Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3801: Switchgear and Protection				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	00 Hrs/week		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Elements of Power System, Measurement, Microprocessor basics

Course Outcomes (CO): Students will be able to

CO1	Classify circuit breakers, L.T. switchgears and understand the relaying principles.
CO2	Select the suitable switchgear for different applications.
CO3	Categorize faults and give protection against it for transformer, generator, transmission lines, bus bar, motors etc.
CO4	Summarize various protections utilised in the power system to maintain stability of the same.

	Course Contents	CO	Hours
Unit 1	**Fundamentals of protection, Circuit Interrupting Devices**: Protective system: Necessity, functions and components, protection paradigms - apparatus protection and system protection, desirable attributes of protection. Circuit Interrupting Devices: L.T. switchgear: - MCB, MCCB, HRC fuses, Isolators, Circuit Breakers: arc voltage, arc interruption, resistance switching, interruption of capacitive and inductive current, circuit breaker ratings, classification of C.B.s - air brake, air blast, vacuum, minimum oil and bulk oil, SF6 C.B., types, construction and applications.	**CO1, CO2**	**(08)**
Unit 2	**Protective Relays:** Fundamental quality requirements, Basic relay terminology- Protective relay, Relay time, Pick up, Reset current, current setting, and Plug setting multiplier (PSM), Time setting multiplier(TSM), Numericals. Over voltage relay, Over current protection, Earth fault protection using overcurrent relay Operation and its characteristics. Directional relay: Need and operation with block diagram, Current and Voltage differential relay: Operation	**CO1, CO2**	**(07)**
Unit 3	**Numerical relays:** Numerical relaying fundamentals, sampling theorem, anti-aliasing filters, least square method for estimation of phasor, Applications for implantation of various numerical relays. Fundamentals of PMU and WAMS, Adaptive protection, AI algorithms such as artificial neural network (ANNs) or fuzzy logic.	**CO2**	**(06)**
Unit 4	**Distance Protection:** Introduction to distance relaying, zones of protection, effect of fault arc resistance, directional properties, setting and coordination of distance relays, pilot wire protection with distance relays, Microprocessor based impedance, reactance and mho relay.	**CO3**	**(06)**
Unit 5	**Protection of Transformer, Generator, Motors:** Transformer protection: Buchholz relay, Percentage differential protection, magnetic inrush current phenomenon, percentage differential relay with harmonic restraint and harmonic blocking schemes, restricted earth fault protection. Generator protection: Stator earth fault, phase fault and ground fault protection, protection against unbalanced loading, loss of excitation, loss of prime mover and over speeding, protection of large motors, rotor overheating, generator- transformer unit protection, IEEE standards for protection of transformer, generator and motors.	**CO3**	**(07)**
Unit 6	**Bus bar protection, Lightning Protection and system grounding:** Bus bar protection: Different bus bar arrangements, differential protection of bus bar, high impedance differential relay. Lightening and switching over voltages, need and types of lightning arresters, travelling waves, insulation coordination. System grounding, need, methods of system grounding, substation ground mats.	**CO3, CO4**	**(06)**

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Text Books	
1.	B.Ram and D.N. Vishwakarma, "Power System Protection and Switchgear". (Unit 1-3)
2.	Sunil S. Rao, "Switchgear Protection and Power Systems", Khanna Publications. (Unit 4-6)
3.	Y. G. Paithankar, S. R. Bhide, "Fundamentals of power system protection" by Prentice hall, India. (Unit 1-6)
Reference Books	
1.	A.G.Phadke, J.S.Thorp, "Computer relaying for power systems", Research studies press ltd. England John Wiley & sons Inc. New York
2.	Blackburn, "Protection of Power system".
3.	M.V. Deshpande, "Switchgear and Protection".
Useful Links	
1.	https://onlinecourses.nptel.ac.in/noc21_ee110/preview, "Power System Protection and Switchgear" by Prof. Bhaveshkumar R. Bhalja, IIT Roorkee
2.	https://nptel.ac.in/courses/108101039 "Power System Protection" by Prof. S.A. Soman, IIT Bombay

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO2
CO 1	3	3	2	1	1	1	1	-	1	-	1	3	1
CO 2	3	3	2	1	-	-	1	-	-	-	2	3	1
CO 3	3	3	2	1	-	1	-	-	1	-	2	3	2
CO 4	3	3	2	1	2	-	1	1	-	-	2	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	-	05
Apply	5	5	10
Analyse	5	5	20
Evaluate	5	5	20
Create	-	5	05
TOTAL	20	20	60

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3802: EHVAC and HVDC Transmission				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	-		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite :

Course Outcomes (CO): Students will be able to

CO1	Describe the architecture, components, and fundamentals of EHVAC and HVDC transmission systems.
CO2	Analyse travelling waves, converter operations, and control strategies in high voltage systems.
CO3	Evaluate overvoltage, stability issues, and insulation coordination.
CO4	Analyse stability, advanced HVDC configurations, and system integration for modern power grids.

	Course Contents	CO	Hours
Unit 1	**EHVAC Introduction & Parameters:** Engineering aspects & growth in EHVAC transmission line, trends & preliminaries & transferability, Transient stability limit & Surge Impedance loading, properties of bundled conductors, inductance & capacitances, Corona Effects: I^2R & corona loss, corona loss formula, charge voltage diagram with corona, Attenuation of travelling waves due to the corona loss, audible noise; corona pulses, their generation & properties, limits for radio interference fields	**CO1**	**07**
Unit 2	**Travelling Waves & Overvoltage:** Theory of traveling and standing waves, differential equations, natural frequencies, open-ended lines, double exponential responses, energization with trapped charge, and wave reflections/refractions, Lightning strokes to lines, their mechanism. Over voltages& their types, recovery voltage & circuit breakers, Ferro resonance over voltage & calculation of switching surges & single-phase equivalents.	**CO2**	**07**
Unit 3	**Voltage Control & Insulation Coordination:** Power circle diagram & its use, voltage control, shunt & series compensation, sub synchronous resonance in series capacitor compensated line & static reactive compensating system. Basics of Insulation Coordination, principle of insulation coordination, Volt-time curves- Rated withstand voltage levels and clearances, relevant standard. Insulation Coordination as applied to Electrical Installation	**CO3**	**07**
Unit 4	**HVDC Technology & Converters:** AC vs. DC transmission comparison (economics, performance, reliability), applications, HVDC system types and components. LCC analysis: six/twelve-pulse converters, VSC: two/three-level, PWM schemes,	**CO1**	**06**
Unit 5	**HVDC Control:** Link Control: Steady-state equivalent circuits of a LCC HVDC Link, Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC HVDC system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation	**CO4**	**08**
Unit 6	**HVDC Stability & Advances:** Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems. Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTDC systems using LCCs. MTDC systems using VSCs. HVDC in wind power application.	**CO4**	**07**

Text Books

1. "EHVAC Transmission Engineering", R. D. Begamudre, New Age International Publishers (Unit 1-3)
2. "HVDC Power Transmission Systems", K. R. Padiyar, New Age International Publishers, 2011 (Unit 4-6)

Reference Books

1. "EHVAC & HVDC Transmission Engg. & Design", Twain Gonen, John Wiley
2. "High Voltage Direct Current Transmission", J. Arrillaga, Peter Peregrinus Ltd., 1983

