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ताळगांव पठार,
गोंय – ४०३ २०६
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(Accredited by NAAC)

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GU/Acad –PG/BoS -NEP Engg./2024-25/770 Date: 22.01.2025

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP Engg./2024/618 dated 30.10.2024

In supersession to the above referred Circular the Syllabus of Semester II of the **Master of Engineering (Power and Energy Engineering)** Programme approved by the Academic Council in its meeting held on 06th December 2024 is attached herewith. The Syllabus of Semester I approved earlier by the Academic Council in its meeting held on 22nd August 2024 is also attached.

The Dean, Faculty of Engineering and Principals of affiliated Colleges offering the **Master of Engineering (Power and Energy Engineering)** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.01.22 17:15:57 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of affiliated Engineering Colleges.

Copy to,

1. The Director, Directorate of Technical Education, Govt. of Goa
2. The Chairperson, BoS in Electrical & Electronics Engineering.
3. The Controller of Examinations, Goa University.
4. The Assistant Registrar Examinations (Prof.), Goa University.
5. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

MASTER OF ENGINEERING (POWER AND ENERGY ENGINEERING) RC 2024-25

TWO YEAR PROGRAMME STRUCTURE						
Semester I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	EEL-500	Non-Conventional Energy Sources	3	0	0	3
2	EEL-501	Power & Energy Laboratory – I	0	0	1	1
3	EEL-502	Advanced Power Electronics	3	1	0	4
4	EEL-503	Photovoltaic System Design	3	1	0	4
Programme Specific Elective (PSE) Courses						
6	EEL-531	Artificial Intelligence Applications to Power Systems	3	1	0	4
OR						
7	EEL-532	High Voltage Alternating Current / Direct Current Transmission	3	1	0	4
Research Specific Elective (RSE) Courses						
8	REC-561	Engineering Research & Publication	3	1	0	4
OR						
9	REC-562	Literature Review & Technical Writing for Engineers	3	1	0	4
		Total	**15**	**4**	**1**	**20**
Semester II						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	EEL-504	Restructured Power Systems	3	0	0	3
2	EEL-505	Power Systems Laboratory I	0	0	1	1
3	EEL-506	Energy Auditing & Management	3	0	0	3
4	EEL-507	Energy Engineering Laboratory	0	0	1	1
5	EEL-508	Solid State AC/DC Drives	3	0	0	3
6	EEL-509	Electric Drives Laboratory	0	0	1	1
Programme Specific Elective (PSE) Courses						
7	EEL-533	Smart Grid	3	0	0	3
8	EEL-534	Smart Grid Laboratory	0	0	1	1
OR						
9	EEL-535	Power Quality	3	0	0	3
10	EEL-536	Power Quality Laboratory	0	0	1	1
Research Specific Elective (RSE) Courses						
11	REC-563	Statistics and Data Analysis for Engineering Research	2	0	0	2
12	REC-564	Statistics and Data Analysis Laboratory	0	0	2	2
OR						
13	REC-565	Statistical Techniques for Engineering Research	2	0	0	2
14	REC-566	Probability & Statistical Analysis Lab	0	0	2	2
		Total	**14**	**0**	**6**	**20**

Issued on: 22/01/2025

Semester III						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**EEL-600**	High Voltage Testing & Measurement	3	0	0	3
2	**EEL-601**	High Voltage Laboratory	0	0	1	1
3	**EEL-602**	Power Electronic Interface to Renewable Energy System	3	0	0	3
4	**EEL-603**	Renewable Energy System Laboratory	0	0	1	1
Programme Specific Elective (PSE) Courses						
5	**EEL-631**	DSP Applications to Power System	3	0	0	3
6	**EEL-632**	Signal Processing Laboratory	0	0	1	1
OR						
7	**EEL-633**	Flexible AC Transmission System	3	0	0	3
8	**EEL-634**	Power System Laboratory II	0	0	1	1
Research Specific Elective (RSE) Courses						
9	**EEL-661**	Electrical Machine Modelling & Simulations	2	0	0	2
10	**EEL-662**	Modelling & Simulation Laboratory	0	0	2	2
OR						
11	**EEL-663**	Optimization Techniques	2	0	0	2
12	**EEL-664**	Optimization Techniques Laboratory	0	0	2	2
Generic Elective (GE) Courses						
13	**GEC-681**	Sustainability Principles & Practices	3	0	0	3
14	**GEC-682**	Sustainability Principles Lab	0	0	1	1
OR						
15	**GEC-683**	Project Management	3	0	0	3
16	**GEC-684**	Project Management Lab	0	0	1	1
		Total	**14**	**0**	**6**	**20**
Semester IV						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
General Elective						
1	**GEC-685**	Financial Management	4	0	0	4
OR						
2	**GEC-686**	Entrepreneurship	4	0	0	4
Dissertation/Internship						
3	**EEL-698**	Dissertation	0	0	0	16
OR						
4	**EEL-699**	Internship	0	0	0	16
		Total	**4**	**0**	**0**	**20**

THREE YEAR PROGRAMME STRUCTURE						
Semester I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**EEL-500**	Non-Conventional Energy Sources	3	0	0	3
2	**EEL-501**	Power & Energy Laboratory – I	0	0	1	1
Programme Specific Elective (PSE) Courses						
3	**EEL-531**	Artificial Intelligence Applications to Power Systems	3	1	0	4
OR						
4	**EEL-532**	High Voltage Alternating Current / Direct Current Transmission	3	1	0	4
Research Specific Elective (RSE) Courses						
5	**REC-561**	Engineering Research & Publication	3	1	0	4
OR						
6	**REC-562**	Literature Review & Technical Writing for Engineers	3	1	0	4
		Total	**9**	**2**	**1**	**12**
Semester II						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**EEL-506**	Energy Auditing & Management	3	0	0	3
2	**EEL-507**	Energy Engineering Laboratory	0	0	1	1
Programme Specific Elective (PSE) Courses						
3	**EEL-533**	Smart Grid	3	0	0	3
4	**EEL-534**	Smart Grid Laboratory	0	0	1	1
OR						
5	**EEL-535**	Power Quality	3	0	0	3
6	**EEL-536**	Power Quality Laboratory	0	0	1	1
Research Specific Elective (RSE) Courses						
7	**REC-563**	Statistics and Data Analysis for Engineering Research	2	0	0	2
8	**REC-564**	Statistics and Data Analysis Lab	0	0	2	2
OR						
9	**REC-565**	Statistical Techniques for Engineering Research	2	0	0	2
10	**REC-566**	Probability & Statistical Analysis Lab	0	0	2	2
		Total	**8**	**0**	**4**	**12**

Issued on: 22/01/2025

Semester III						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**EEL-502**	Advanced Power Electronics	3	1	0	4
3	**EEL-503**	Photovoltaic System Design	3	1	0	4
Programme Specific Elective (PSE) Courses						
5	**EEL-631**	DSP Applications to Power System	3	0	0	3
6	**EEL-632**	Signal Processing Laboratory	0	0	1	1
OR						
7	**EEL-633**	Flexible AC Transmission System	3	0	0	3
8	**EEL-634**	Power System Laboratory II	0	0	1	1
		Total	**9**	**0**	**3**	**12**
Semester IV						
Sr. No	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**EEL-504**	Restructured Power Systems	3	0	0	3
2	**EEL-505**	Power Systems Laboratory	0	0	1	1
3	**EEL-508**	Solid State AC/DC Drives	3	0	0	3
4	**EEL-509**	Electric Drives Laboratory	0	0	1	1
Generic Elective (GE) Courses						
5	**EEL-681**	Sustainability Principles & Practices	3	0	0	3
6	**EEL-682**	Sustainability Principles Lab	0	0	1	1
OR						
7	**EEL-683**	Project Management	3	0	0	3
8	**EEL-684**	Project Management Lab	0	0	1	1
		Total	**9**	**0**	**3**	**12**

