsonEducation,2007.
3. KonstantinosE. Parsopoulos and Michael N.Vrahatis,,, Particle Swarm Optimization and Intelligence: Advances and Applications", Informat IonscIencereference,IGIGlobal,,2010.
4. NPPadhy,,, Artificial Intelligence and Intelligent Systems", Oxford UniversityPress,2005.

Reference Papers:

1. "Shuffled frog-leaping algorithm: a memetic meta-heuristic for discrete optimization" byMuzaffareusuff,KevinlanseyandFayzulpasha,EngineeringOptimization,Taylor&Francis, Vol.38,No.pp.129–154,March2006.
2. "ANewMetaheuristicBat-InspiredAlgorithm"byXin-SheYang,NatureInspiredCooperative Strategies for Optimization (NISCO 2010) (Eds. J. R. Gonzalez et al.), Studies inComputationalIntelligence,SpringerBerlin,284,Springer,65-74(2010).
3. "FireflyAlgorithmsforMultimodalOptimization"Xin-SheYang,O.WatanabeandT.Zeugmann(Eds.),Springer-VerlagBerlinHeidelberg,pp.169–178,2009.

Web References:

1. https://www.worldscientific.com/doi/10.1142/9781848166820_0006
2. https://iwaponline.com/h2open/article/3/1/135/74697/Evolutionary-algorithms-swarm-intelligence-methods
3. https://link.springer.com/book/10.1007/978-3-662-03423-1
4. https://nptel.ac.in/courses/112103301

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Explain soft computing techniques
2. Discuss the Discrete and continuous problems
3. Explain Single solution based and population based algorithms

4. Write Properties of Swarm intelligent Systems
5. Explain Single objective and multi-objective problems.
6. Explain difference between Genetic Algorithm versus Conventional Optimization Techniques
7. Explain different types of crossover and mutation operators
8. Explain GA and PSO algorithms for so Selective Harmonic Elimination in inverters and PI controller tuning.
9. Explain ACO and ABC algorithms for solving Economic Dispatch without loss and PI controller tuning.
10. Define Loudness and Pulse Emission
11. Explain BA and SFL A algorithms for solving ELD without loss and PI controller tuning.
12. Write about Concept of Pareto optimality
13. Write about NSGA-II algorithm and application to general two objective optimization problem Virtual population of frogs comparison of memes and genes

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MTPS12043 PROGRAMMABLE LOGIC CONTROLLERS &APPLICATIONS 3 0 0 3

Course Objectives:

1. To have knowledge on PLC.
2. To acquire the knowledge on programming of PLC.
3. To understand different PLC registers and their description.
4. To have knowledge on data handling functions of PLC.
5. To know how to handle analog signal and converting of A/D in PLC.

Course Code	Course Outcomes	Mapping with POs and PSOs						Dok
		PO1	PO2	PO3	PO4	PSO1	PSO2	
MTPS12043.1	Understand the PLCs and their I/O modules	2	2	3	-	2	3	L2,L4
MTPS12043.2	Develop control algorithms to PLC using ladder logic etc	2	-	2	3	-	2	L3,L5
MTPS12043.3	Manage PLC registers for effective utilization in different applications	1	2	-	2	2	1	L4,L5
MTPS12043.4	Handle data functions and control of two axis and their axis robots with PLC	2	1	2	-	2	-	L2,L3
MTPS12043.5	Design PID controller with PLC.	3	2	-	2	1	2	L3,L5

SYLLABUS

UNIT– I: **10 Hours**

PLC Basics:

PLC system, I/O modules and interfacing, CPU processor, programming equipment, programming formats, construction of PLC ladder diagrams, devices connected to I/O modules. **COs – CO1**

Self-Learning Topics: digital electronics

UNIT–II: **10 Hours**

PLC Programming:

Input instructions, outputs, operational procedures, programming examples using contacts and coils. Drillpress operation. Digital logic gates, programming in the Boolean algebra system, conversion examples.Ladder diagrams for process control: Ladder diagrams and sequence listings, ladder diagram construction and flow chart for spray process system. **COs – CO2**

Self-Learning Topics: Digital logic gates.

UNIT – III: **PLC Registers** **10 Hours**

Characteristics of Registers, module addressing, holding registers, input registers, output registers. PLCFunctions: Timer functions and Industrial applications, counters, counter function industrial applications, Arithmetic functions, Number comparison functions, number conversion functions.

COs– CO3

Self-Learning Topics: relay logic

UNIT- IV: **10 Hours**

Data Handling functions:

SKIP, Master control Relay, Jump, Move, FIFO, FAL, ONS, CL Rand Sweep functions and their applications. Bit Pattern and changing a bit shift register, sequence functions and applications, controlling of two axis and three axis Robots with PLC, Matrix functions. **COs– CO4**

Self-Learning Topics: Master control Relay

UNIT-V: **Analog PLC operation:** **10 Hours**

Analog modules and 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. **COs – CO5**

Self-Learning Topics: PID principles.

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

Expert Talk (To be Delivered by SMEs from Industries)	**COs**	**POs / PSOs**
1. Programming in the Boolean algebra system	CO1–CO5	PO1,PO3,PO4,PSO2
2. PID tuning, PID functions	CO1–CO5	PO1,PO2,PO4,PSO1, PSO2

Textbooks:

1.Xin-SheYang,,,Recent Advances in Swarm Intelligence and Evolutionary Computation",Springer International Publishing,Switzerland,2015.

2.Kalyanmoy Deb,,Multi-Objective Optimization usingEvolutionary Algorithms",John Wiley &Sons,2001.

3.JamesKennedy and Russel EEberheart,,,Swarm Intelligence",The Morgan Kaufmann Seriesin Evolutionary Computation,2001.

ReferenceBooks:

1.Introduction to Programmable Logic Controllers- Gary Dunning-CengageLearning.

2.Programmable Logic Controllers–W.Bolton-Elsevier publisher.

Web References:

1.https://www.gbctechtraining.com/blog/world-plcs-closer-you-think-plc-applications-our-everyday-lives

2. https://tulip.co/blog/programmable-logic-controller-what-is-a-plc/

3. https://en.wikipedia.org/wiki/Programmable_logic_controller

4. https://nptel.ac.in/courses/108105088

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

1. Programmable Logic Controllers &Applications
2. Design the operation of a drill press module and draw the necessary Ladder diagram.
3. Explain the following
   i) AND gate and relay and PLC equivalents
   ii) NOR gate and relay and PLC equivalents
4. Discuss about ladder diagrams and sequence listings.
5. What are the characteristics of PLC registers? Explain the function of any two types of PLC registers in detail.
6. Discuss the application of a dual counter for parts to be counted on a conveyor belt. Assume required design considerations.
7. Explain the JUMP with NON-RETURN with an application.
8. Explain the FAL function of a PLC with a schematic of its operations.
9. How do you change the status of bit pattern of a register? Explain.
10. Using a PLC sequencer and timing, explain the following dishwasher application.