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Useful Links			
1.	https://nptel.ac.in/courses/108104013 "High Voltage DC Transmission", IIT Kanpur, Dr. S.N. Singh		
2.	https://nptel.ac.in/courses/108104048 "High Voltage Engineering", IIT Kanpur, Prof. Ravindra Arora		

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	1	1	1	-	-	1	-	3	3	-
CO 2	3	3	2	2	-	-	-	-	1	-	3	3	1
CO 3	3	3	2	2	-	1	-	-	-	-	3	3	-
CO 4	3	3	2	2	1	-	-	-	-	-	3	3	1

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	10	5	15
Apply	5	5	15
Analyse	5	5	20
Evaluate	-	5	10
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
RM3803: Research Methodology				
Teaching Scheme			**Examination Scheme**	
Lectures	03 Hrs/week		MSE	20
Tutorials	00 Hrs/week		ISE	20
Total Credits	03		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite: Basic understanding of core concepts, mathematics, statistics, critical/scientific thinking skills

Course Outcomes (CO): Students will be able to

CO1	Understand fundamentals of research, research process, methods, and methodology.
CO2	Apply research design and problem formulation techniques to solve research problem.
CO3	Analyse data using statistical tools and methods. (Use of latest data processing tools)
CO4	Prepare reports, research papers/ following research ethics and publish research in various forms.

	Course Contents	CO	Hours
Unit 1	**Introduction:** Meaning and objective of research, motivations in research, characteristics components of research work, criteria of good research, Research process, type of research, fundamental, pure or Theoretical research, Applied Research, Descriptive Research, Evaluation Research, Experimental research, Survey Research, Qualitative Research, Quantitative Research, interdisciplinary Research.	**CO1**	**(08)**
Unit 2	**Research Design:** Research design, definition, essentials of research design, Research problem steps in research design, good research design, important concepts. Literature review -purpose, sources, and importance, research gap, Objectives – problem statement, Hypothesis,	**CO2**	**(08)**
Unit 3	**Data collection and Analysis:** Sources of data collection, Library sources, E-sources, primary data, secondary data, data collection methods, interviews, questionnaire schedule. Measurement, sampling, scaling - sample design, types of sample design, different scales, sampling error, Normal distribution.	**CO3**	**(06)**
Unit 4	**Data Analysis and tools:** Data processing, Classification, Statistical series, Qualitative vs Quantitative data analyses, Interpretation of data, Hypothesis testing, Measures of central tendency and dispersion, mean, media, mode, range, variance, standard deviation.	**CO3**	**(06)**
Unit 5	**Research Report Writing:** Research report, Different types, contents of report, executive summary, chapterization – contents of chapter, report writing, different report formats, bibliography/references, **Research and publication ethics:** significance of research ethics, Citation, plagiarism, publishing process journal publication, journal metrics. Use of AI tools in writing research articles. Use of AI Tools	**CO4**	**(07)**
Unit 6	**IPR: Meaning**, nature and scope of Intellectual property (IP), Importance of IPR in engineering, patents, copyrights, trademarks.	**CO4**	**(05)**

List of Submission: Assignment questions on every unit shall be given to students.

Text Books

1. Kothari, C. R., & Garg, G. Research Methodology: Methods and Techniques, 4th ed., New Age International

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	Publishers, New Delhi, 2019. (Units 1, 2, 3 and 4)
2.	Panneerselvam, R. Research Methodology, 2nd ed., PHI Learning Pvt. Ltd., New Delhi, 2013. (Units 1, 2 and 3)
3	Kumar, R. Research Methodology: A Step-by-Step Guide for Beginners, 4th ed., Pearson Education India, New Delhi, 2019. (Units 1 and 2)
4	Malhotra, N. K. Research Methodology: An Applied Orientation, 7th ed., Pearson Education India, New Delhi, 2020. (Units 3 and 4)
5	Pavithra, R. H. Research Methodology and Techniques of Data Analysis, Current Publications, New Delhi, 2023. (Unit 3)
6	Bhandari, M. K. Intellectual Property Rights, 4th ed., Central Law Publications, Allahabad, 2024. (Unit 6)
Reference Books	
1.	B. L. Garg, R. Kavdia, S. Agrawal, and U. K. Agarwal, Research Methodology. Jaipur, India: RBSA Publishers, 2019. (Unit 1 and 2)
2.	D. Deb, R. Dey, and V. E. Balas, Engineering Research Methodology. Singapore: Springer, 2019. (Unit 2)
3.	J. P. Lal, S. Bishla, and D. Singh, Research Methodology and Data Analysis. New Delhi, India: Publishing House, 2023. (Unit 3 and 4)
4	D. Chawla and N. Sondhi, Research Methodology. New Delhi, India: Vikas Publishing House, 2011. (Unit 1, 3 and 4)
5	P. K. Praveena and R. P. Thevannoor, Research Report Writing. New Delhi, India: Bharti Publications, Sept. 24, 2021. (Unit 5)
6	M. Vidhya Sree, M. K. Singh, P. Bisht, and Z. Beevi, Research Methodology and IPR Strategies. New Delhi, India: Technical Publications, 2022. (Unit 6)
Useful Links	
1.	https://youtu.be/1vf8ZvADxfY "Research methodology" by Dr Devika Bhatnagar
2.	https://www.youtube.com/watch?v=lfWlbjl1zzU "Research Methodology" by Prof. Edamana Prasad, Prof. Prathap Haridoss,IIT Madras.
3.	https://www.youtube.com/watch?v=E2gGF1rburw "Research Methodology in Natural Sciences" by Prof. Soumitro Banerjee, Department of Physical Sciences, IISER Kolkata.

Mapping of COs and POs

PO→ CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	1	1	2	3	1	2	1	1	1	2
CO 2	2	3	2	3	2	2	2	1	1	1	1	1	2
CO 3	2	3	2	3	3	2	3	2	2	2	2	1	1
CO 4	3	2	3	2	3	2	3	3	2	3	2	2	2

Guideline for Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	5	5	20
Understand	5	5	10
Apply	5	5	10
Analyze	5	5	20
Evaluate	-	-	-
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3814: Robotics in Automation (Program Elective -IV)				
Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	00 Hrs/week		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite: Basics of Electrical Machines, Control Systems, Sensors & Actuators

Course Outcomes (CO): Students will be able to

CO1	Understand the fundamentals, classifications, and applications of industrial robots.
CO2	Analyse electrical actuators, sensors, and drives used in robotic automation.
CO3	Apply basic robot kinematics and control concepts for automation tasks.
CO4	Interpret industrial robotic automation systems and safety practices in real-world applications.