Semester V						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	**EEL-600**	High Voltage Testing & Measurement	3	0	0	3
2	**EEL-601**	High Voltage Laboratory	0	0	1	1
3	**EEL-602**	Power Electronic Interface to Renewable Energy System	3	0	0	3
4	**EEL-603**	Renewable Energy System Laboratory	0	0	1	1
Research Elective						
5	**EEL-661**	Electrical Machine Modelling & Simulations	3	0	0	3
6	**EEL-662**	Modelling & Simulation Laboratory	0	0	1	1
OR						
7	**EEL-663**	Optimization Techniques	3	0	0	3
8	**EEL-664**	Optimization Techniques Laboratory	0	0	1	1
		Total	**9**	**0**	**3**	**12**
Semester VI						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
General Elective						
1	**GEC-685**	Financial Management	4	0	0	4
OR						
2	**GEC-686**	Entrepreneurship	4	0	0	4
Dissertation/Internship						
3	**EEL-698**	Dissertation	0	0	0	16
OR						
4	**EEL-699**	Internship	0	0	0	16
		Total	**4**	**0**	**0**	**20**

Semester I
Programme Specific Core (PSC) Courses
Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-500
Title of the Course : Non-Conventional Energy Sources
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable the students to 1. Describe the fundamentals and main characteristics of wind, solar PV, small hydro, fuel cell, Tidal, and other new renewable energy technologies. 2. Develop the basic technological idea about various New & Renewable energy Conversion Technology. 3. Design small scale PV and wind energy systems considering various aspects of site selection and load requirement.	
Content:		**No. of Hours**
Unit -1	**Introduction of Energy Sources:** Conventional, Nonconventional, Renewable, Non-renewable sources of Energy, prospects and perspectives, advantages, Energy Scenario, worlds production and reserves of commercial energy sources, Introduction to different sources of Nonconventional Energy, Solar energy, Fuel Cell, Wind Energy, Tidal Energy, Geothermal Energy, Hydrogen Energy.	**11**
Unit -2	**Solar Energy: Solar** energy alternatives, solar radiation, availability, measurement and estimation, solar geometry, solar thermal conversion devices and storage applications, Solar Photovoltaic conversion, basics of technology, PV-powered agricultural facility, micro-irrigation systems, remote area applications, portable applications, PV power for domestic use applications, BOS components of solar PV systems, Design & Economic considerations	**11**
Unit -3	**Wind Energy: -** Wind energy conversion principles, Types, and classification of WECS, Aerodynamic theories, Power, torque and speed characteristics, general concepts of airfoils and aerodynamics, Site Selection Criteria, Analysis of wind flow, measurement of wind speed, Power in wind, performance calculations of wind turbine, Electrical systems, Economics of wind energy utilization.	**12**
Unit- 4	**Other Non-Conventional Energy Sources: -**Biomass-Biomass as a source of energy, methods of obtaining energy from biomass, biomass gasification, classification of biogas plants, pyrolysis. Tidal- Basic principle of tidal power, components of tidal power plant, operation methods of utilization of tidal energy, estimation of single basin systems and double cycle systems,	**11**

	Fuel cells - Principle and classification, types, polarization curve and efficiency. Storage systems for renewable energy applications.	
Pedagogy:	Reflective Learning, Constructive learning and Collaborative & Inquiry based.	
References/ Readings:	1. Chetan Singh Solanki, "Solar Photovoltaics", PHI learning Pvt Ltd., New Delhi, 3rd Edition, 2015. 2. G D Rai, "Non-Conventional Energy Sources," Khanna Publications, 2011 3. John Twidell and Tony Weir, "Renewable Energy sources", Taylor and Francis, 3rd edition, 2015 4. S. P. Sukhatme, "Solar Energy- Principle of Thermal collector and storage," TMH publication, Third edition, 2017	
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand various aspects of renewable energy sources, various components used, and applications CO 2. Decide about the site selection based on the environmental parameters. CO 3. Analyse economic and environmental aspects of renewable energy sources CO 4. Decide the ratings and specifications of SPV and wind turbines based on the load requirements	

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Name of the Programme : **Master of Engineering (Power and Energy Engineering)**
Course Code : **EEL-501**
Title of the Course : **Power & Energy Laboratory-I**
Number of Credits : **01 (1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable the students to: 1. Understand the power system components and interconnection. 2. Interpret the experimental results with practical power system. 3. Analyse different power converters and electrical devices. 4. Practice simulation and experimental studies in power system.	
Contents:	Minimum 8 experiments to be performed from the given list	**No. of Hours**
Sr No	**Title of the Experiment**	**30**
1	Single phase semi/ fully controlled converter circuit	
2	Single phase PWM Inverter circuit	
3	Design and Simulation of Buck, Boost, Buck-Boost converter with feedback	
4	Design and Simulation of Three phase PWM control based Inverter circuit	
5	V/F control of 3 phase induction motor using VFD	
6	Simulation study of Solar PV energy system	
7	Study and analyze the Solar radiation by using a Pyranometer and Pyro heliometer	
8	Determination of I-V and P-V Characteristics of solar PV module for different insolation and temperature conditions	
9	Performance assessment of Grid connected and Standalone 1kWp Solar power system	
10	Simulation study of Wind energy conversion system	
11	Formation of Y_{BUS} using any technique	
12	Load flow study of using Gauss Seidal method	
Pedagogy:	Constructive learning and Collaborative learning	
References/ Readings:	1. Chetan Singh Solanki, 'Solar Photovoltaic, Fundamentals, Technologies, Applications', PHI publishers, 2019, 3rd edition. 2. Jayant Baliga, 'Fundamentals of Power semiconductor devices', Springer, 2008, 1st edition. 3. Hadi Sadat, 'Power system analysis', McGraw Hill- international edition-1999 4. Stagg and EI-Abiad, 'Computer methods in power system analysis', McGraw Hill- international edition-1986.	
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand and learn different power system analysis techniques. CO 2. Develop software approach for power system studies. CO 3. Analyze the power system data for load flow studies	

	CO 4. Apply computational methods for large scale power system studies

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Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-502
Title of the Course : Advanced Power Electronics
Number of Credits : 04 (3L+1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Electronics Devices, Circuit Analysis, Fourier Analysis	
Course Objectives:	The course will enable the students to: 1. To Develop power converters with better performance for challenging applications 2. To comprehend the concepts of different power converters and their applications 3. To analyze and design switched mode regulators for various industrial applications 4. To choose appropriate devices for a particular converter topology. 5. To Model existing and modified power converters under small signal and steady state condition	
Content:		**No. of Hours**
Unit -1	**Single & three phase converters:** Single phase converters Fully controlled converters – Evaluation of input power factor and harmonic factor – single phase dual converters – power factor Improvements Techniques– Extinction angle control – symmetrical angle control, PWM –single phase sinusoidal PWM – single phase series converters – overlap analysis – Applications & Problems. Three phase converters –fully controlled converters – Definition of THD and PF, Evaluation of input power factor and harmonic factor under various load current. **Design of Switching Power Converters:** Controller Design: Introduction - Design of Power Converters Components: Design of magnetic components-design of transformer - Design of Inductor and current transformer - Selection of filter capacitors - Selection of ratings for devices - input filter design.	**15**
Unit -2	**Pulse Width Modulated Inverters** (single phase): Principle of operation - performance parameters - single phase bridge inverter -evaluation of output voltage and current with resistive and inductive loads - Voltage control of single phase inverters - single PWM - Multiple PWM - sinusoidal PWM - modified PWM - phase displacement Control - Advanced modulation techniques for improved performance - Trapezoidal, staircase, stepped, harmonic injection and delta modulation - Advantage - application - numerical problems. Pulse Width Modulated Inverters (three phase). Three phase inverters - analysis of 180-degree condition for output voltage and current with resistive, inductive loads - analysis of 120-degree Conduction - voltage	**15**