- Soap release solenoid, Input valve for hot water
- wash impeller operation
- Drain water valve

11. Drain pump motor
12. Heat element for drying cycle
13. Write short notes on the following
    a)Input output devices connected to PLC
    b) PLC analog signal processing
    c) PLC Master control Relay

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Cherukupally (V) Near Tagarapuvalasa Bridge
Bhogapuram (M), Vizianagaram (Dist) 531162

MTCC1205 POWER SYSTEM SIMULATION LABORATORY-II 0 0 4 2

Course Objectives:

1. The student should understand the modeling of various aspects of Power System analysis and develop the MATLAB programming.
2. The student should analyze symmetrical and unsymmetrical faults.
3. The student should analyze Transient stability and load frequency deviation in single and two area systems

Course Code	Course Outcomes	Mapping with POs and PSOs						
		PO1	PO2	PO3	PO4	PSO1	PSO2	DoK
MTCC1205.1	The student should analyze load flow solution obtained using GS and NR methods.	2	3	-	2	2	3	L2
MTCC1205.2	The student should analyze symmetrical and unsymmetrical faults.	3	-	2	2	1	2	L3
MTCC1205.3	The student should analyze Transient stability and load frequency deviation in single and two area systems	2	1	3	-	3	1	L3

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

List of Experiments

1. Load Flow Solution Using Gauss Siedel Method **COs:CO1**
2. Load Flow Solution Using Newton Raphson Method **COs:CO1**
3. Load Flow Solution Using Decoupled Method **COs:CO1**
4. Symmetrical Fault analysis using Z-bus **COs: CO2**
5. Unsymmetrical Fault analysis using Z-bus **COs: CO2**
6. Economic Load Dispatch with &without transmission losses **COs: CO2**
7. Transient Stability Analysis using modified Euler's method. **COs: CO3**
8. Transient Stability Analysis using modified R-K method. **COs:CO3**
9. Transient Stability Analysis Using Point By Point Method **COs:CO3**
10. Load Frequency Control of Single Area Control& Two Area Control system With and without controllers. **COs:CO3**

Exercise Problems

1. Determination of Load Flow Solution of an Alternator.

2. Fault analysis on Alternator
3. Measurement of Economic Load Dispatch on transmission line model
4. Determination of Transient Stability Analysis.
5. Determination of Load Frequency Control of Single Area Control& Two Area Control system.

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MTPS1206 **POWER CONVERTERS LABORATORY** **0 0 4 2**

Course Objectives:

1. To expose students to operation and characteristics of power semiconductor devices and passive components, their practical application in power electronics.
2. To provide a practical exposure to operating principles, design and synthesis of different power electronic converters.
3. To introduce students to industrial control of power electronic circuits as well as safe electrical connection and measurement practices.

Course Code	Course Outcomes	Mapping with POs and PSOs						DoK
		PO1	PO2	PO3	PO4	PS01	PS02	
MTPS1206.1	Analyze and test the power semiconductor devices and their applications.	2	3	-	2	2	3	L2
MTPS1206.2	Compare and contrast various power semiconductor devices according to their applications.	3	2	2	-	1	2	L3
MTPS1206.3	Analyse industrial control of power electronic circuits as well as safe electrical connection and measurement practices.	2	2	3	2	2	1	L3

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

List of Experiments

1. Study of DC-DC non-isolated converters such as Buck & Boost converter **COs:CO1**
2. Study of DC-DC Buck-Boost and Cuk converters. **COs:CO1**
3. Study of 1-ϕ dual converter. **COs:CO1**
4. Determination of input p.f. and harmonic factor for 1-ϕsemi- converter and 1-ϕ full converter (Inductive load) **COs:CO1**
5. Study of p.f. improvement in 1-ϕ full-converter with symmetric and extinction angle control. **COs:CO1**
6. Study of 1-ϕ square wave and sinusoidal PWM inverter **COs:CO2**
7. Study of 3-ϕ inverter with 120o and 180o mode of operation. **COs:CO2**
8 Study of 3-ϕ sinusoidal PWM inverter. **COs:CO2**
9. Study of 3-level NPC inverter **COs:CO2**
10. Study of 5-level cascaded H-bridge inverter. **COs:CO2**
11. Determination of input p.f. and harmonic factor for 3-ϕ full converter . **COs:CO3**
12. Determination of input p.f. and harmonic factor for 3-ϕ semi converter **COs:CO3**
13. Study the characteristics of IGBT, MOSFET & GTO"s. **COs:CO3**

14. Design of gate drive circuits for IGBT & MOSFET"s. **COs:CO3**

Exercise Problems

1. Study of DC – DC Converters
2. Study of 1-phase Dual converter
3. Study of 3-level NPC Inverter
4. Study of 5-level cascaded H-bridge Inverter
5. Design of gate drive circuits for IGBT
6. Determination of input p.f. and harmonic factor for 3-ϕ semi converter

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Bhogapuram (M), Vizianagaram (Dist.) 531162

MTPS21051 **Energy Audit Conservation&Management** **3 0 0 3**

(Power Systems)

Course Objectives:

The main objectives of the course is to

1. To learn the basics of energy audit and energy conservation schemes.
2. To comprehend the principles of energy management
3. Understand the need of energy efficientmotors and lighting design practices.
4. To learn about power factor improvement techniques and energy instruments.
5. To learn about the economic aspects of energy equipment.

Course Code	Course Outcomes	Mapping with POs and PSOs							Dok
		PO1	PO2	PO3	PO5	PO6	PSO1	PSO2	
MTPS21051.1	Understand the fundamental concepts and objectives of energy auditing	3	2	-	1	-	3	2	L2 L3
MTPS21051.2	Understand the fundamentals of energy management and its role in optimizing energy use across various sectors.	3	2	-	1	-	3	2	L3, L4
MTPS21051.3	Understand the principles of energy efficiency in electric motors and lighting systems.	2	1	-	1	-	2	2	L3, L4
MTPS21051.4	Identify and evaluate various methods of power factor correction such as the use of capacitors, synchronous condensers, and phase advancers.	1	2	2	-	-	3	2	L4, L5
MTPS21051.5	Evaluate the economic feasibility of energy conservation and management projects using appropriate financial indicators.	-	2	3	-	-	3	3	L5, L6

SYLLABUS

UNIT – I: Basic Principles of Energy Audit **12 hours**

Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams and load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit.