	Course Contents	CO	Hours
Unit 1	**Introduction to Robotics in Automation:** Definition and scope of robotics, Evolution of industrial robots, Classification of robots (Cartesian, SCARA, Articulated, Delta), Components of a robotic system, Role of robotics in industrial automation.	**CO1**	**05**
Unit 2	**Actuators, Drives and Sensors in Robotics:** Electrical actuators: DC motors, Servo motors, Stepper motors, Comparison of motors used in robotics, Drive systems and motor control basics, Sensors in robotics: position, proximity, force, vision (overview), Encoders and resolvers for position feedback.	**CO2**	**07**
Unit 3	**Robot Kinematics and Control Basics:** Degrees of freedom (DOF), Joint types and robot configuration, Forward kinematics (basic concepts), Open-loop and closed-loop control in robots, Introduction to PLC and microcontroller-based robot control.	**CO3**	**07**
Unit 4	**Industrial Automation and Safety:** Robotic automation cells, Robot integration with conveyors, PLCs, and HMIs, Introduction to collaborative robots (Cobots), Industrial communication basics (Ethernet, Fieldbus – overview), Safety standards and hazards in robotic automation Case studies of robots in electrical and electronics industries	**CO4**	**07**

Text Books

1.	Mikell P. Groover, "Industrial Robotics: Technology, Programming and Applications", McGraw-Hill Education 2016, (Unit 01-04)
2.	J. J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education, 2022. (Unit 01,02)

Reference Books

1.	S. R. Deb, "Robotics Technology and Flexible Automation", McGraw-Hill, 2010, (Unit 03 & 04)
2.	John J. Craig. "Introduction to Robotics: Mechanics and Control', Pearson Education, (Unit 03)
3.	R. M. Murray, Z. Li, and S. S. Sastry, "A Mathematical Introduction to Robotic Manipulation", CRC Press, 2017 (Unit 01)

Useful Links

1.	https://nptel.ac.in/courses/107106090 "Introduction To Robotics", IIT Madras, Prof. Asokan T Prof. Balaraman Ravindran Prof. Krishna Vasudevan
2.	https://nptel.ac.in/courses/112107289 "Robotics and Control : Theory and Practice", IIT Roorkee, Prof. N. Sukavanam Prof. M. Felix Orlando
3.	https://www.youtube.com/playlist?list=PLXDsvE7qtfNf_N99hJZbdTEM001mOii6_

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Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	2	1	2	1	-	-	-	-	2	3	2
CO 2	2	2	3	2	3	-	-	-	1	-	2	2	3
CO 3	3	3	2	2	2	1	-	-	1	-	2	3	2
CO 4	2	3	3	2	3	-	-	-	1	-	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	-	-	-
Apply	5	5	20
Analyse	5	5	15
Evaluate	5	5	15
Create	5	5	10
TOTAL	20	20	60

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Final Year (Sem – VII-Mode-1-Academic) B. Tech. Electrical Engineering

EE3854: PLC and SCADA Automation (Industrial Program Elective -IV)

Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	00 Hrs/week		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite: Basics of Electrical Machines, Control Systems, Sensors & Actuators

Course Outcomes (CO): Students will be able to

CO1	Identify and recall the fundamental components and architecture of PLCs, SCADA systems, HMIs, and DCS in industrial automation
CO2	Apply PLC programming to implement control sequences, configure HMI screens, and utilize SCADA protocols for data acquisition and monitoring
CO3	Apply PID control and motor-drive concepts using PLCs to achieve desired control actions in closed-loop systems
CO4	Analyze PLC–SCADA–DCS integrated systems to identify control issues, troubleshoot faults, and communicate solutions effectively.

	Course Contents	**CO**	**Hours**
Unit 1	**Programmable Logic Controller (PLC)** Role of automation in Industries, Overview of Industry 4.0 and Smart Manufacturing, benefits of automation, Necessity of PLC, Definition, Historical background, Parts of a PLC, Block diagram of PLC, Principles of operation, PLC size & application, PLC hardware components, selection criterion, advantages and disadvantages, specifications, Electromagnetic control relays, Contactors, Manually & Mechanically operated switches, Sensors, Output control devices, Seal-in circuits, Electrical interlocking circuits, Safety PLCs and fail-safe concepts, Converting relay schematics into PLC ladder programs, Ladder Logic Program from a narrative description.	**CO1**	**05**
Unit 2	**PLC Programming** Introduction, IEC 61131-3 Standard, Types of PLC languages, Ladder diagram format, Ladder relay instructions, Ladder relay programming, Timers and counters, Program/Flow control instructions, Math instructions, Data manipulation, Data transfer instructions & special function instructions, PLC Installation Practices, Editing, and Troubleshooting: PLC enclosures, Electrical noise, Leaky inputs and outputs, Grounding, Voltage variations & surges, Program editing and commissioning, Preventive maintenance, Troubleshooting.	**CO2**	**06**
Unit 3	**Advanced Functions and Applications of PLC** PID Tuning methods, PID Module, Real-time process control using PID in actual applications (e.g., flow, pressure, temperature), AC Motor starters, Overload protection, VFD, DC Motor Controllers. Interfacing PLC to Motor Drives, Need and Advantages of using HMI, PLC-HMI interface, Developing ladder logic for Sequencing of motors, Car parking, Tank level control, Temperature control, Elevator, Bottle filling plant, Traffic light controller	**CO3**	**07**
Unit 4	**SCADA and Distributed Control Systems (DCS)** **SCADA-** Introduction, definitions and history of Supervisory Control and Data Acquisition, typical SCADA system Architecture, important definitions HMI, MTU, RTU, communication means, Desirable Properties of SCADA system, advantages, disadvantages and applications of SCADA, Introduction to popular SCADA platforms: WinCC, Wonderware, Ignition; SCADA Protocols: Open systems interconnection (OSI) Model, TCP/IP protocol, Modbus model, Device Net, Control Net, Ether Net/IP, Process Field bus (Profibus). **Distributed Control Systems (DCS)-** Introduction, History of DCS, DCS concept, Communication in DCS, Modes of DCS, DCS hardware & software, DCS structure, Architectural feature of DCS, DCS design considerations, Manual and redundant backup designs, Advantages & disadvantages. Integration of PLC, SCADA, with DCS and IIoT platforms	**CO4**	**08**
Text Books			

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1.	Frank Petruzzula, "Programmable Logic Controllers", McGraw Hill, New York, 5th Edition, 2016. (Unit 1,2)
2.	Stuart A. Boyer, "SCADA: Supervisory Control and Data Acquisition", Fourth Edition, ISA- The Instrumentation, Systems, and Automation Society, 2010 (Unit 2,4)
3.	Lukcas M. P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York.
4.	Curtis D. Johnson, "Process Control Instrumentation Technology", Pearson New International.
Reference Books	
1.	Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson Delmar Ceneage Learning.
2.	Ronald L. Krutz, "Securing SCADA Systems", Wiley.
3.	D. Popovic and V. P. Bhatkar, "Distributed Computer Control for Industrial Automation", Marcel Dekker, Inc., New York.
4.	Katariya Sanjay B., "Industrial Automation Solutions for PLC, SCADA, Drive and Field Instruments: Easy to Learn Industrial Automation", Notion Press.
Useful Links	
1.	https://nptel.ac.in/courses/108105062, Industrial Automation and Control, IIT Kharagpur ,Prof. S. Mukhopadhyay, Prof. S. Sen
2.	https://nptel.ac.in/courses/108106022, Energy Management Systems and SCADA, IIT Madras Dr. K. Shanti Swarup

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	2	1	3	2	1	-	1	2	2	3	2
CO 2	2	2	3	2	3	2	-	1	-	2	2	2	3
CO 3	3	3	2	2	3	2	1	-	1	2	2	3	2
CO 4	2	3	3	2	3	2	-	1	-	2	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	-	-	-
Apply	5	5	20
Analyse	5	5	15
Evaluate	5	5	15
Create	5	5	10
TOTAL	20	20	60

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EE3824: Power Quality (Program Elective -IV)

Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	00 Hrs/week		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Electrical Power System, Power system analysis

Course Outcomes (CO): Students will be able to

CO1	Distinguish between the various categories of power quality problems in industry and their impact on performance.
CO2	Analyse harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads
CO3	Apply appropriate solution techniques for power quality mitigation based on the type of problem.
CO4	Summarize the importance of grounding on power quality and Introduce power distribution protection techniques and its impact on voltage quality.