	control of three phase inverters - sinusoidal PWM - Third Harmonic PWM – 60-degree PWM – space vector modulation - Comparison of PWM techniques - harmonic reductions - Current Source Inverter - numerical problems	
Unit- 3	**Multilevel Inverters:** Two level voltage source inverter - Multilevel concept – Classification of multilevel inverters – Diode clamped multilevel inverter – principle of operation – main features – improved diode Clamped inverter – principle of operation – Flying capacitors multilevel inverter – principle of operation – main features. Cascaded multilevel inverter – principle of operation – main features – Multilevel inverter applications – reactive power compensation – back-to-back intertie system – adjustable drives – Switching device currents – dc link capacitor voltage balancing – features of Multilevel inverters – comparisons of multilevel converters. **Matrix converter:** Basic topology of matrix converter; Commutation – current path; Modulation techniques - scalar modulation, indirect modulation; Matrix converter as only AC-DC converter; AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter; Performance comparison with matrix converter with DC link converters	**15**
Unit- 4	**Resonant Pulse Inverters**: Resonant pulse inverters – series resonant inverters – series resonant inverters with unidirectional switches – series resonant inverters with bidirectional Switches – analysis of half bridge resonant inverter - evaluation of currents and voltages of a simple resonant inverter – analysis of half bridge and full bridge resonant inverter with bidirectional switches – Frequency response of series resonant inverters – for series loaded inverter – for parallel loaded inverter –For series and parallel loaded inverters – parallel resonant inverters – Voltage control of resonant inverters. Resonant converters: Resonant converters – Zero current switching resonant converters – L type ZCS resonant converter – M type ZCS resonant converter – zero voltage switching resonant converters – comparison between ZCS and ZVS resonant Converters – Two quadrant ZVS resonant converters – resonant dc-link Inverters – evaluation of L and C for a zero current switching inverter.	**15**
Pedagogy:	Constructivist, Collaborative and Reflective approach	
References/ Readings:	1. Abraham I. Pressman, Switching Power Supply Design, McGraw Hill International. IEEE Publications on Power Electronics, 2007. 2. Joseph Vithayathil, Power Electronics - Principles and Applications, McGraw Hill Inc., New York, 1995. 3. M. H. Rashid, Power Electronics - Circuits, Devices and Applications, P.H.I Private Ltd. New Delhi, Second Edition, 1994. 4. N. Mohan et.al. Power Electronics- Converters, Applications and	

	Design, John Wiley & Sons (Asia) Private Ltd., Singapore, 1996. 5. R W Erickson and D Makgimovic, Fundamental of Power Electronics Springer, 2nd Edition, 2020.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand Principle of Operation Advanced Power Converters. CO 2. Develop and analyze various converter topologies. CO 3. Describe the operation of multilevel inverters with switching strategies for high power applications. CO 4. Comprehend the design of resonant converters and switched mode power supplies.

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Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-503
Title of the Course : Photovoltaic System Design
Number of Credits : 04 (3L+1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Renewable Energy	
Course Objectives:	The course will enable the students to: 1. Understand the working of Photovoltaic System 2. Analyze Photovoltaic System 3. Design a Photovoltaic System and its applications. 4. Learn the grid connected PV systems.	
Content:		**No. of Hours**
Unit -1	A Historical perspective, PV cell characteristics and equivalent circuit, model of PV cell, open circuit voltage, short circuit current and peak power, data sheet study, cell efficiency, effect of temperature, fill factor, identical and non-identical cells in series and parallel, protection of cells and modules in series and parallel, Insolation and Irradiance, energy on a horizontal flat plate, energy on a tilted flat plate, Atmospheric effects, air mass, clearness index	**15**
Unit -2	Sizing PV for applications without Battery, Battery capacity, Battery C-rate, Battery efficiency, PV system design- load profile, days of autonomy, battery sizing, PV array sizing	**15**
Unit -3	Maximum power point tracking (MPPT) – concept, input impedance of Buck, Boost and Buck-Boost converter, MPPT Algorithms, PV-Battery Interface- Direct PV-Battery, Battery charger, slope compensation, Batteries in series, charge equalization, Batteries in parallel.	**15**
Unit- 4	PV and water pumping, hydraulic energy and power, total dynamic head, centrifugal pump, reciprocating pump, pv power pumped hydro application PV grid interface, grid connection principle, PV to grid topologies,3 -phase grid connected system, 1-phase grid connected system, PV-grid interface examples	**15**
Pedagogy:	Constructivist approach, Collaborative approach. Reflective approach	
References/ Readings:	1. Chetan Singh Solanki; Solar Photovoltaics Fundamentals, Technologies and Applications; Prentice Hall India ltd.,2015 2. Dr. B.H. Khan; Non-conventional; Tata McGraw Hill, 2009 3. Dr. VM Domkundwar; Solar energy and non-Conventional energy sources, Dhanpat Rai and company, 2022 4. Gilbert M, Masters; Renewable and efficient Electric Power Systems, Wiley Interscience, New Jersey, 2004 5. S. P. Sukhatme; Solar energy; Tata McGraw Hill Publishing Company Ltd, PHI Learning Private Limited.2017	

Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the PV cell and PV power generation CO 2. Analyse the PV conversion system. CO 3. Design the PV system along with the application of water pumping CO 4. Study the analysis and the design of grid connected PV system.

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Programme Specific Elective (PSE) Courses
Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-531
Title of the Course : Artificial Intelligence Applications to Power Systems
Number of Credits : 04 (3L+1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Power Systems	
Course Objectives:	The course will enable the students to: 1. Understand soft computing concepts and techniques and foster their abilities in designing appropriate techniques for a given scenario. 2. Analyze soft computing-based solutions for real-world problems. 3. Implementation of given problem using appropriate techniques 4. Evaluate the performance using different techniques studied	
Content:		**No. of Hours**
Unit -1	**Evolution of Computing: Soft Computing Constituents,** From Conventional AI to Computational Intelligence: Machine Learning Basics. Fuzzy logic: Fuzzy Sets, Operations on Fuzzy Sets, Fuzzy Relations, Membership Functions: Fuzzy Rules and Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy. Expert Systems, Fuzzy Decision Making.	**15**
Unit -2	**Neural Networks:** Introduction, Supervised Learning Neural Networks, Perceptron, Adaline, Back propagation Multilayer perceptrons, Radial Basis Function Networks, Unsupervised Learning and Other Neural Networks, Competitive Learning Networks, Kohonen Self Organizing Networks, Learning Vector Quantization, Hebbian Learning	**15**
Unit -3	**Evolutionary Computing:** Genetic algorithm: Basic concept, encoding, fitness function, Reproduction, Basic genetic programming concepts, differences between GA and Traditional optimization methods, Applications, Variants of GA. Simulated Annealing, Bio inspired algorithms - Particle Swarm optimization	**15**
Unit- 4	**AI applications to Power system:** Fuzzy logic-based controller for Electric Drive, ANN-based Speed control of Induction motor drives, Application of ANN and Fuzzy logic in power system: Load forecasting, Load scheduling. Application of GA in Economic load dispatch, Reactive power control and Power flow	**15**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Simon Haykin, Neural Network and Learning Machines, 3rd Edition, Pearson Education India, 2016. 2. Sivanandam and Deepa, Principles of soft computing, 3rdEdition, Wiley, 2018. 3. S. Rajasekharan and G.A.V.Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms, 2 nd Edition, PHI, 2017.	