CO's: CO1

Self-Learning Topics: Energy audit- definitions, concept

UNIT – II: Energy Management **12 hours**

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manager, qualities and functions, language, Questionnaire – check list for top management **CO's: CO2**

Self-Learning Topics: Basic Principles of energy management.

UNIT – III: Energy Efficient Motors and Lighting **12 hours**

Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics – variable speed , variable duty cycle systems, RMS - voltage variation-voltage unbalance- over motoring-motor energy audit. lighting system design and practice, lighting control, lighting energy audit. **CO's: CO3**

Self-Learning Topics: Factors affecting efficiency

UNIT- IV: Power Factor Improvement and energy instruments **10 hours**

Power factor – methods of improvement, location of capacitors, Power factor with non-linear loads, effect of harmonics on p.f, p.f motor controllers – Energy Instruments- watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's. **CO's: CO4**

Self-Learning Topics: Power factor concepts

UNIT-V: Economic Aspects and their computation **10 hours**

Economics Analysis depreciation Methods, time value of money, rate of return, present worth method, replacement analysis, lifecycle costing analysis – Energy efficient motors. Calculation of simple payback method, net present value method- Power factor correction, lighting – Applications of life cycle costing analysis, return on investment. **CO's: CO5**

Self-Learning Topics: Concept of depreciation Methods

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

Expert Talk (To be Delivered by EMs from Industries) **CO's/ PO's / PSO's**

1. Energy Audit Conservation&Management CO1–CO6PO1, PO2,PO3,PO6,PSO1, PSO2

2. Smart Energy Management Systems (EMS) CO1–CO6PO1, PO2,PO3,PO6,PSO1, PSO2

Text Books:

1. Energy management by W.R.Murphy & G.Mckay Butter worth, Heinemann publications, 1982.
2. Energy management hand book by W.CTurner, John Wiley and sons, 1982.

Reference Books:

1. Energy efficient electric motors by John.C.Andreas, Marcel Dekker Inc Ltd-2nd edition,1995
2. Energy management by Paul o' Callaghan, Mc-graw Hill Book company-1st edition, 1998
3. Energy management and good lighting practice : fuel efficiency- booklet12-EEO

Web References:

1. https://archive.nptel.ac.in/courses/108/104/108104052/
2. https://archive.nptel.ac.in/courses/108/101/108101040/#

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	---	---
L2	30	---
L3	40	20
L4	30	40
L5	---	30
L6	---	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define energy audit.
2. What is the difference between energy conservation and energy efficiency?
3. List any four objectives of an energy management program.

L2: Understand

1. What are the core principles of energy management, and how do they contribute to energy

efficiency?

2. What are the essential steps in establishing an effective energy management program within an organization?
3. How should energy management outcomes be reported to stakeholders?
4. Identify and discuss the essential qualities that make an effective energy manager.

L3: Apply

1. How do specific constructional features of energy-efficient motors, such as improved core materials or optimized winding configurations, contribute to reduced energy losses?
2. Describe the effects of voltage unbalance on motor performance and efficiency. What measures can be taken to mitigate these effects?
3. Using the lumen method, design a lighting layout for an office space measuring 20m x 15m with a required illuminance of 500 lux. Assume appropriate utilization and maintenance factors.

L4: Analyzing

1. Analyze the effectiveness of different methods for improving power factor, such as the use of static capacitors, synchronous condensers, and phase advancers.
2. Evaluate the factors influencing the optimal placement of power factor correction capacitors within an electrical network. How does the location (e.g., at the load, distribution panel, or substation) affect the efficiency of power factor correction and the overall system performance?
3. Examine how non-linear loads, such as variable frequency drives and rectifiers, impact the power factor of an electrical system. What challenges do they present, and what strategies can be employed to mitigate their effects?

L5: Evaluating

1. Compare the Straight-Line and Declining Balance methods of depreciation for an energy-efficient motor.
2. Compare the lifecycle costs of two motors: Motor X with a higher initial cost but lower operating costs, and Motor Y with a lower initial cost but higher operating costs. Which motor is more cost-effective over a 10-year period?
3. A company is considering two energy-saving projects: Project A with an internal rate of return (IRR) of 12% and Project B with an IRR of 9%. If the company's minimum acceptable rate of return (MARR) is 10%, which project should be selected, and why?

L6: Create

1. Design a net present value analysis tool that evaluates the financial benefits of implementing power factor
2. Design a comparative study model that evaluates the impact of different depreciation methods (Straight-Line, Declining Balance, Sum-of-the-Years-Digits) on the financial statements of an energy-efficient motor over its useful life.

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Board of Studies (EEE)

MTPS21052 **Smart Grid Technologies** **3 0 0 3**
(Power Systems)

Course Objectives:

The main objectives of the course is to

1. To understand concept of smart grid and developments on smart grid.
2. To understand smart grid technologies and application of smart grid concept in hybrid electric vehicles etc.
3. To have knowledge on smart substations, feeder automation and application for monitoring and protection.
4. To Design and manage smart grid systems effectively
5. To Analyze and optimize smart grid performance.

Course Code	Course Outcomes	Mapping with POs and PSOs							Dok
		PO1	PO2	PO3	PO5	PO6	PSO1	PSO2	
MTPS21052.1	Understand the Concept of Smart Grids and Analyze the Integration of Renewable Energy in Smart Grids	1	2	3	-	-	3	2	L2, L3
MTPS21052.2	Analyze the structure and design of a smart grid, including its components such as advanced metering infrastructure (AMI), communication networks, and control systems.	-	3	2	1	-	2	3	L3, L4
MTPS21052.3	Understand the principles of microgrids and distributed energy resources (DERs), and design their integration into larger smart grid systems.	1	3	3	1	-	2	3	L3, L4
MTPS21052.4	Design a microgrid for different environments (e.g., urban, rural, or off-grid settings) considering factors such as energy demand, renewable resource availability, and reliability.	-	2	3	1	-	3	2	L4, L5
MTPS21052.5	Understand and apply voltage and frequency control techniques, including voltage regulation and automatic frequency regulation, to maintain grid stability and quality.	1	2	-	-	-	3	3	L5, L6

SYLLABUS

UNIT – I: Introduction to Smart Grid **12 hours**

Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient &Self-Healing Grid, Present development & International policies on Smart Grid. Case study of Smart Grid **CO's: CO1**

Self-Learning Topics: Comparison with Traditional Grids

UNIT-II: Smart Grid Technologies Part 1 **12 hours**

Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers.