	Course Contents	**CO**	**Hours**
Unit 1	**Power Quality Phenomenon:** Power quality phenomenon - Sources and effects of power quality problems, Need for concern of Power quality, types of power quality disturbances: Transients - classification and origin, Short duration voltage variation-interruption, sag, swell, Long duration voltage variation, voltage unbalance, waveform distortion: notching, harmonics and voltage flicker	**CO1**	**07**
Unit 2	**Transient Overvoltage:** Sources of transient overvoltage, devices for overvoltage protection, switching transient problems with loads, computer tools for transient analysis, IEEE and IEC standards for power quality.	**CO1**	**05**
Unit 3	**Fundamentals of Harmonics:** Harmonic distortion, power system quantities under non sinusoidal conditions, harmonic indices, harmonic sources from industrial loads, effects of harmonic distortion, devices for controlling harmonic distortion, standards on harmonics.	**CO2**	**07**
Unit 4	**Power Quality Monitoring and Mitigation Techniques:** Monitoring considerations, power quality measurement equipment, application of intelligent systems, power quality monitoring standards, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques Mitigation of Power quality problems- Harmonic elimination: Transmission and distribution systems, resonance, shunt capacitors, transformers, ground systems, DSTATCOM and UPQC, sag and swell correction using DVR	**CO3, CO4**	**08**

Text Books

1. Roger C. Dugan, "Electrical Power Systems Quality", McGraw-Hill Publication (Unit 1-4)
2. Math H. Bollen, "Understanding Power Quality Problems", IEEE press. (Unit 1-2)
3. J. Arrillaga, "Power System Quality Assessment", Jonh Willey.

Reference Books

1. Arindam Ghosh, "Power quality Enhancement Using Custom Power Devices". Kluwer Academic Publishers.
2. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications

Useful Links

1. https://nptel.ac.in/courses/108102179 ,"Power Quality", IIT Delhi, Prof. Bhim Singh.
2. https://nptel.ac.in/courses/108107157," Power Quality Improvement Technique, IIT Roorkee, Prof. Avik Bhattacharya

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Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO2
CO 1	3	3	2	1	1	1	-	-	2	-	1	3	1
CO 2	3	3	2	1	-	-	-	-	1	-	2	3	1
CO 3	3	3	2	1	1	-	-	-	2	-	2	3	2
CO 4	3	3	2	1	-	-	1	1	-	-	2	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	10
Apply	5	5	10
Analyse	5	5	20
Evaluate	5	5	20
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad					
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering					
EE3834: FACTS (Program Elective -IV)					
Teaching Scheme			**Examination Scheme**		
Lectures	02 Hrs/week		MSE	20	
Tutorials	00 Hrs/week		ISE	20	
Total Credits	02		ESE	60	
			Duration of ESE	02 Hrs 30 Min	

Prerequisite :

Course Outcomes (CO): Students will be able to

CO1	Apply knowledge to learn FACTS concepts.
CO2	Evaluate power system compensation requirements for improved voltage control and stability.
CO3	Analyse specific use of FACTS devices
CO4	Examine the need and impact of compensation techniques in enhancing power system performance.

	Course Contents	CO	Hours
Unit 1	Interconnections of Transmission Lines, Power Flow in an AC System, Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of controllable Parameters.	**CO1**	**08**
Unit 2	FACTS Controllers, Benefits from FACTS technology, HVDC vs. FACTS Static Shunt Compensators	**CO2**	**06**
Unit 3	Objectives of Shunt Compensation, Methods of Controllable Var Generation, Static Var Compensators: SVC and STATCOM, Comparison Between STATCOM and SVC, Static Var Systems.	**CO3**	**06**
Unit 4	Objectives of Series Compensation, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators, Introduction to UPFC, Self-study and presentation on 'Case study of existing FACT systems'	**CO4**	**06**

Text Books

1.	N.G. Hingorani & Gyugyi, "Understanding FACTS", IEEE Press, 1999 (Unit 1-2)
2.	Introduction To Facts Controllers Theory, Modeling, and Applications, Kalyan K. SenMey Ling Sen, IEEEPress,A JOHN WILEY & SONS, INC., Publication(Unit 2-4)

Reference Books

1.	Power Electronic Control in Electrical Systems , E. Acha, V.G. Agelidis, O. Anaya-Lara, T. J.E. Miller Newnes Power Engineering Series, Oxford.
2.	Flexible AC Transmission System (FACTS) Devices, Ernest Nkusi, AV Akademikerverlag publication
3.	Flexible AC transmission systems (FACTS) , Yong Hua Song IEE Press.

Useful Links

1.	https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee58, "Facts Devices", By Prof. Avik Bhattacharya, IIT Roorkee

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO2
CO 1	3	1	-	-	2	1	1	-	-	-	3	3	-
CO 2	3	2	2	1	2	1	1	-	1	-	3	3	-
CO 3	3	3	2	2	1	-	1	-	1	-	3	3	-
CO 4	3	3	1	1	3	1	1	1	1	-	1	3	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	-	-	-
Apply	10	8	20
Analyse	5	5	20
Evaluate	5	4	20
Create	-	3	-
TOTAL	20	20	60

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Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering

EE3844: Design of Energy Efficient Machines (Program Elective -IV)

Teaching Scheme		Examination Scheme	
Lectures	02 Hrs/week	MSE	20
Tutorials	00 Hrs/week	ISE	20
Total Credits	02	ESE	60
		Duration of ESE	02 Hrs 30 Min

Prerequisite: Electrical Machines, Electrical Drives

Course Outcomes (CO): Students will be able to

CO1	Analyze energy efficiency needs, losses, efficiency, life-cycle cost, IE classes, and basic energy auditing of electrical machines.
CO2	Evaluate the effect of materials, design, cooling, and thermal parameters on electrical machine efficiency.
CO3	Analyze and compare energy-efficient induction motors and special electrical machines with conventional machines.
CO4	Apply energy-efficient drives, standards, and case studies to achieve industrial energy savings.

	Course Contents	CO	Hours
Unit 1	**Fundamentals of Energy Efficiency in Electrical Machines:** Energy scenario and need for energy efficiency, losses in electrical machines, efficiency and life-cycle cost concept, IE efficiency classes, basics of energy auditing of electrical machines., overview of IS and IEC efficiency standards	**CO1, CO4**	**8**
Unit 2	**Materials and Design Aspects for Energy Efficiency:** Magnetic, conducting, and insulation materials used in energy-efficient machines, effect of material selection on losses and efficiency, cooling and thermal considerations, key design parameters affecting machine efficiency.	**CO2, CO3**	**6**
Unit 3	**Energy-Efficient Induction and Special Electrical Machines:** Design features of energy-efficient induction motors, loss reduction techniques, brief overview of Permanent Magnet Synchronous Motors, Brushless DC motors, and Switched Reluctance Motors, comparison of conventional and energy-efficient machines.	**CO3, CO2**	**6**
Unit 4	**Energy-Efficient Drives**: Standards, and Applications Role of power electronic drives and Variable Frequency Drives in energy saving, motor-drive matching, energy labeling, industrial applications and selected case studies of energy-efficient machines.	**CO4, CO1**	**6**

Text Books

1. P. S. Bimbhra, Electrical Machinery, Khanna Publishers, New Delhi. (Unit 1-2)
2. Stephen J. Chapman, Electric Machinery Fundamentals, McGraw-Hill Education. (Unit 1-4)

Reference Books

1. Ned Mohan, Power Electronics: Converters, Applications and Design, John Wiley & Sons.
2. A. K. Sawhney, A Course in Electrical Machine Design, Dhanpat Rai & Co.
3. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press.