	4. Timothy J.Ross, Fuzzy Logic with Engineering Applications, 3rd Edition Wiley, 2011.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand soft computing concepts and techniques and foster their abilities in designing appropriate techniques for a given scenario. CO 2. Analyse soft computing-based solutions for real-world problems. CO 3. Implementation of given problem using appropriate techniques CO 4. Evaluate the performance using different techniques studied

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Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-532
Title of the Course : High Voltage Alternating Current / Direct Current Transmission
Number of Credits : 04 (3L+1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of Electrical Circuit Analysis and Power System	
Course Objectives:	The course will enable the students to: 1. To analyze the need of HV Power transmission using Line conductors and Cable. 2. To understand and calculate the Transmission Line Parameters 3. To understand HVAC power transmission and analyze the performance at No load and Load conditions 4. To understand DC HV Transmissions and its applications and Control.	
Content:		**No. of Hours**
Unit -1	**HV Transmission line Geometry and other Aspects**: Aspects of HV Transmission Line Design. Standard HVAC Transmission Voltages, percentage power loss and power handling capacity of HV transmission line, mechanical considerations in line performance. Line and ground Parameters. Calculations of line resistance, Inductance and Capacitance of three phase line. Corona effects, radio interference, audible noise due to HV Transmission.	**14**
Unit -2	**HVAC Power transmission**: Concept of Long Transmission line, Travelling Wave theory, Reflection and Refraction of travelling waves, No load voltage conditions and charging current, Ferranti effect, Static Reactive Compensating systems. Transmission Parameter (ABCD Parameters)	**16**
Unit -3	**HV Cable Transmission and over voltages**: Over voltages due to lightning and switching, lightning Arrestor. Aspects of HV Cable transmission, Types of HV Cables, properties of Cable Insulation materials. Electrical Characteristics of HV Cable, Electrical Stress in dielectric of cables, capacitance, insulation resistance and loss factor.	**15**
Unit- 4	**HVDC transmission**: Classification of HVDC systems, advantages of HVDC system.AC Interconnection and its limitations, DC Interconnection. Components of HVDC Transmission, Convertor stations, converter transformers. HVDC System Pole, Ground Electrode, two terminals and multiterminal DC systems. DC Circuit Breakers, Applications of HVDC Transmission	**15**
Pedagogy:	Reflective Learning, Constructive learning and Collaborative & Inquiry based.	
References/	1. Kuffel & Zaengel, High Voltage Engineering Fundamentals, Pergamon	

Readings:	Press, Second Edition, 1984 2. Lewis W. W. Protection of Transmission Lines against Lightning, Wiley and Sons publication, Second edition, 1992 3. K. R. Padiyar , HVDC Power transmission systems, New Age International 1996 4. Rakosh Das Begamudre, Extra High Voltage AC Transmission Engineering, New age International Publisher Third Edition 2006 5. W. Kimbark Vol I, Direct Current Transmission. Wiley InterScience Publications. 2017
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the different aspects of HV Power Transmission CO 2. Explain qualitative and quantitative methods of analyzing HV Power Transmission. CO 3. Analyse and compute HV power transmission using transmission Lines and HV Cables CO 4. Compare HV AC and HV DC power transmission and analyse their system configurations.

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Issued on: 22/01/2025

Research Specific Elective (RSE) Courses
Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : REC-561
Title of the Course : Engineering Research & Publications
Number of Credits : 04 (3L+1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review, defining the research objectives. 2. Explain qualitative and quantitative methods of data analyses and its importance. 3. Classify research publications, select appropriate journals based on research areas. 4. Practice ethics in publication and academic integrity	
Content:		**No. of Hours**
Unit -1	**Overview of scientific research in engineering**, foundational and fundamental concepts like types of research and considerations for research in specific domains, motivation to do research, critical thinking, assumptions and hypotheses, basic and applied research, importance of formulation of broad research objectives	**15**
Unit -2	**Purpose and Methodology of Literature Search and Review** of the scientific and engineering publications. Sources such as scholarly databases, public domain, open access, current literature, review articles, critical review and gap analysis, defining research objectives	**15**
Unit -3	**Quantitative and qualitative Data –** importance of data in research, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**15**
Unit- 4	**Preparation of Publications-** Elements of research publications, types of publications, writing for journal publications, basic requirements for publication, selection of journals, journal quality indicators, peer review, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity	**15**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 2. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for Science and Engineering', Taylor & Francis Publications, 2022,	

	ISBN:9781003139058 3. Michael Jay Katz, 'From Research to Manuscript', Springer Publication, 2009, ISBN:9781402094668. 4. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work', Springer Publications, 2022, ISBN:9783030900243
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of literature review, defining the research objectives. CO 2. Explain qualitative and quantitative methods of data analyses and its importance. CO 3. Classify research publications, select appropriate journals based on research areas. CO 4. Practice ethics in publication and academic integrity

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Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : REC-562
Title of the Course : Literature Review & Technical Writing for Engineers
Number of Credits : 04 (3L+1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review and writing a review paper. 2. Explain the method to be followed to write a review paper. 3. Classify data for qualitative and quantitative analysis 4. Demonstrate technical writing for conference.	
Content:		**No. of Hours**
Unit -1	**Overview on Literature Review**, difference between objectives of literature review and research objectives; types of literature review, qualitative and quantitative reviews, search strategies, primary and secondary sources, database search strategies, field search, root search, complimentary search, meta-analysis	**15**
Unit -2	**Database management of literature reviews**, bibliometric analysis, importance of writing a review paper, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity; public domain, open access, current literature.	**15**
Unit -3	**Technical writing on a specific research topic**, structure of the paper, abstract, introduction, experimental, simulation, analysis, discussion, inferences, title, acknowledgment, referencing, presentation of tables, figures, graphs, equations; comparison between technical writing for conference papers and journal paper	**15**
Unit- 4	**Importance of data in research**, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**15**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 2. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058. 3. Michael Jay Katz, 'From Research to Manuscript', Springer Publication, 2009, ISBN:9781402094668	

	4. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work – Multidisciplinary Guide to Systematic Approaches', Springer Publications, 2022, ISBN:9783030900243.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of literature review and writing a review paper. CO 2. Explain the method to be followed to write a review paper. CO 3. Classify data for qualitative and quantitative analysis CO 4. Demonstrate technical writing for conference.

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Semester II
Programme Specific Core (PSC) Courses
Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-504
Title of the Course : Restructured Power Systems
Number of Credits : 03 (3L)
Effective from AY : 2024-25

Pre-requisites for the Course:	NIL	
Course Objectives:	1. To develop more understanding on the concepts of restructured power systems and present development in the area of power system deregulation. 2. To introduce the fundamental concepts relevant to transmission pricing, congestion management, power exchanges and power market models. 3. To have a better understanding and identify the scope for operation and control of restructured power market including bidding strategies	
Content:		**No of Hours**
Unit -1	**Introduction to restructuring of power industry**: - Reasons for restructuring of power industry; Understanding the restructuring process, Unbundling and privatization, Entities involved, Levels of competition, Market place mechanisms. Reforms in Indian power sector: Framework of Indian power sector, Reform initiatives, Availability based tariff (ABT), Electricity Act 2003, Open Access issues, Power exchange. Study of international power markets.	**11**
Unit -2	**Fundamentals of Economics: -**Consumer and suppliers behavior, Total utility and marginal utility, Law of diminishing marginal utility, Elasticity of demand and supply curve, Market equilibrium, Consumer and supplier surplus, Global welfare, Deadweight loss. Philosophy of Market Models: -Monopoly model, Single buyer model, Wholesale competition model, Retail competition model, distinguishing features of electricity as a commodity, Four pillars of market design.	**11**
Unit -3	**Pricing of transmission network usage and loss allocation: -** Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing, Rolled-in transmission pricing paradigm, Marginal transmission pricing paradigm, Composite pricing paradigm, Merits and demerits of different paradigms, Classification of loss allocation methods, Pro-rata methods, Incremental methods, Power flow tracing-based allocation. Transmission Congestion Management: -Transfer capability, Importance of congestion management, Effects of congestion, Classification of congestion management methods, ATC, TTC, TRM, CBM, ATC calculation using DC and AC model, Nodal pricing, Locational Marginal Prices (LMPs).	**12**