CO's: CO2

Self-Learning Topics: Advanced Metering Infrastructure (AMI)

UNIT-III: Smart Grid Technologies Part 2 **12 hours**

Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU). **CO's: CO3**

Self-Learning Topics: Sensors used in Smart Grids

UNIT- IV: Micro grids and Distributed Energy Resources **10 hours**

Concept of micro grid, need & applications of microgrid, formation of microgrid, Issues of interconnection, protection & control of microgrid. Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel cells, microturbines, Captive power plants, Integration of renewable energy sources. **CO's: CO4**

Self-Learning Topics: Control and Management of Grids

UNIT-V: Power Quality Management in Smart Grid **10 hours**

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighbourhood Area Network (NAN), Wide Area Network (WAN). **CO's: CO5**

Self-Learning Topics: Advanced Grid Control Techniques

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

Expert Talk (To be Delivered by SGs from Industries) CO's/ PO's / PSO's

1. Energy Storage Systems in Smart Grids CO1–CO6PO1, PO2,PO3,PO6,PSO1, PSO2
2. Cyber security Challenges in Smart Grids CO1–CO6PO1, PO2,PO3,PO6,PSO1, PSO2

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press

Reference Books:

1. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, AkihikoYokoyama, "Smart Grid: Technology and Applications", Wiley
2. Jean Claude Sabonnadière, Nouredine Hadjsaïd, "Smart Grids", Wiley Blackwell 19
3. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
4. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
5. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press
6. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011

Web References:

1. https://archive.nptel.ac.in/courses/108/104/108104052/
2. https://archive.nptel.ac.in/courses/108/101/108101040/#

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	---	---
L2	30	---
L3	40	30
L4	30	40
L5	---	20
L6	---	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. Define the term Smart Grid
2. What is meant by the evolution of the electric grid?
3. List any three functions of a smart grid.

L2: Understand

1. Explain how smart meters differ from traditional energy meters
2. Describe the concept of real-time pricing and how it benefits consumers and utilities.
3. How do smart meters support demand-side management?

L3: Apply

1. Apply the concept of substation automation to design a basic automated protection scheme for a smart substation.
2. Apply GIS tools to map and analyze the layout of an urban power distribution network.
3. Demonstrate how GIS data can help improve outage response time in a smart grid.

L4: Analyzing

1. Analyze how micro grids contribute to grid stability during natural disasters and power outages.
2. Evaluate the potential challenges in integrating a microgrid into the main utility grid, considering factors like power quality and reliability.
3. Analyze the economic benefits and environmental impacts of deploying a micro grid in rural or off-grid areas.

L5: Evaluating

1. Evaluate the impact of electromagnetic compatibility (EMC) issues on the performance of smart grid systems, and propose strategies to mitigate these issues.
2. Assess the significance of power quality in a smart grid environment and how it affects the overall grid performance and end-user experience.
3. Evaluate how power quality management in a smart grid can address the challenges of voltage sags, harmonics, and flickers.

L6: Create

1. Design a power quality management strategy for a smart grid that addresses EMC issues arising from the integration of electric vehicles (EVs) and renewable energy sources issues.
2. Create a schematic diagram of a smart grid showing how power quality issues (voltage sags, harmonics, flickers) are managed using power quality conditioners and filters..
3. Propose a solution to mitigate electromagnetic interference (EMI) from smart meters in a smart grid environment, including a system for monitoring and controlling emissions.

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MTPS21053 **Power Quality and Custom PowerDevices** **3 0 0 3**
(Power Systems)

Course Objectives:

The main objectives of the course is to

1. To understand significance of power quality and power quality parameters.
2. To know types of transient over voltages and protection of transient voltages.
3. To understand harmonics, their effects, harmonic indices and harmonic minimization techniques.
4. To understand the importance of power devices and their applications.
5. To understand different compensation techniques to minimize power qualitydisturbances.

Course Code	Course Outcomes	Mapping with POs and PSOs							Dok
		PO1	PO2	PO3	PO5	PO6	PS01	PS02	
MTPS21053 .1	Understand the Fundamentals of Power Quality Issues	3	2	1	-	-	3	2	L2, L3
MTPS21053 .2	Analyze the Sources and Effects of Power Quality Problems	-	3	2	1	-	2	3	L3, L4
MTPS21053 .3	Apply Power Quality Standards and Regulations	-	1	2	3	1	2	3	L3, L4
MTPS21053 .4	Use Instruments and Tools for Power Quality Monitoring and Analysis	1	2	-	1	-	3	2	L4, L5
MTPS21053 .5	Evaluate Harmonic Distortion and Propose Mitigation Techniques	-	2	3	-	-	3	3	L5, L6

SYLLABUS

UNIT – I: Introduction to Power Quality **12 hours**

Overview of Power Quality, Concern about the Power Quality, General Classes of Power Quality Problems, Voltage Unbalance, Waveform Distortion, Voltage fluctuation, Power Frequency Variations, Power Quality Terms, Voltage Sags, swells, flicker and Interruptions - Sources of voltage and current interruptions, Nonlinear loads. **CO's: CO1**

Self-Learning Topics: Types of power quality disturbances

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, Utility Lightning Protection, Load Switching Transient Problems. 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 generation **CO's: CO2**

Self-Learning Topics: Protection techniques of Power

UNIT-III: Harmonic Distortion and solutions **12 hours**

Voltage vs. Current Distortion, Harmonics vs. Transients - Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Sources of harmonics, Locating Sources of Harmonics, System Response Characteristics, Effects of Harmonic Distortion, Inter harmonics, Harmonic Solutions Harmonic Distortion Evaluation, Devices for Controlling Harmonic Distortion, Harmonic Filter Design, Standards on Harmonics. **CO's: CO3**

Self-Learning Topics: Power Quality Monitoring Equipment and indices.