Useful Links

1. https://nptel.ac.in/courses/108101038, "Power Electronics", IIT Bombay, Prof. B.G. Fernandes, Prof. Kishore Chatterjee
3. https://nptel.ac.in/courses/108102146 , "Electrical Machines", IIT Delhi, Prof. G.Bhuvaneshwari

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	2	3	-	1	1	-	-	2	3	3	3
CO 2	2	3	2	2	2	1	1	-	-	3	3	2	3
CO 3	3	2	1	2	2	-	1	-	-	2	3	3	2
CO 4	3	3	2	3	1	1	1	1	-	3	3	2	2

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

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Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	-	-	-
Apply	10	8	20
Analyse	5	5	20
Evaluate	5	4	20
Create	-	3	-
TOTAL	20	20	60

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Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering

EE3815: Advanced Control System (Program Elective -V)

Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	00 Hrs/week		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite: Digital and Intelligent Control System

Course Outcomes (CO): Students will be able to

CO1	Apply the concept of linearization, diagonalization of a given non-linear system & nullity of a matrix.
CO2	Analyse control systems to determine controllability and observability using state-space techniques.
CO3	Evaluate the stability of control systems by comparing different Lyapunov functions and control strategies.
CO4	Develop the concept of pole-placement and observer design.

	Course Contents	**CO**	**Hours**
Unit 1	**Review of Linear Algebra Concepts:** Field, Vector space, linear combination, linear independence, bases of a vector space, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space of a matrix, Eigen value and Eigen vector of a matrix, similarity transform, Diagonalisation	**CO1**	**06**
Unit 2	**Modern Control & Stability Analysis:** Concept and computation of systems modes, controllability theorem, Observability theorem, Controllable and observable sub spaces, Stability Analysis: Stability of linear systems, stability types and their definitions for any general system, Stability of an equilibrium point, Lyapunov stability theory for LTI systems.	**CO2**	**06**
Unit 3	**Modern Control Design:** Converting the mathematical model to controllable canonical form and its use for pole placement, Concept of linear observer and its design, Design of reduced order observer, Compensator design using separation principle, Poles of compensator, Open loop and close-loop systems	**CO3**	**06**
Unit 4	**Optimal Control Theory:** Introduction to the philosophy of optimal control, formulation of optimal control problem, different performance criterion, Linear quadratic regulator (LQR) and optimum gain matrix, Riccati equations, conceptual models and statistical models for random processes, Kalman filter.	**CO4**	**06**

Text Books

1. Jamkar, R. G., M. Gopal, "Modern Control System Theory" New Age International (P) Limited, New Delhi, 2000 Automation using PLC, SCADA and DCS, Global press, 2018, 1 st Edition. (Unit No. 02, 03)
2. Nagarath I. J. and Gopal M., Control System Engineering, 5/e, New Age Publishers, 2007, (Unit no. 02.03 & 04)
3. Ogata K., Modern Control Engineering, 5/e, Prentice Hall of India, 2010. (Unit no. 02.03 & 04)
4. Gopal M, Modern Control System Theory, 2/e, New Age Publishers, 1984 (Unit no. 02.03 & 04)

Reference Books

1. Bernard Friedland, "Control System Design: An Introduction to State-Space Methods", Dover Publications, NC. Mineola, New York, 2012.
2. Thomas Kailath, "Linear Systems", Prentice-HallInc., NewJersey,1986 Unit no. 01,
3. D.S. Naidu, "Optimal Control Systems" First Indian Reprint, CRC Press, 2009. Unit no. 04

Useful Links

1. https://archive.nptel.ac.in/content/syllabus_pdf/108103007.pdf
2. https://nptel.ac.in/courses/101108047, " Advanced Control system design for Aerospace vehicle, IISC Banglore, Dr. Radhkant Padhi.

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Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	1	-	1	1	-	-	-	1	1	1
CO 2	3	3	2	1	-	1	1	-	1	-	1	2	2
CO 3	3	3	2	2	2	-	1	-	1	-	2	2	1
CO 4	3	3	3	2	2	1	1	1	1	-	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	-	-	-
Apply	5	5	20
Analyse	5	5	15
Evaluate	5	5	15
Create	5	5	10
TOTAL	20	20	60

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3825: Generation Planning and Load Forecasting (Program Elective -V)				
Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Elements of Power System, Power System Analysis

Course Outcomes (CO): Students will be able to

CO1	Determine the power and energy requirements required to balance supply and demand under varying system conditions.
CO2	Analyze cost, scheduling, and reliability aspects of power generation systems.
CO3	Examine the different methods used to analyse electrical load demand and to achieve economic system operation.
CO4	Assess power system practices by examining capacity, demand trends, load dispatch and economic aspects.

	Course Contents	CO	Hours
Unit 1	**Power System Generation Planning:** Objectives and factors affecting to system planning, Reactive power planning. Role of generation planning in integrated power systems, Various types of power plants and operational planning and economics.	**CO1**	**08**
Unit 2	**Generation Scheduling and Economic Dispatch:** Introduction, Scheduling Objectives, Constraints in Scheduling, Unit Commitment, Hydro-Thermal Scheduling, Short-Term vs Long-Term Scheduling, Economic Dispatch, Economics dispatch problem, 0Thermal system dispatch with Network losses, Lambda iteration method, Gradient methods of economic dispatch, Newtons method. Causes of generation inadequacy, reliability indices.	**CO2**	**07**
Unit 3	**Load Forecasting:** Classification of loads, Factors affecting load forecasting, Load Growth characteristics, Load forecasting methods: i) Extrapolation ii) Co-relation techniques, Energy forecasting peak demand forecasting, Weather sensitive and non-weather sensitive forecasting, Annual and Monthly Forecasting, Total Forecasting.	**CO3**	**07**
Unit 4	**Load dispatch:** Introduction, Objectives of load dispatch, Consideration for centralized control of system operations. Requirements of the central load dispatch centre, Constraints in Load Dispatch. **Case study:** Indian Power System: Generation plant and its installed capacity, regional grid operation, Central Electricity Authority (CEA) planning approach, Demand Growth & Load Pattern, Demand Growth & Load Pattern, Economic & Environmental Constraints, Forecast & Reliability etc.	**CO4**	**08**

Text Books

1. C. L. Wadhwa, Electrical Power Systems, 8th ed. New Delhi, India: New Age International, 2010.[Unit 1-4]
2. D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, 4th ed. New Delhi, India: McGraw-Hill Education, 2011. [Unit 1-2]
3. K. U. Möller, Electric Power Planning, New York, NY, USA: Wiley, 1982.