Unit- 4	**Market power and generators bidding: -** A tributes of perfectly competitive market, Firms supply decision under perfect competition, Imperfect competition, Monopoly, Oligopoly, Electricity markets under imperfect competition Sources of market power, Effect of market power, Identifying market power, Financial markets, Introduction to optimal bidding by a generator company. Smart Grid Bidding Strategies:Forward and Future market; Operation and control. Type and Classification of ancillary services, Sources of reactive power, Black start capability service, Provisions of ancillary services, Markets for ancillary services.	**11**
Pedagogy:	Reflective Learning, Constructive learning and Collaborative & Inquiry based.	
References/ Readings:	1. Daniel Kirschen and Goran Strbac, "Fundamentals of Power System economics", John Wiley & Sons ltd publication. 2. K. Bhattacharya, J. E. Daadler, and Math H.J Bollen, "Operation of restructured power systems", Kluwer Academic Publication, 1st Edition. 3. L. L. Lai , "Power System Restructuring and Deregulation", John Wiley & Sons publication. 4. Sally Hunt , "Making competition work in electricity", John Wiley & Sons publication.	
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the knowledge of the new dimensions associated with theoperation of the power system market and fundamentals of microeconomics CO 2. Examine the various operating mechanism between conventional and restructured power system CO 3. Evaluate and assess various power markets and market architectural aspects CO 4. Develop issues related to efficient pricing and usage of the transmission network and generation entity in the power market operation	

Name of the Programme : **Master of Engineering (Power and Energy Engineering)**
Course Code : **EEL-505**
Title of the Course : **Power Systems Laboratory-I**
Number of Credits : **01 (1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	MATLAB/SIMULINK	
Course Objectives:	The course will enable the students to: 1. Understand the power system components and interconnection. 2. Interpret the experimental results with practical power system. 3. Analyse different power converters and electrical devices. 4. Practice simulation and experimental studies in power system.	
Contents:	Minimum 8 experiments to be performed from the given list	**No. of Hours**
Sr. No.	**Title of the Experiment**	
1	Developing simulation model for calculation of the available transfer capability using power transfer distribution factors	**30**
2	Simulation and analysis of hybrid energy system	
3	Load flow analysis using power world	
4	Fault studies using Z-Bus matrix	
5	Economic load dispatch neglecting losses and (a) No generation unit included (b) Generator units included by using MATLAB	
6	Computation of various transfer capabilities and transmission reliability margin in a power system	
7	Computation of various distribution factors in a power system	
8	Performance of DC load flow analysis	
9	Study and analysis of optimal bidding strategies for a generation company in a power market	
10	Study and analysis of the locational marginal pricing methods.	
Pedagogy:	Constructive learning and Collaborative learning	
References/ Readings:	1. Daniel Kirschen and Goran Strbac, "Fundamentals of Power System economics", John Wiley & Sons ltd publication. 2. K. Bhattacharya, J. E. Daadler, and Math H.J Bollen, "Operation of restructured power systems", Kluwer Academic Publication, 1st Edition. 3. Hadi Sadat, 'Power system analysis', McGraw Hill- international edition-1999 4. Stagg and EI-Abiad, 'Computer methods in power system analysis', McGraw Hill- international edition-1986.	
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand and learn different power system analysis techniques.	

	CO 2. Develop software approach for power system studies. CO 3. Analyze the power system data for load flow studies CO 4. Apply computational methods for large scale power system studies

Name of the Programme : **Master of Engineering (Power and Energy Engineering)**
Course Code : **EEL-506**
Title of the Course : **Energy Auditing & Management**
Number of Credits : **03 (3 L)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Fundamentals of Electrical Engineering	
Course Objectives:	The course will enable the students to 1. Understand various aspects of energy use, energy conservation measures, energy audits and environmental impacts. 2. Apply the various methodologies / technologies for effective utilization of energy sources and promotion of energy efficiency. 3. Analyze the Plan and carry out practical energy audit of various sectors. 4. Compute the analysis of the environmental and cost economics of using energy in various sectors.	
Content:		**No of Hours**
Unit -1	**General aspects of energy management:** Energy scenario, Energy pricing, Energy sector reforms, Energy Security. Energy Conservation and its importance, EC act 2001, Schemes of Bureau of Energy Efficiency (BEE) including designated consumers, state designated agencies, Definition and objectives of Energy Management, Energy Audit, Types and methodologies, Energy auditing report format, Energy Audit Instruments, Benchmarking and Energy performance, Energy Management centers and their importance, Energy and Environment	**10**
Unit -2	**Energy efficiency in electrical utilities:** Electrical system, Electric motors, Compressed air system, HVAC and refrigeration system, Pumps, pumping system. Lighting system, DG set system, Demand side Management, load control, Energy efficient technologies in Electrical system. Economics of power factor improvement. Power Quality issues related to energy efficient technologies.	**12**
Unit -3	**Energy efficiency in thermal utilities:** Fuels and combustion, Boiler systems, Boiler types and classification, performance evaluation of Boilers, Boiler Blowdown, energy conservation opportunities. Steam system, Furnaces, Insulation, Refractories, Cogeneration, Waste heat recovery Systems.	**13**
Unit- 4	**Economics and Finance:** Project management, steps in project management, project planning techniques Case studies of energy audit projects. Energy performance contracts and role of Energy Service Companies. Financial management, investment need, Appraisal and criteria for Energy management projects, financial analysis techniques, Sensitivity and risk analysis, financing options, costing techniques, life cycle/levelized cost	**10**

Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning
References/ Readings:	1. BEE, "Guide books on Energy Audit & Management", Bureau of Energy efficiency, New Delhi, 2009 2. Amlan Chakrabarti, "Energy Engineering & Management", Prentice hall India ltd., 2011 3. Shashank Jain, "Energy Auditing"- TERI Publications, 2008 4. P. Balasubramanian, "Energy Auditing made simple", Prentice hall India ltd., 2013 5. W.R. Murphy, "Energy Management", A Wiley Inter Science Publications, 2012 6. W.C. Turner, "Energy Management Handbook", John Wiley & Sons, A Wiley Inter Science Publications, 2007
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand various aspects of energy use, energy conservation measures, energy audits and environmental impacts CO 2. Apply the various methodologies / technologies for effective utilization of energy sources and promotion of energy efficiency CO 3. Analyze the Plan and carry out practical energy audit of various sectors CO 4. Compute the analysis of the environmental and cost economics of using energy in various sectors

Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-507
Title of the Course : Energy Engineering laboratory
Number of Credits : 01(1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Fundamentals of Electrical Engineering	
Course Objectives:	The course will enable the students to: 1. Understand various aspects of energy use, energy conservation measures, energy audits and environmental impacts. 2. Apply the various methodologies / technologies for effective utilization of energy sources and promotion of energy efficiency. 3. Analyze the Plan and carry out practical energy audit of various sectors. 4. Compute the analysis of the environmental and cost economics of using energy in various sectors.	
Contents:	Minimum 8 experiments to be performed from the given list	**No. of Hours**
Sr No	**Title of the Experiment**	
1	Analysis of domestic bill/ industrial bill/interstate bill	**30**
2	Comparison of energy consumption of lighting systems and estimation of potential savings from retrofitting.	
3	Heat loss detection in an air-conditioned room using thermal imaging.	
4	Efficiency assessment of motors.	
5	Efficiency assessment of solar water heating system by comparing temperature rise and energy input.	
6	Assessment of natural light usage to reduce artificial lighting need during daytime.	
7	Energy saving using VFD for pumping application – case study	
8	Energy saving using step down transformer for lighting load – case study	
9	Analysis of energy consumption of star labelled consumer equipments.	
10	Estimation of energy saving through Power factor improvement.	
Pedagogy:	Constructive learning and Collaborative learning	
References/ Readings:	1. BEE, “Guide books on Energy Audit & Management”, Bureau of Energy efficiency, New Delhi, 2009 2. Amlan Chakrabarti, “Energy Engineering & Management”, Prentice hall India ltd., 2011 3. Shashank Jain, “Energy Auditing”- TERI Publications, 2008 4. P. Balasubramanian, “Energy Auditing made simple”, Prentice hall India ltd., 2013	
Course	After taking this course, student will be able to:	

Outcomes:	CO 1. Understand various aspects of energy use, energy conservation measures, energy audits and environmental impacts CO 2. Apply the various methodologies / technologies for effective utilization of energy sources and promotion of energy efficiency CO 3. Analyze the Plan and carry out practical energy audit of various sectors CO 4. Compute the analysis of the environmental and cost economics of using energy in various sectors

Issued on: 22/01/2025

Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-508
Title of the Course : Solid State AC/DC Drives
Number of Credits : 03(3L)
Effective from AY : 2024-25

Pre-requisites for the Course:	Electrical Machines	
Course Objectives:	The course will enable the students to 1. Study speed torque characteristics of DC motor and induction motor. 2. Study the various control strategies of DC and AC drives. 3. Study the advanced control strategies of DC and AC drives 4. Study the AI based control of Electric drives	
Content:		**No of Hours**
Unit -1	**Introduction to Electric Drives:** Motor-Load system –Dynamics, load torque, steady state stability, speed control and multi quadrant operation –speed Torque characteristics of DC motor –braking of series and separately excited dc motor, speed torque characteristics of induction motor.	**11**
Unit -2	**Control of DC drives**: Analysis of series and separately excited DC motor with single phase and Three phase converters operating in different modes and configurations- Analysis of series and separately excited DC motor fed from different choppers, effect of saturation in series motors-Closed loop control of dc drives-two quadrant and four quadrant operation	**11**
Unit -3	**Control of AC drives**: Variable frequency operation of 3- phase inductions motors, constant flux operation, current fed operations, Dynamic and regenerative braking of CSI and VSI fed drives, Torque Equations, Constant torque operations, Static rotor resistance control and slip power recovery scheme – Combined stator voltage control and rotor resistance control.	**12**
Unit- 4	**Advanced control of AC drives**: Principles of vector control –Direct and indirect vector control of induction motor – Flux vector estimation, DTC- sensor less vector control-speed estimation methods- **Applications of Fuzzy logic and Artificial Neural Network** for the control of AC drives	**11**
Pedagogy:	Constructivist, Collaborative and Reflective approach	
References/ Readings:	1. Bimal K Bose, Modern Power electronics and AC Drives," Pearson education asia 2002. 2. Dubey, G.K, Power Semiconductor Controlled Drives, Prentice	

	HallInternational, New Jersey, 1989. 3. Krishnan. R, Electrical Motor Drives- Modeling, Analysis and Control Prentice Hall of India Pvt Ltd., 2nd Edition, 2003. 4. Paul .C.Krause, Oleg Wasyncznk, Scott. D. Sudhoff,Analysis of Electric Machinery and Drive Systems, 2nd edition, Wiley Interscience, John wiley& Sons, 2002. 5. Werner Leonard, Control of Electrical Drives' 3rd edition, Springer,2001
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the speed torque characteristics of DC motor and induction motor. CO 2. Analyze the control strategies of AC and DC drives CO 3. Develop models to simulate the advanced techniques in AC drives CO 4. Apply AI methods in control of AC/DC drives.

Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-509
Title of the Course : Electric Drives Laboratory
Number of Credits : 01(1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Electrical Machines	
Course Objectives:	The course will enable the students to: 1. Study speed torque characteristics of DC motor and induction motor. 2. Study the various control strategies of DC and AC drives. 3. Study the advanced control strategies of DC and AC drives 4. Study the AI based control of Electric drives.	
Contents:	Minimum 8 experiments to be performed from the given list	**No. of Hours**
Sr No	**Title of the Experiment**	**30**
1	Energy conservation using variable frequency drive.	
2	PWM control of 3 phase induction motor	
3	Speed Control of BLDC motor drive	
4	Speed Control of PMSM motor drive	
5	Speed Control of PMDC motor drive	
6	Modelling of DC-DC converters	
7	Simulation of solid state closed loop speed control of DC motor.	
8	AI based speed control of DC motor	
9	Modelling of DC motor, Induction motor and synchronous motor drives	
10	Design and implementation of a gate driver circuit for MOSFET and IGBT	
Pedagogy:	Constructive learning and Collaborative learning	
References/ Readings:	1. Bimal K Bose, Modern Power electronics and AC Drives," Pearson education asia 2002. 2. Dubey, G.K, Power Semiconductor Controlled Drives, Prentice HallInternational, New Jersey, 1989. 3. Krishnan. R, Electrical Motor Drives- Modeling, Analysis and Control Prentice Hall of India Pvt Ltd., 2nd Edition, 2003. 4. Paul .C.Krause, Oleg Wasyncznk, Scott. D. Sudhoff,Analysis of Electric Machinery and Drive Systems, 2nd edition, Wiley Interscience, John wiley& Sons, 2002.	
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the speed torque characteristics of DC motor and induction motor. CO 2. Analyze the control strategies of AC and DC drives CO 3. Develop models to simulate the advanced techniques in AC drives	

	CO 4. Apply AI methods in control of AC/DC drives.

Issued on: 22/01/2025

Program Specific Elective (PSE) Courses
Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-533
Title of the Course : Smart Grid
Number of Credits : 03(3 L)
Effective from AY : 2024-25

Pre-requisites for the Course:	Power Systems	
Course Objectives:	The course will enable the students to 1. To assess the importance and significance of different smart grid components 2. To assess the role of different Smart Grid Technologies including Smart metering 3. To have a better understanding and identify the scope for power quality management, demand side management and communication system for the smart grids	
		No of Hours
Unit -1	**Introduction to Smart Grid**: Distributed generation resources, Distributed Generation integration to power grid, Concept of micro grid, need & applications of micro grid, formation of micro grid, Operation, Protection & Control of micro grid. Definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, Smart Grid standards, Policies, Applications, Smart Grid control layer and elements, National and International Initiatives in Smart Grid.	**11**
Unit -2	**Smart Grid Technologies:** Technology Drivers, Smart energy resources, Feeder Automation, Transmission systems: SCADA, Energy Management systems, Wide area monitoring, Protection and control, Distribution systems: Distribution Management Systems, Fault Detection, Isolation and service restoration, Outage management. Introduction to Communication Technology, Two Way Digital Communications Paradigm, Synchro- Phasor Measurement Units (PMUs) –Wide Area Measurement Systems (WAMS).	**11**
Unit -3	**Advanced Metering Infrastructure and Security Issues**: Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection. Cyber Security Challenges in smart grids, Load altering attacks, False data injection attacks, Defence Mechanisms, Privacy challenges.	**11**
Unit- 4	**Demand Side and Power Quality Management of Smart Grids :**Demand side management of Smart Grid, Demand response analysis of Smart Grid, Pricing and Energy Consumption	**12**