UNIT- IV: Custom Power Devices **10 hours**

Custom power and custom power devices, voltage source inverters, reactive power and harmonic compensation devices, compensation of voltage interruptions and current interruptions, static series and shunt compensators, compensation in distribution systems, interaction with distribution equipment, installation considerations. **CO's: CO4**

Self-Learning Topics: Custom Power Systems and Devices

UNIT-V: Application of custom power devices in power systems **10 hours**

Static and hybrid Source Transfer Switches, Solid state current limiter - Solid state breaker. P-Q theory – Control of P and Q, Dynamic Voltage Restorer (DVR): Operation and control – Interline Power Flow Controller (IPFC): Operation and control of Unified Power Quality Conditioner (UPQC); Generalized power quality conditioner. **CO's: CO5**

Self-Learning Topics: General usage of Power devices in different systems

Board of Studies: Electrical and Electronics Engineering

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

Approved in ACM No: 02

Expert Talk (To be Delivered by SGs from Industries) **CO's/ PO's / PSO's**

1. Power Quality: Challenges and Solutions CO1–CO6PO1, PO2,PO3,PO6,PSO1, PSO2
2. Custom Power Devices: Design & Application CO1–CO6PO1, PO2,PO3,PO6,PSO1, PSO2

Text Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press

Reference Books:

1. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, AkihikoYokoyama, "Smart Grid: Technology and Applications", Wiley
2. Jean Claude Sabonnadière, NouredineHadjsaïd, "Smart Grids", Wiley Blackwell 19
3. Peter S. Fox Penner, "Smart Power: Climate Changes, the Smart Grid, and the Future of Electric Utilities", Island Press; 1 edition 8 Jun 2010
4. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks." Institution of Engineering and Technology, 30 Jun 2009
5. Stuart Borlase, "Smart Grids (Power Engineering)", CRC Press
6. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011

Web References:

1. https://archive.nptel.ac.in/courses/108/104/108104052/
2. https://archive.nptel.ac.in/courses/108/101/108101040/#

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1(%)	Internal Assessment #2(%)
L1	---	---
L2	30	---
L3	40	20
L4	30	40
L5	---	30
L6	---	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What is power quality, and why is it important in electrical power systems?
2. Why has power quality become a significant concern in modern electrical systems?
3. What are the potential economic and operational impacts of poor power quality on industrial and commercial facilities?
4. Why has power quality become a significant concern in modern electrical systems?

L2: Understand

1. What are the primary causes of transient over voltages in power systems?
2. How do lightning strikes and capacitor switching operations lead to transient over voltages?
3. What is the main objective of overvoltage protection in electrical systems?
4. What are capacitor switching transients, and why are they a concern in power systems?

L3: Apply

1. Calculate the apparent, active, and reactive power for a system where the current waveform contains significant harmonic components.
2. Given the harmonic spectrum of a current waveform, compute the Total Harmonic Distortion (THD) and discuss its implications on system performance and compliance with standards.
3. Explain the occurrence of inter harmonics in power systems and evaluate their potential effects on lighting systems, particularly regarding flicker and performance degradation.

L4: Analyzing

1. Compare and contrast the functionalities and applications of compensating-type custom power devices such as D-STATCOM, DVR, and UPQC.
2. Analyze the role of Voltage Source Inverters in the operation of custom power devices. Why are VSIs preferred over Current Source Inverters (CSI) in these applications?
3. Evaluate the effectiveness of shunt compensators like D-STATCOM in mitigating reactive power issues and harmonics in a distribution network.

L5: Evaluating

1. Evaluate the advantages and limitations of static source transfer switches (SSTS) compared to hybrid transfer switches in terms of transfer speed, reliability, and suitability for critical load protection.
2. Compare the operational performance of SSCLs and traditional mechanical breakers in terms of speed, maintenance requirements, and fault isolation capabilities.
3. Evaluate the application of P-Q theory in the control of active and reactive power in power systems. How does this theory enhance the performance of custom power devices like UPQC?
4. Analyze the role of DVRs in compensating voltage sags and swells. Evaluate their effectiveness in different fault scenarios and their impact on sensitive load protection.

L6: Create

1. Design a hybrid Source Transfer Switch (STS) that combines solid-state and electromechanical components.
2. Develop a Solid-State Fault Current Limiter (SSFCL) for a medium-voltage distribution system.

Chairperson
Board of Studies (EEE)

MTPS2106 **Renewable Energy Sources** **3 0 0 3**
(Open Elective)

Course Objectives:

The main objectives of the course is to

1. To study the solar radiation data, equivalent circuit of PV cell and its I-V & P-V characteristics
2. To understand the concept of Wind Energy Conversion & its applications.
3. To study the principles of biomass and geothermal energy.
4. To understand the principles of Ocean Thermal Energy Conversion (OTEC), motion of waves and power associated with it.
5. To study the various chemical energy sources such as fuel cell and hydrogen energy along with their operation and equivalent circuit.

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO4	PO5	PO8	PSO2	
MTPS2106.1	Analyze solar radiation data, extra-terrestrial radiation, radiation on earth's surface and solar Energy Storage.	-	3	2	1	1	3	1	L2,L3
MTPS2106.2	Illustrate the components of wind energy systems.	1	3	-	1	1	1	1	L3, L4
MTPS2106.3	Illustrate the working of biomass, digesters and Geothermal plants.	2	2	-	-	1	-	1	L3, L4
MTPS2106.4	Demonstrate the principle of Energy production from OTEC, Tidal and Waves.	3	1	-	2	1	1	1	L4,L5
MTPS2106.5	Evaluate the concept and working of Fuel cells & MHD power generation.	-	3	2	2	1	2	2	L5,L6

SYLLABUS

Unit –I: Solar Energy **14 Hours**

Introduction - Renewable Sources - prospects, solar radiation at the Earth Surface - Equivalent circuit of a Photovoltaic (PV) Cell - I-V & P-V Characteristics - Solar Energy Collectors: Flat plate Collectors, concentrating collectors - Solar Energy storage systems and Applications: Solar Pond - Solar water heating - Solar Green house. **CO's: CO1**

Self-Learning Topics: Modeling and implementation of maximum-power-point-tracking (MPPT) algorithms for PV systems.

Unit –II: Wind Energy **10 Hours**

Introduction - basic Principles of Wind Energy Conversion, the nature of Wind - the power in the wind - Wind Energy Conversion - Site selection considerations - basic components of Wind Energy Conversion Systems (WECS) - Classification - Applications. **CO's: CO2**

Self-Learning Topics: wind farm control strategies for wake steering and power smoothing.

Unit –III: Biomass and Geothermal Energy **12 Hours**

Biomass: Introduction - Biomass conversion technologies - Photosynthesis, factors affecting Bio digestion - classification of biogas plants - Types of biogas plants - selection of site for a biogas plant.

Geothermal Energy: Introduction, Geothermal Sources – Applications - operational and Environmental problems. **CO's: CO3**

Self-Learning Topics: Advanced biomass pre treatment and enzymatic hydrolysis techniques for second-generation bio-fuels.