Reference Books

1. R. L. Sullivan, Power System Planning, New York, NY, USA: McGraw-Hill, 1988.
2. A. J. Wood and B. F. Wollenberg, Power Generation, Operation, and Control, 3rd ed. New York, NY, USA: Wiley, 2012.
3. D. M. G. Newbery, Privatization, Restructuring, and Regulation of Network Utilities, The Walras-Pareto Lectures, Cambridge, MA, USA: MIT Press, 2000. ISBN: 978-0-262-14068-3. [Unit 4]

Useful Links

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1.	https://nptel.ac.in/courses/117103149, "Operation And Planning Of Power Distribution Systems", IIT Guwahati, Prof. Sanjib Ganguly
2.	http://digimat.in/nptel/courses/video/108107112/L54.html ," Electrical Distribution System Anaysis", Prof. N.P. Padhy.

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	2	1	1	-	3	-	-	1	-	3	1
CO 2	3	3	1	1	1	-	1	-	-	-	-	3	1
CO 3	3	2	-	2	2	1	1	-	-	-	1	3	1
CO 4	3	2	2	2	3	2	-	2	2	2	2	3	3

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	05	-	-
Understand	05	05	10
Apply	05	10	20
Analyse	05	05	20
Evaluate	-	-	10
Create	-	-	-
TOTAL	20	20	60

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3835: Advanced Electric Vehicles (Program Elective -V)				
Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	00 Hrs/week		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite: Power electronics, Control System, Electrical Machines

Course Outcomes (CO): Students will be able to

CO1	Apply the concept of power train for electric vehicles and electric drives.
CO2	Adapt the different energy storage technologies used for modern trends in hybrid electric vehicle.
CO3	Evaluate different types of EV battery chargers and EVSE based on performance, safety, standards, and application requirements.
CO4	Analyse system models used in EV control applications.

	Course Contents	CO	Hours
Unit 1	**Components of Power Train**: Introduction: Components of conventional vehicle and propulsion load; power train of HEV and EV; efficiency considerations for conventional vehicle, HEV and EV; multi-motor in-wheel EVs; impact and benefits of EV on utility grid.	**CO1**	**06**
Unit 2	**Charger Classification:** classification based on charging levels (region-wise), modes, plug types, standards related to: connectors, types of AC-DC converters; working principles, Types of DC-DC converter used for EV chargers; Applications of AI in charging technologies.	**CO2**	**06**
Unit 3	**Control Systems for Electric Vehicle:** Importance of control system in Electrical vehicle, Study of control architecture in Electric vehicle, Systems models and their classifications, principles used in modelling of systems, Fundamental studies of Modelling of vehicle dynamics and control.	**CO3**	**06**
Unit 4	**Batteries for EV Application:** Performance criterion for EV batteries- Energy density, Amp hour density, Energy efficiency, Cost, Operating temperature, number of life cycles, recharge and self-discharge rates and commercial availability, battery management system(BMS), advancement in BMS, some reference batteries and extension to nonautomotive sectors Applications of control techniques in Traction control, Vehicle Control.	**CO4**	**06**

Text Books

1. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 2015. (Unit no. 01, 03)
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press. 2021 (Unit no. 02, 04)
3. Tom Denton, "Automotive Electrical and Electronic Systems", 5th Edition, Routledge, 2018 (Unit no. 01, 04)

Reference Books

1. E. Karden, S. Ploumen, B. Fricke, T. Miller and K. Snyder, "Energy storage devices for future hybrid electric vehicles," J. Power Sources, vol. 168, no. 1, pp. 2–11, 2007. Unit no. 04
2. Rajesh Rajamani, Vehicle Dynamics and Control, Springer, Second Edition, 2012, Unit no. 01,02,03

Useful Links

1. https://nptel.ac.in/courses/108102121 "Vehicle Dynamics and Electric Motor Drives", IIT Delhi Prof. Amit Jain Prof. Avanish Tripathi
2. https://nptel.ac.in/courses/108106170 "Fundamentals of Electric vehicles: Technology & Economics" , IIT Madras, Prof. Ashok JhunjhunwalaProf. Prabhjot KaurProf. Kaushal Kumar JhaProf. L Kannan

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CO 2	3	2	1	2	2	1	-	-	-	2	1	2	2
CO 3	3	3	2	2	3	2	-	-	-	1	2	2	2
CO 4	3	3	2	2	2	1	-	-	-	1	2	1	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	-	-	-
Apply	5	5	15
Analyse	5	5	15
Evaluate	5	5	15
Create	5	5	15
TOTAL	20	20	60

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3845: Electrical Utilization and Traction (Program Elective -V)				
Teaching Scheme			**Examination Scheme**	
Lectures	02 Hrs/week		MSE	20
Tutorials	--		ISE	20
Total Credits	02		ESE	60
			Duration of ESE	02 Hrs 30 Min

Prerequisite : Electrical Machines, Electrical Drives

Course Outcomes (CO): Students will be able to

CO1	Apply electrical utilization principles in illumination, heating, welding systems.
CO2	Apply lighting design methods for practical engineering problems.
CO3	Analyse train motion, tractive effort, and energy use in electric traction systems.
CO4	Compare motors, control methods, and power supply systems for AC and DC traction

	Course Contents	CO	Hours
Unit 1	**Illumination:** Introduction, Laws of illumination, Measurement of illumination. Sources of light Discharge lamp, High-intensity discharge lamps, LED lighting systems, Decorative Lighting & Special Lighting Schemes: Flood Lighting, Street Lighting, Signage, Basic principles of light control, Types and design of lighting schemes, Methods of lighting calculations.	**CO1, CO2**	**07**
Unit 2	**Electric Heating and Welding:** Classification of electric heating methods, resistance heating, design of heating element, arc furnaces, arc furnaces, induction heating, high frequency eddy current heating, dielectric heating. Resistance welding, electric arc welding, ultrasonic welding, electron beam welding, laser beam welding, requirements of good weld, electric welding equipment.	**CO1**	**06**
Unit 3	**Train Movement and Energy Consumption:** Introduction to electric traction, Systems of electric traction, Systems of track electrification, Typical speed-time curves, Crest speed, Average speed, Schedule speed, Factors affecting schedule speed, Mechanics of train movement, Tractive effort for propulsion of train, Determination of specific energy output, Factors affecting specific energy consumption, Dead weight, Accelerating weight and adhesive weight.	**CO3**	**06**
Unit 4	**Electric traction methods and its control:** Features of traction motors, suitable motors for traction, Starting and speed control of DC and AC traction motors, Drum controllers, Contactor type controllers, Current collection system, Current collectors for overhead system, Power supply arrangement for AC and DC track electrification. **Case study Metro-Traction Systems.**	**CO4**	**07**

Text Books

1. J. B. Gupta, "Utilization of Electrical Power and Electric Traction", S. K. Kataria and Sons, 10th edition 2012, Reprint 2018.[Unit 1-4]
2. R. K. Rajput, "Utilisation of Electrical Power", Laxmi Publications, 1st Edition, 2007.[Unit 1-2]

Reference Books

1. E. Openshaw Taylor, "Utilization of Electric Energy", Orient Longman, Edition 1971, Reprint 2006
2. N. V. Suryanarayana, "Utilization of Electric Power", New Age International Publishers, 1st Edition 1994, Reprint 2005
3. H. Partab, "Art and Science of Utilization of Electrical Energy", Dhanpat Rai and Sons, 2014