	Scheduling, Controllable Load Models, Dynamics and Challenges, Electric Vehicles and Vehicle-to-Grid Systems, Demand Side Ancillary Services Energy Management. 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.	
Pedagogy:	Reflective Learning, Constructive learning and Collaborative & Inquiry based.	
References/ Readings:	1. Ekanayake J, Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, Wiley Publications. 2. Stuart Borlase, Smart Grid: Infrastructure, Technology and Solutions, CRC Press 3. Momoh J., "Smart Grid: Fundamentals of design and analysis", John Wiley & Sons 4. S. K. Salman, "Introduction to the Smart Grid: Concepts, Technologies and Evolution", IET Energy Engineering Series, 1st Edition	
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand various aspects of smart grid technologies, components, architectures, and applications CO 2. Study and compare the advanced metering and communication infrastructure and justify the feasibility of the same for smart grid applications. CO 3. Analyze microgrid and distributed generation as a part of modern hybrid systems with advantages and challenges in smart grid operations CO 4. Apply load modeling techniques, demand side management, demand response implementation, power quality assessment techniques in smart grid operations	

Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-534
Title of the Course : Smart Grid Laboratory
Number of Credits : 01 (1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Power Systems	
Course Objectives:	The course will enable the students to: 1. To assess the importance and significance of different smart grid components 2. To assess the role of different Smart Grid Technologies including Smart metering 3. To have a better understanding and identify the scope for power quality management, demand side management and communication system for the smart grids	
Contents:	Minimum 8 experiments to be performed from the given list	**No. of Hours**
Sr No	**Title of the Experiment**	
1	Study and analysis of components of smart grid	
2	Study and analysis of DC Microgrid System	
3	Study and analysis of AC Microgrid System	
4	Study and analysis of Islanding protection in Microgrid	
5	Study and analysis of protection of Distributed generation sources (wind & solar PV generation).	
6	Simulation of Grid connected PV with MPPT (P&O) system	**30**
7	Simulation of Hybrid power system (PV+BESS+Diesel Generator)	
8	Modeling & Simulation of Electric Vehicle Charging System.	
9	Design of protection scheme for active distribution network using ETAP software.	
10	To Design overall system comprising of Generation Transmission & Distribution inSimulator	
Pedagogy:	Constructive learning and Collaborative learning	
References/ Readings:	1. Ekanayake J, Jenkins N., Liyanage K., Wu, J., Yokoyama A., Smart Grid: Technology and applications, Wiley Publications. 2. Stuart Borlase, Smart Grid: Infrastructure, Technology and Solutions, CRC Press 3. Momoh J., "Smart Grid: Fundamentals of design and analysis", John Wiley & Sons 4. S. K. Salman, "Introduction to the Smart Grid: Concepts, Technologies and Evolution", IET Energy Engineering Series, 1st Edition	
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand various aspects of smart grid technologies,	

	components, architectures, and applications CO 2. Study and compare the advanced metering and communication infrastructure and justify the feasibility of the same for smart grid applications. CO 3. Analyze microgrid and distributed generation as a part of modern hybrid systems with advantages and challenges in smart grid operations CO 4. Apply load modeling techniques, demand side management, demand response implementation, power quality assessment techniques in smart grid operations

Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : EEL-535
Title of the Course : Power Quality
Number of Credits : 03(3 L)
Effective from AY : 2024-25

Pre-requisites for the Course:	Nil	
Course Objectives:	The course will enable the students to 1. Understand various terms related to power quality and various types of disturbances contributing to power quality (PQ) issues, Harmonic limits as per IEEE standards 2. Measure and analyze power quality data and evaluate PQ indices. 3. Characterize PQ events and apply suitable mitigation strategies.	
Content:		**No of Hours**
Unit -1	**Introduction:** Introduction to the Power Quality (PQ) problem, Factors contributing to PQ issues (DG integration, usage of non linear loads, sudden load change), PQ issues: Poor power factor, Transients, over voltage surges, spikes, short duration and long duration voltage variations, sag, swell, voltage imbalance, waveform distortion, Power frequency variation, Harmonics, DC injection, DC offset in load, Notching. **Power Quality and EMC Standards**: IEC Electromagnetic compatibility standard, IEEE Std 519-1992, Revisions in IEEE Std 519-2014, IEEE Std 1547, harmonic limits as per the standards. Power acceptability curves.	**11**
Unit -2	**Power Quality Considerations in Industrial Power Systems: Behavior of** Single phase and three phase static AC/DC and DC/AC converters, DG integration, Adjustable speed drives, Battery chargers, Arc furnaces, computers, UPS, consumer electronics (Fluorescent and LED lighting) **Characterization of single phase and three phase voltage sag:** Voltage sag magnitude, and monitoring, theoretical calculation of voltage sag magnitude and sag duration, Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.	**11**
Unit -3	**Analysis Methods** Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices – Analysis of voltage sag: Detroit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop	**12**

	balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction. Time domain methods, Frequency domain methods: Fourier Transform, Wavelet transforms.	
Unit- 4	**Mitigation of Interruptions & Voltage Sags**: Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time, installing mitigation equipment, improving equipment immunity Utility-Customer interface –Harmonic filters: passive, active and hybrid filters Custom power devices: Network reconfiguring Devices, System-Equipment interface devices – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller, Control strategies: P-Q theory, Synchronous detection method	**11**
Pedagogy:	Constructivist, Inquiry based, Reflective learning approaches	
References/ Readings:	1. Math H. Bollen, Understanding power quality problems: Voltage Sags and Interruptions, Wiley- IEEE press, 2000. 2. Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, Power quality: Problems and Mitigation Techniques, Wiley, 2015 3. Ghosh and G. Ledwich, Power Quality Enhancement using custom power devices, NY: Springer, 2012. [E-book] Available: Springer Book archive 4. Angelo Baggini , Handbook of power quality, John Wiley and Sons, 2008	
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand terminologies and various sources contributing to PQ issues, their severity levels, PQ parameters and indices, and mitigation strategies. CO 2. Explain / Discuss the types and characteristics of PQ disturbances, types and operating principle of mitigation devices and various measurements CO 3. Analyze various components of a power signal under disturbance conditions, analyze single phase & three phase circuits for sinusoidal & and non sinusoidal voltage source, balanced, unbalanced loads, Linear and Non linear load CO 4. Formulate rating of mitigating devices	

Name of the Programme : **Master of Engineering (Power and Energy Engineering)**
Course Code : **EEL-536**
Title of the Course : **Power Quality Laboratory**
Number of Credits : **01(1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	NIL	
Course Objectives:	The course will enable the students to: 1. Understand various terms related to power quality and various types of disturbances contributing to power quality (PQ) issues, Harmonic limits as per IEEE standards 2. Measure and analyze power quality data and evaluate PQ indices. 3. Characterize PQ events and apply suitable mitigation strategies.	
Contents:	Minimum 8 experiments to be performed from the given list	**No. of Hours**
Sr No	**Title of the Experiment**	**30**
1	Measurement & Analysis of Power Quality Parameters using PQ Analyzer	
2	Reduction of Current harmonics using fitter	
3	Reduction of Voltage and small problems in distribution system using DVR	
4	Mitigation of Voltage in a single feeder distribution system using MATLAB/ Simulink	
5	Simulation and analysis of PQ improvement in a grid connected Wind System using STATION	
6	Study of Voltage Flicker	
7	Study The effect of nonlinear load on the Power Quality	
8	Study the effect of harmonics on energy meter reading	
9	Calculation of distortion power factor	
10	Effect of unbalanced and nonlinear load in a three phase System	
Pedagogy:	Constructive learning and Collaborative learning	
References/ Readings:	1. Math H. Bollen, Understanding power quality problems: Voltage Sags and Interruptions, Wiley- IEEE press, 2000. 2. Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, Power quality: Problems and Mitigation Techniques, Wiley, 2015 3. Ghosh and G. Ledwich, Power Quality Enhancement using custom power devices, NY: Springer, 2012. [E-book] Available: Springer Book archive 4. Angelo Baggini , Handbook of power quality, John Wiley and Sons, 2008	
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand terminologies and various sources contributing to PQ issues, their severity levels, PQ parameters and indices, and mitigation strategies.	