Unit –IV: Energy from Oceans, Waves & Tides **12 Hours**

Oceans: Introduction - Ocean Thermal Electric Conversion (OTEC) – methods - prospects of OTEC in India.

Waves: Introduction - Energy and Power from the waves - Wave Energy conversion devices.
Tides: Basic principle of Tide Energy -Components of Tidal Energy. **CO's: CO4**

Self-Learning Topics: Advanced fluid dynamics modelling of ocean currents for tidal-stream turbine optimization**.**

Unit –V: Chemical Energy Sources **12 Hours**

Fuel Cells: Introduction - Fuel Cell Equivalent Circuit - operation of Fuel cell - types of Fuel Cells - Applications.

Hydrogen Energy: Introduction - Methods of Hydrogen production - Storage and Applications
Magneto Hydro Dynamic (MHD) Power generation: Principle of Operation - Types.

Self-Learning Topics: Magneto hydro dynamic (MHD) channel design under different working fluids (liquid metal vs. plasma) and magnetic field configurations **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. G.D.Rai, Non-Conventional Energy Sources, Khanna Publications, 2011.
2. John Twidell & Tony Weir, Renewable Energy Sources, Taylor & Francis, 2013.

Reference Books:

1. S.P.Sukhatme & J.K.Nayak, Solar Energy-Principles of Thermal Collection and Storage, TMH, 2011.
2. John Andrews & Nick Jelly, Energy Science- principles, Technologies and Impacts, Oxford, 2nd edition, 2013.
3. Shoba Nath Singh, Non- Conventional Energy Resources, Pearson Publications, 2015.

Web References:

1. https://nptel.ac.in/courses/103103206
2. https://archive.nptel.ac.in/courses/103/103/103103206/

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	---	---
L2	30	---
L3	50	20
L4	20	40
L5	---	30
L6	---	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What is renewable energy
2. What are the different types of solar collectors?
3. Discuss the advantages and disadvantages of wind energy.
4. Describe the process of hydropower generation

L2: Understand

1. Discuss the environmental impacts of solar energy systems.
2. Explain the difference between renewable and non-renewable energy sources
3. What are the advantages and limitations of using wind energy?
4. Describe the process of energy generation in a wind turbine.

L3: Apply

1. Develop a Solar Water Pumping System for Irrigation

2. How can you apply the principles of wind energy to design a new type of turbine?.
3. How can renewable energy be used to power a home?

L4: Analyzing

1. Analyze the environmental benefits and drawbacks of using wind energy
2. Compare the efficiency and cost-effectiveness of different energy storage technologies in renewable energy systems
3. Analyze the impact of intermittency on the integration of solar and wind energy into the national grid.

L5: Evaluating

1. Evaluate the benefits of using a three-phase supply for residential versus industrial setups.
2. Briefly explain the environmental factors associated with wind energy.
3. Describe with a neat sketch the working of WECS with main components
4. Prioritize the advantage and limitations of Tidal power plant.

L6: Create

1. Compare open-cycle and closed-cycle MHD systems, discussing the working fluid, heat source, and typical thermal-to-electric conversion efficiencies for each.
2. Design a hybrid power plant combining solar thermal input with an open-cycle MHD generator, detailing the thermodynamic cycle and expected overall efficiency.

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MTPS2107 Battery Management Systems and Charging Stations 3 0 0 3
(Open Elective)

Course Objectives:

The main objectives of the course is to

1. Able to understand the working of different batteries for EV applications
2. Able to know the fundamentals of battery charging methods and their advantages
3. Able to know the different kinds of equipment in charging station
4. Able to know the requirements of battery management.
5. Able to know method of modelling batteries and their simulation studies.

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	
MTPS2107.1	Describe the construction and operation of different batteries for EV applications	2	2	-	-	1	2	1	L2,L3
MTPS2107.2	Describe charging algorithms of different batteries and balancing methods of battery packs	-	2	-	-	1	2	1	L2, L3
MTPS2107.3	Describe the different kinds of infrastructure needed in the charging stations	-	2	-	-	1	2	1	L3, L4
MTPS2107.4	Describe the requirements of battery management and their maintenance.	-	2	-	-	1	1	1	L4,L5
MTPS2107.5	Obtain the modeling of batteries and develop their simulation models.	-	3	2	1	1	2	2	L5,L6

SYLLABUS

Unit –I: 14 Hours

EV Batteries: Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel. Lead Acid Batteries: Lead acid battery basics, special characteristics of lead acid batteries, battery life and maintenance, Li-ion batteries. Nickel-based Batteries: Nickel cadmium, Nickel metal hydride batteries. Sodium-Based Batteries: Introduction, sodium sulphur batteries, sodium metal chloride (Zebra) batteries. Lithium Batteries: Introduction, the lithium polymer battery, lithium ion battery. **CO's: CO1**

Self-Learning Topics: Series and Parallel connection of Cells.

Unit –II:

Battery charging strategies : Charging algorithms for a single battery: Basic terms for charging performance evaluation and characterization, CC charging for NiCd / NiMH batteries, CV charging for lead acid batteries, CC/CV charging for lead acid and Li-ion batteries, MSCC charging for lead acid, NiMH and Li-ion batteries, TSCC/CV charging for Li-ion batteries, CVCC/CV charging for Li-ion batteries, Pulse charging for lead acid, NiCd/NiMH and Li-ion batteries, Charging termination techniques. **CO's: CO2**

Self-Learning Topics: Constant Current (CC) Charging, Pulse Charging.

Unit –III:

Charging Infrastructure: Domestic Charging Infrastructure, Public charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone. **CO's: CO3**

Self-Learning Topics: Home-based charging setups.