Useful Links

1. https://nptel.ac.in/courses/126105026 "Traction Engineering", IIT Kharagpur, Prof. Hifjur Raheman
2. https://nptel.ac.in/courses/108104140 "Fundamentals of Electric Drives", IIT Kanpur, Prof. Shyama Prasad Das
3. https://onlinecourses.nptel.ac.in/noc23_ag06/preview "Traction Engineering", by Prof. Hifjur Raheman IIT Kharagpur

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Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	2	1	2	1	1	-	-	-	2	3	2
CO 2	3	3	3	-	2	1	1	-	-	-	2	3	3
CO 3	3	3	2	-	-	1	-	-	-	-	2	3	2
CO 4	3	2	1	1	-	1	-	-	1	-	1	2	2

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	-	20
Apply	5	5	20
Analyse	5	10	10
Evaluate	5	5	10
Create	-	-	-
TOTAL	20	20	60

DEPARTMENT OF ELECTRICAL ENGINEERING
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Electrical Engineering Department

Government College of Engineering, Karad					
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering					
EE3806: Energy Management and Audit (Multi-disciplinary Minor – 06)					
Teaching Scheme			**Examination Scheme**		
Lectures	02 Hrs/week		MSE	20	
Tutorials	----		ISE	20	
Total Credits	02		ESE	60	
			Duration of ESE	02 Hrs 30 Min	

Prerequisite: Basics of Power System

Course Outcomes (CO): Students will be able to

CO1	Acquire the basic concepts of energy audit, energy management and energy policies.
CO2	Analyze the energy audit instruments, procedures and techniques.
CO3	Illustrate the energy management need, different aspects of it and financial analysis.
CO4	Adapt the knowledge for energy saving potential of thermal and electrical systems for maximizing and optimizing system efficiency.

	Course Contents	CO	Hours
Unit 1	**General Aspects:** Review of energy scenario in India, general philosophy and need of energy audit and management, basic elements and measurements, mass and energy balances, scope of energy auditing industries, evaluation of energy conserving opportunities, energy performance contracts, fuel and energy substitution, need for energy policy for industries, national & state level energy policies	**CO1**	**06**
Unit 2	**Energy Audit Concepts:** Need of Energy audit, types of energy audit, energy management (audit) approach, understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, duties and responsibilities of energy auditors, energy audit instruments, procedures and techniques.	**CO2**	**07**
Unit 3	**Principles and Objectives of Energy Management:** Design of energy management programmes, development of energy management systems, importance, Indian need of energy Management, duties of energy manager, preparation and presentation of energy audit reports, monitoring and targeting, some case study and potential energy savings. Financial analysis: Introduction, fixed and variable costs, Interest charges, simple pay-back period, discounted cash flow methods, net present value method and internal rate of return method, factors affecting analysis.	**CO3**	**07**
Unit 4	**Energy Management methods:** Supply side methods to minimize supply, demand gap, renovation and modernization of power plants, reactive power management, demand side, conservation in motors, pumps and fan systems, energy efficient motors, energy conservation in boilers, steam turbines and industrial heating systems, cogeneration and waste heat recovery, thermal insulation, heat exchangers and heat pumps.	**CO4**	**06**

Text Books

1. De, B. K., "Energy Management audit & Conservation", (2nd Edition), Vrinda Publication, 2010. (Unit 1 to 4)
2. Murphy, W. R., "Energy Management (1st edition)", Elsevier India Private Limited, 2007.

Reference Books

1. Elias P. Gyftopoulos, "Industrial Energy Conservation Manuals", (1st edition) MIT Press, 1982
2. K. Smith, C.B. (Ed. 4), "Energy Management Principles: applications, benefits, savings", Amsterdam: Pergamon Press,1981.

Useful Links

1. https://nptel.ac.in/courses/112105221 "Energy Conservation and Waste Heat Recovery", IIT Kharagpur, Prof. Prasanta Kumar Das, Prof. A Bhattacharya
2. https://beeindia.gov.in/content/energy-auditors

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Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO2
CO 1	3	1	-	1	-	2	1	-	-	1	2	2	1
CO 2	2	3	1	3	2	1	-	1	1	-	2	3	2
CO 3	2	2	2	2	1	3	1	1	2	3	2	2	1
CO 4	3	3	3	3	2	3	1	1	1	3	3	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern(with revised Bloom's Taxonomy)

Knowledge Level	MSE	ISE	ESE
Remember	-	-	-
Understand	5	5	20
Apply	10	10	20
Analyse	5	5	20
Evaluate	-	-	-
Create	-	-	-
TOTAL	20	20	60

DEPARTMENT OF ELECTRICAL ENGINEERING Board Of Studies Year GCE KARAD

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Electrical Engineering Department

Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3807: Switchgear and Protection Lab				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	25
Prerequisite : Elements of Power System, Microprocessor basics, MATLAB				
Course Outcomes (CO): Students will be able to				
CO1	Demonstrate tests on various Equipment's e. g. fuse, MCB, relays etc. and analyse the test results.			
CO2	Implement Overvoltage, Undervoltage, Overcurrent, earth fault and phase protections using Numerical Relays.			
CO3	Interpret various protective schemes used for transformers, generators, transmission lines and feeders.			
CO4	Perform simulation and modelling of protection system using ETAP/PSCAD/ATP.			

Course Contents		CO
Implementation of following concepts		
Experiment 1	Demonstration of different switches, MCB, ELCB, MCCB.	**CO1**
Experiment 2	To study various fuses and plot inverse time characteristics of the fuse.	**CO1**
Experiment 3	Substation single line diagram drawing using ETAP, Power world Simulator.	**CO4**
Experiment 4	Protective zone coordination using ETAP, Power world Simulator.	**CO4**
Experiment 5	Operating Characteristics of Microprocessor Based (Numerical) Over/Under Voltage Relay	**CO2**
Experiment 6	Operating Characteristics of Microprocessor Based (Numerical) Over –Current Relay	**CO2**
Experiment 7	Operating Characteristics of Microprocessor Based (Numerical) differential Relay	**CO2**
Experiment 8	IDMT Characteristics of Over Voltage or Under Voltage Relay (Solid State or Electromechanical type).	**CO2**
Experiment 9	Operation of Buchholz Relay	**CO3**
Experiment 10	Operation and working of feeder protection.	**CO3**
Experiment 11	Operation and working of Differential protection of Alternator	**CO3**
Experiment 12	Operation and working of Differential protection of Transformer	**CO4**
	Minimum 10 number of Experiments (Should cover all CO's)	

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Mapping of Cos and Pos

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	3	3	2	1	2	1	1	-	1	3	1
CO 2	3	3	3	3	1	1	1	1	1	-	2	3	1
CO 3	3	3	3	3	1	1	1	-	1	-	1	3	2
CO 4	3	3	3	3	-	-	-	-	1	-	2	3	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25

Task I	Proactive Attentiveness
Task II	Core Competency
Task III	Submission/ Neatness/ Writing skills

(Tasks can be decided by course coordinator)

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3808: Power System Lab				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	--

Prerequisite : Elements of Power System, Power System Analysis

Course Outcomes (CO): Students will be able to

CO1	Identify fundamental power system components, transmission models, and fault types through simulation tools.
CO2	Demonstrate load flow, fault analysis, harmonic behaviour, and stability concepts using MATLAB/ETAP.
CO3	Apply simulation techniques to analyse power quality, converter performance, travelling waves, and system protection.
CO4	Evaluate system performance and stability under varying operational conditions using advanced analysis and optimization methods.