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	CO 2. Explain / Discuss the types and characteristics of PQ disturbances, types and operating principle of mitigation devices and various measurements CO 3. Analyze various components of a power signal under disturbance conditions, analyze single phase & three phase circuits for sinusoidal & and non sinusoidal voltage source, balanced, unbalanced loads, Linear and Non linear load. CO 4. Formulate rating of mitigating devices

Research Specific Elective (RSE) Courses

Name of the Programme : Master of Engineering (Power and Energy Engineering)

Course Code : REC-563

Title of the Course : Statistics and Data Analysis for Engineering Research

Number of Credits : 2

Effective from AY : 2024-25

Pre-requisites for the Course:	Basic Knowledge of Statistics	
Course Objectives:	The course will enable the students to 1. Explain the different types of data and parameter estimations 2. Explain standard probability distributions 3. Select the appropriate parameter estimation & distribution method 4. Co-relate different Hypotheses	
Content:		**No of Hours**
Unit -1	**Data Analysis:** Types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, experimental data, Qualitative data collection, questioners, rating scale, conducting survey. Statistical Modeling and Graphical Diagnostics - Scatter Plot, Stem-and-Leaf Plot, Histogram, Box Plot **Correlation and Regression Modeling:** Basic concept and numericals.	**9**
Unit -2	**Probability distributions and Sampling distributions:** Basic introduction to Bernoulli, Binomial and Normal distribution. Basic introduction to Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Unit -3	**Parameter estimation:** Point Estimation – Concept, unbiased estimator, method of maximum likelihood. Parameter estimation of standard distributions- Binomial and Normal. Confidence Interval Estimation - Concept, Confidence interval on mean of single normal population with variance known, Confidence interval on the ratio of variances of two normal distributions	**7**
Unit- 4	**Tests of Hypotheses:** Introduction, Type I and type II errors, significance level and power of the test, Test of hypotheses - on mean of single normal population with variance known, on variance of single normal population.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488 2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4	

Issued on: 22/01/2025

	4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1 5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Explain the different types of data and probability distributions. CO 2. Select the appropriate parameter estimation & distribution method CO 3. Apply estimators for the given situations. CO 4. Evaluate Hypotheses based on the statistical considerations.

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Name of the Programme : **Master of Engineering (Power and Energy Engineering)**
Course Code : **REC-564**
Title of the Course : **Statistics and Data Analysis Lab**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic Knowledge of Statistics	
Course Objectives:	The course will enable the students to 1. Apply the different types of data and parameter estimations 2. Analyze standard probability distributions 3. Demonstrate parameter estimation & distribution methods 4. Co-relate different Hypotheses	
Content:		**No of Hours**
	Using open-source software like libreoffice or any proprietary software perform following experiments: 1. Obtain measures of central tendency and dispersion. 2. Obtain Quartiles, Percentiles and prepare Box-and-Whisker Diagram 3. Develop Pie chart, Bar Chart, Histogram and Stem-and-Leaf Plot, 4. Develop_correlation using Pearson's Correlation Coefficient and showing Scatter Diagrams and Trendlines 5. Develop Linear and Nonlinear Regression Models 6. Obtain probability values involving probability distributions – Binomial and Normal 7. Obtain values of Normal, t-distribution, Chi-square and F-statistic. 8. Develop confidence interval for single population and two populations with variance known. 9. Develop confidence interval on the ratio of variances of two normal distributions. 10. Perform test of hypotheses on mean/variance of single/ two population(s).	**60**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488 2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4 4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1 5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,	

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply the different types of data and parameter estimations CO 2. Analyze standard probability distributions CO 3. Demonstrate parameter estimation & distribution methods CO 4. Co-relate different Hypotheses

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Name of the Programme : **Master of Engineering (Power and Energy Engineering)**
Course Code : **REC-565**
Title of the Course : **Statistical Techniques for Engineering Research**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of Statistics and Probability	
Course Objectives:	The course will enable the students to 1. Understand the importance of statistical methods for research 2. Select the appropriate factorial design method for a given set of experimental plan. 3. Apply basic probability theorems and draw relevant inferences. 4. Analyze suitable probability model for given set of data	
Content:		**No of Hours**
Unit-1	**Overview on Statistical methods**, collection of data, one dimensional and two-dimensional statistical analysis, computation of central tendency and dispersion for grouped and ungrouped data, correlation preliminary, understanding variability in data.	**6**
Unit-2	**Design of Experiments**, Preparation of experimental plan, full factorial design, fractional factorial design, identification of parameters and levels, randomization, replication, blocking, interaction; numerical; Optimization methods for two parameters.	**9**
Unit-3	**Probability Preliminary**: Introduction to Probability, definition, Sample Space, Events, Conditional Probability, Theorem on total probability, Bayes' theorem. Random Variable: Introduction, Discrete and Continuous distribution, Characteristics- Mean, Variance and distribution function.	**8**
Unit-4	**Probability and Sampling Distribution**: Bernoulli, Binomial, Exponential, Normal, distribution. Mean, variance and distribution function, important properties, approximations and applications. Statistic and Sampling Distribution: Population and Sample. Statistic, Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Tahvir Mustafy, Tauhid U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 2. Jiju Antony, 'Design of Experiments for Engineers & Scientists', Elsevier, 2023, ISBN 978-044-315-1736 3. Douglas Montgomery, 'Design and Analysis of Experiments', Wiley India, Eighth Edition, 2013, 9788126540501 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504	

	5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7 6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of statistical methods for research CO 2. Select the appropriate factorial design method for a given set of experimental plans. CO 3. Apply basic probability theorems and draw relevant inferences. CO 4. Analyze suitable probability model for given set of data

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Name of the Programme : Master of Engineering (Power and Energy Engineering)
Course Code : REC-566
Title of the Course : Probability & Statistical Analysis Lab
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Statistics and Probability	
Course Objectives:	The course will enable the students to 1. Apply basic probability theorems and draw relevant inferences. 2. Analyze suitable probability model for given set of data 3. Demonstrate factorial design methods 4. Synthesize fractional and full factorial experimental design data	
Content:		**No of Hours**
	Using open-source software like libreoffice or any proprietary software perform following experiments: 1. Obtain probability values involving discrete probability distributions - Bernoulli, Binomial. 2. Obtain probability values involving continuous probability distributions - Exponential and Normal distributions. 3. Obtain values of Normal, t-distribution, Chi-square and F-statistic. 4. Obtain values of Mean, Variance and distribution function of Bernoulli and Binomial distribution. 5. Obtain values of Mean, Variance and distribution function of Exponential and Normal distributions. 6. Obtain values of central tendency of grouped and ungrouped data. 7. Obtain values of dispersion of grouped and ungrouped data. 8. Analyse experimental output using full factorial design. 9. Analyse experimental output using fractional factorial design. 10. Analyse a full case study in involving full factorial design or fractional factorial design.	**60**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Tahvir Mustafy, Tauhid U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 2. Jiju Antony, 'Design of Experiments for Engineers & Scientists', Elsevier, 2023, ISBN 978-044-315-1736 3. Douglas Montgomery, 'Design and Analysis of Experiments', Wiley India, Eighth Edition, 2013, 9788126540501 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504 5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7 6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,	

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply basic probability theorems and draw relevant inferences. CO 2. Analyze suitable probability model for given set of data CO 3. Demonstrate factorial design methods CO 4. Synthesize fractional and full factorial experimental design data

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