Unit –IV:

Battery-Management-System Requirements: Battery-pack topology, BMS design requirements, Voltage sense, Temperature sense, Current sense, Contactor control, Isolation sense, Thermal control, Protection, Charger control, Communication via CAN bus, Log book, SOC estimation, Energy estimation, Power estimation, Diagnostics. **CO's: CO4**

Self-Learning Topics: Voltage Sense – Monitoring individual cell and total pack voltage

Unit –V:

Battery Modelling: General approach to modelling batteries, simulation model of rechargeable Li-ion battery, simulation model of a rechargeable NiCd battery, Parameterization of NiCd battery model, Simulation examples. **CO's: CO5**

Self-Learning Topics: Dynamic behavior representation under charge/discharge cycles

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Text Books:

1. Electric Vehicles Technology Explained by James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., Uk. (Unit-1)
2. Energy Systems for Electric and Hybrid Vehicles by K.T. Chau, IET Publications, First edition, 2016. (Unit-2)

Reference Books:

1. Modern Electric Vehicles Technology by C.C.Chan, K.T Chau, Oxford University Press Inc., New york , 2001. (Unit-3)
2. Battery Management Systems Vol. – II Equivalent Circuits and Methods, by Gregory L.Plett, Artech House publisher, First edition 2016. (Unit-4)
3. Battery Management Systems: design by Modelling by Henk Jan Bergveld, Wanda S. Kruijt, Springer Science & Business Media, 2002. (Unit-5)

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	---	---
L2	40	---
L3	40	20
L4	20	40
L5	---	30
L6	---	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What is the main function of a Battery Management System (BMS)?
2. What are the common types of EV charging stations?
3. Describe the basic components of a Battery Management System.
4. Explain the difference between Level 1, Level 2, and DC fast charging stations.

L2: Understand

1. Why is cell balancing important in a battery pack?
2. How does a charging station determine how much power to deliver to an EV?
3. Discuss how a BMS manages battery charging and discharging.
4. Explain the working principle of a fast charging station.

L3: Apply

1. How would you use a BMS to monitor a lithium-ion battery in an electric bike?
2. How would a BMS respond if a battery cell overheats?
3. Describe the application of BMS in electric buses and its role in fleet safety.

4. Explain how to integrate solar power into an EV charging station.
5. Apply the concept of power conversion in EV fast charging stations.

L4: Analyzing

1. Compare centralized and distributed BMS architectures.
2. What are the potential failure points in a charging station system?
3. Analyze the challenges in interoperability between different EVs and public charging stations.
4. Examine the role of BMS in preventing thermal runaway.
5. Analyze the power flow and communication process between an EV and a fast charger.

L5: Evaluating

1. Evaluate the need for fast charging stations in urban areas.
2. What are the key factors to consider when selecting a BMS for an EV?
3. Evaluate the effectiveness of BMS in extending battery life.
4. Critically assess the challenges in implementing universal charging standards.
5. Evaluate the cost-effectiveness of installing DC fast chargers in rural areas.

L6: Create

1. Explain the role of thermal effects in battery modeling and how they are integrated into simulation models.
2. Design and describe a simulation example showing the charge/discharge behavior of a Li-ion battery

Chairperson
Board of Studies (EEE)

MTPS2108 **Concepts of Power System Engineering** **3 0 0 3**
(Open Elective)

Course Objectives:

The main objectives of the course is to

1. To understand the types of electric power plants and their working principles.
2. To understand the concepts of electric power transmission and distribution.
3. To gain the knowledge of protection and grounding of power system components.
4. To know the economic aspects of electrical energy.
5. To learn the importance of power factor improvement and voltage control.

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO4	PO6	PO11	PSO2	
MTPS2108.1	Know the concepts of power generation by various types of power plants.	3	1	-	1	-	2	1	L2,L3
MTPS2108.2	Learn about transmission line concepts and distribution systems schemes.	3	1	-	-	-	1	1	L3, L4
MTPS2108.3	Learn about protection equipments and grounding methods of power system.	3	1	-	-	-	1	2	L3, L4
MTPS2108.4	Know the economic aspects of electrical energy and their importance.	3	1	-	1	-	2	1	L4,L5
MTPS2108.5	Know the importance of power factor improvement and voltage control in power systems.	3	1	-	1	-	2	1	L5,L6

SYLLABUS

Unit –I: **14 Hours**

Power Generation Concepts & Types: Generation and sources of Energy – working principle and Schematic diagram approach of Thermal Power Plant – Hydro Power Plant - Nuclear Power Plant – Gas Power Plants – Comparison between Power Plants. **CO's: CO1**

Self-Learning Topics: Understand how daily and annual load curves influence plant efficiency and design.

Unit –II: **10 Hours**

Transmission and Distribution Concepts: Types of Conductors Materials – Constants of Transmission Line – Classification of Overhead Transmission Lines – Performance of Short

Transmission Lines – Simple Problems. Basic concept of Sub Station – Distribution Systems – Connection Schemes of Distribution Systems – Structure of Cables – Differences between Overhead & Underground systems. **CO's: CO2**

Self-Learning Topics: Understand how alternating current distribution affects conductor performance.

Unit –III: 12 Hours

Protection and Grounding: List of Faults – Basic concepts of fuse – Circuit Breakers – Relays – SF6 Circuit Breakers – Vacuum Circuit Breakers – Operation of Lightning Arrester – Grounding and its advantages - Methods of Neutral Grounding: Resistance - Reactance and Resonant Grounding – Numerical Problems**.** **CO's: CO3**

Self-Learning Topics: Study the role of sulfur hexafluoride in arc quenching and insulation.

Unit –IV: 10 Hours

Economic Aspects: Definitions of Load - Load & Load Duration Curves - Load Factor - Demand Factor – Utilization Factor – Types of tariff - Cost of Electrical Energy – Expression for Cost of Electrical Energy – Numerical Problems. **CO's: CO4**

Self-Learning Topics: Understand how to analyze load variation over time for system planning and optimization.

Unit –V: 10 Hours

Power Factor Improvement and Voltage Control: Power Factor – Effects and Causes of low Power Factor- Shunt & Series Capacitor Compensation - Numerical Problems – Need of Voltage Control – Types of Voltage regulating Devices. **CO's: CO5**

Self-Learning Topics: Understand how low power factor increases system losses and reduces voltage levels.

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

Approved in ACM No: 02

Text Books:

1. Power System Stability and Control by P. Kundur – Mc Graw Hill Publishers.
2. Power System Analysis John J. Grainger, William D. Stevenson- Mc Graw Hill Publishers.

Reference Books:

1. Electrical Power Systems by C.L.Wadwa - New Age International Publishers.

Web References:

1. https://archive.nptel.ac.in/courses/108/105/108105104/

2. https://onlinecourses.nptel.ac.in/noc22_ee17/preview

Internal Assessment Pattern

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

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What is a Transformer and its Role in Power Systems?
2. Explain the Purpose of Circuit Breakers in Power Systems.
3. List the Major Components of a Power System.

L2: Understand

1. Explain the significance of load curves in power system planning
2. Describe the purpose and operation of protective devices in T&D systems.
3. Describe the role and components of a substation in the power system.
4. Discuss the advantages and disadvantages of overhead versus underground transmission lines.

L3: Apply

1. Explain how power factor correction contributes to the overall efficiency of the power system.
2. Explain types of Traiff. Derive the expression for cost of Electrical energy.
3. Difference between Overhead line and underground cable.

L4: Analyzing

1. Explain the operation of SF_6 Circuit Breaker
2. Explain the operation of Lightning arrester.
3. Explain the effects and causes of Low power factor.

L5: Evaluating

1. Discuss the potential economic benefits of enhanced voltage stability, such as reduced equipment wear and lower maintenance costs

2. Justify the use of hybrid parameters in transistor modeling.
3. Discuss the long-term economic benefits of maintaining a high power factor.

L6: Create

1. What is the role of reactive power compensation in voltage control, and how do capacitor banks assist in this process?
2. Describe the effects of inductive loads on power factor and how can capacitor compensation be used to counter these effects.

Chairperson
Board of Studies (EEE)

MTPS2109 **Applications of Power Converters** **3 0 0 3**

(Open Elective)

Course Objectives:

The main objectives of the course is to

1. To understand the inverters for induction heating applications.
2. To understand the power converters for different industrial applications.
3. To understand modeling of high voltage power supplies using the power converters for radar and space applications.
4. To understand modeling of low voltage and high current power supplies using the power converters for microprocessors and computer loads.
5. To understand the applications of DC-DC converters.

Course Code	Course Outcomes	Mapping with POs and PSOs							DoK
		PO1	PO2	PO3	PO4	PO5	PO11	PSO2	
MTPS2109.1	Analyze power electronic application requirements.	-	3	2	1	1	2	1	L2,L3
MTPS2109.2	Identify suitable power converter from the available configurations.	-	3	-	1	-	2	2	L3, L4
MTPS2109.3	Develop improved power converters for any stringent application requirements.	-	1	3	2	1	3	2	L3, L4
MTPS2109.4	Improvise the existing control techniques to suit the application.	-	1	3	2	1	1	2	L4,L5
MTPS2109.5	Design of Bi-directional converters for charge/discharge applications.	-	1	3	2	1	1	2	L5,L6

SYLLABUS

Unit –I: **14 Hours**

Inverters for Induction Heating: For induction cooking, induction hardening, melting, and welding applications **CO's: CO1**

Self-Learning Topics: Basic concepts of electromagnetic induction and its role in heating.

Unit –II: **10 Hours**

Power Converters for Lighting, pumping and refrigeration Systems: Electronic ballast, LED power drivers for indoor and outdoor applications. PFC based grid fed LED drivers, PV / battery fed LED drivers. PV fed power supplies for pumping/refrigeration applications. **CO's: CO2**

Self-Learning Topics: Overview of power conversion systems used in lighting, pumping, and refrigeration.

Unit –III: **12 Hours**

High Voltage Power Supplies - Power supplies for X-ray applications - power supplies for radar applications - power supplies for space applications**.**

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

Unit –IV: **10 Hours**

Low voltage high current power supplies: Power converters for modern microprocessor and computer loads**.** **CO's: CO4**

Self-Learning Topics: Overview of low voltage high current power supplies

Unit –V: **10 Hours**

Bi-directional DC-DC (BDC) converters: Electric traction, automotive Electronics and charge/discharge applications, Line Conditioners and Solar Charge Controllers. **CO's: CO5**

Self-Learning Topics: Key components and operating principles of bi-directional DC-DC Converters.

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

Approved in ACM No: 02

Text Books:

1. Ali Emadi, A. Nasiri, and S. B. Bekiarov: Uninterruptible Power Supplies and Active Filters, CRC Press, 2005.
2. M. Ehsani, Y. Gao, E. G. Sebastien and A. Emadi: Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 1st Edition,CRC Press, 2004.

Reference Books:

1. William Ribbens: Understanding Automotive Electronics, Newnes, 2003.

Web References:

1. https://archive.nptel.ac.in/courses/117/103/117103148/
2. https://onlinecourses.nptel.ac.in/noc24_ee130/preview

Internal Assessment Pattern

Cognitive Level	Internal Assessment #1 (%)	Internal Assessment #2 (%)
L1	---	---
L2	30	---
L3	50	20
L4	20	40

L5	---	30
L6	---	10
Total (%)	100	100

Sample Short and Long Answers questions of Various Cognitive Levels

L1: Remember

1. What is the principle of induction heating?
2. List common applications of induction heating.
3. What is the typical frequency range used in induction heating inverters?
4. Name two advantages of using inverters in induction heating systems.

L2: Understand

1. Explain how electronic ballasts differ from conventional magnetic ballasts in lighting systems.
2. Discuss the advantages of using LED power drivers in indoor vs. outdoor lighting applications
3. Explain why PFC-based LED drivers are important in grid-connected systems.
4. Describe how power converters enable PV-based pumping systems to operate efficiently throughout the day

L3: Apply

1. Calculate the output voltage needed for an X-ray power supply if the tube requires 80 kV and a current of 10 mA.
2. Design a basic block diagram of a high-voltage DC power supply suitable for radar transmitters.
3. Illustrate how voltage regulation can be achieved in a high-voltage power supply for X-ray applications.
4. Apply your knowledge of insulation and safety practices to propose suitable insulation methods for high-voltage supplies used in space applications.
5. Calculate the input power required by a high-voltage power supply delivering 100 kV at 1 mA with an overall efficiency of 80%.

L4: Analyzing

1. Analyze how load transients in modern microprocessors affect the performance of low-voltage high-current power supplies.
2. Compare the efficiency of different converter topologies (e.g., Buck, multiphase Buck) used for low-voltage high-current supplies in computing systems
3. Examine the impact of output voltage ripple on the performance of microprocessor loads

4. Analyze the need for high dynamic response in power supplies for modern computer loads.
5. Differentiate between single-phase and multiphase power converters in terms of current sharing and transient response.

L5: Evaluating

1. Evaluate the suitability of a bidirectional buck-boost converter for electric vehicle (EV) traction applications.
2. Evaluate the impact of different control strategies (e.g., current-mode vs. voltage-mode) on the stability and transient response of BDC converters in solar charge controllers
3. Evaluate the thermal management challenges in high-power bidirectional converters for electric traction applications.

L6: Create

1. Design a bidirectional DC-DC converter circuit for a solar charge controller that can charge and discharge a 48 V battery bank.
2. Develop a simulation model for a bidirectional buck-boost converter used in electric traction systems, including regenerative braking mode.
3. Create a block diagram for a BDC converter-based power management system in a hybrid electric vehicle.

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