Course Contents		CO
Implementation of following concepts		
Experiment 1	Short-circuit analysis (3-phase and LG faults) of a transmission system using MATLAB.	**CO1**
Experiment 2	Transmission line modelling and Ferranti effect analysis using long line model in MATLAB/Simulink	**CO1**
Experiment 3	Load flow analysis of a multi-bus power system using Newton–Raphson method in MATLAB/Simulink.	**CO2**
Experiment 4	Harmonic analysis and THD evaluation of a 6-pulse HVDC converter with and without AC filters in MATLAB.	**CO2**
Experiment 5	Travelling wave analysis on transmission lines and reflection/refraction study at different terminations using MATLAB.	**CO3**
Experiment 6	Modelling and harmonic analysis of 6-pulse HVDC converter with AC filter design using MATLAB/Simulink	**CO3**
Experiment 7	Model of a transmission line with lumped parameters using ETAP.	**CO1**
Experiment 8	Development of a radial distribution system single-line diagram and load flow analysis using ETAP.	**CO2**
Experiment 9	Symmetrical fault analysis of an EHV system using ETAP.	**CO2**
Experiment 10	Unsymmetrical fault analysis of an EHV system using ETAP.	**CO2**
Experiment 11	Perform the load flow analysis on ETAP.	**CO2**
Experiment 12	Study of zones protection characteristics of Transformer and Motor zone of a given network using ETAP.	**CO4**
Experiment 13	Economic dispatch using lambda iteration method	**CO4**
Experiment 14	Load – frequency dynamics of single- area and two area power systems	**CO4**
	Minimum number of Experiments: 12 (Should cover all CO's)	

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Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	2	1	1	-	-	-	-	1	3	1
CO 2	3	3	2	3	3	1	-	1	1	-	2	3	2
CO 3	2	3	3	3	3	2	1	2	1	1	2	3	3
CO 4	3	3	2	3	3	3	1	1	1	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Exp 11	Exp 12	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25	25	25

Task I	Proactive Attentiveness
Task II	Core Competency
Task III	Submission/ Neatness/ Writing skills

(Tasks can be decided by course coordinator)

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3819: Robotics in Automation Lab (Program Elective- IV Lab)				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	--

Prerequisite: Basic knowledge of MATLAB/Simulink, control systems, electrical machines, and sensors used in automation.

Course Outcomes (CO): Students will be able to

CO1	Model robotic actuators such as DC, stepper, and servo motors using MATLAB/Simulink.
CO2	Analyze open-loop and closed-loop control techniques, including PID control, for robotic and automation systems.
CO3	Simulate basic robotic systems, including single-link and two-link manipulators, using kinematic concepts.
CO4	Design industrial automation applications using PLC logic, sensors concepts through simulation.

	Course Contents	**CO**
Implementation of following concepts		
Experiment 1	Modelling and simulation of DC motor for robotic actuator applications.	**CO1**
Experiment 2	Simulation of Stepper motor drive for precise position control.	**CO1**
Experiment 3	Modelling and control of Servo motor for robotic joint movement.	**CO1**
Experiment 4	Simulation of open-loop and closed-loop control systems for robotic motion.	**CO2**
Experiment 5	Design and simulation of PID controller for speed control of robotic actuator.	**CO2**
Experiment 6	Modelling of single-link robotic arm and position analysis.	**CO3**
Experiment 7	Simulation of two-link robotic arm and joint angle response.	**CO3**
Experiment 8	Forward kinematics simulation of a robotic manipulator using MATLAB.	**CO3**
Experiment 9	Simulation of sensor models used in robotics.	**CO4**
Experiment 10	Simulation of PLC-based motor control logic using State flow.	**CO4**
Experiment 11	Case study simulation of automated industrial robotic process.	**CO4**
	Minimum number of Experiments: 10 (Should cover all CO's)	

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	1	3	-	-	-	-	-	1	3	1
CO 2	3	3	2	2	3	1	-	1	1	-	2	3	2
CO 3	2	3	3	3	3	1	-	1	1	1	2	3	3
CO 4	3	3	3	3	3	2	1	2	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25

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Task I	Proactive Attentiveness
Task II	Core Competency
Task III	Submission/ Neatness/ Writing skills

(Tasks can be decided by course coordinator)

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Government College of Engineering, Karad				
Final Year (Sem – VII-Mode-1-Academic) B. Tech. Electrical Engineering				
EE3859: PLC and SCADA Automation Lab (Industrial Elective- IV Lab)				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	--

Prerequisite: Basic knowledge of MATLAB/Simulink, control systems, electrical machines, and sensors used in automation.

Course Outcomes (CO): Students will be able to

CO1	Develop a deeper understanding of concepts in industrial automation.
CO2	Select components/equipment for industrial automation.
CO3	Interface the PLC with hardware devices to develop the ladder program for industrial applications.
CO4	Design and apply the SCADA and DCS systems for industrial applications.

Course Contents		CO
Implementation of following concepts		
Experiment 1	Understand the PLC and various components. Interfacing of discrete input and output devices with PLC for ON and OFF operation. Verify all logic gates.	**CO1**
Experiment 2	Set/Reset (Latch/Unlatch) operation: many push buttons for ON (set/latch) and one push button for OFF (reset/unlatch) operation.	**CO1**
Experiment 3	Application using a combination of counter and timer for lamp ON/OFF operation.	**CO1**
Experiment 4	DOL starter and star delta starter operation by using PLC.	**CO2**
Experiment 5	PLC-based thermal (temperature) ON/OFF control using an analog input device.	**CO2**
Experiment 6	Tank level control by using PLC.	**CO3**
Experiment 7	PLC-based speed, position, flow, level, and pressure measurement system. (Any one or two applications)	**CO3**
Experiment 8	To study the operation of single-acting cylinders, double-acting cylinders with 3-2 valve & 5-2 valve	**CO3**
Experiment 9	PLC interfaced with SCADA and status read/command transfer operation.	**CO4**
Experiment 10	Parameter reading of PLC in SCADA, for thermal (temperature) control performed in PLC.	**CO4**
Experiment 11	To understand hardware and software platforms for DCS	**CO4**
Experiment 12	Alarm Management System using DCS.	
	Minimum number of Experiments: 10 (Should cover all CO's)	

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	1	1	3	-	-	-	-	-	1	3	1
CO 2	3	3	2	2	3	1	-	1	1	-	2	3	2
CO 3	2	3	3	3	3	1	-	1	1	1	2	3	3
CO 4	3	3	3	3	3	2	1	2	2	2	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

DEPARTMENT OF ELECTRICAL ENGINEERING Board Of Studies Year GCE KARAD

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Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Exp 9	Exp 10	Avg
Task I	15	15	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25	25	25

Task I	Proactive Attentiveness
Task II	Core Competency
Task III	Submission/ Neatness/ Writing skills

(Tasks can be decided by course coordinator)

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3829: Power Quality Lab (Program Elective- IV Lab)				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	--

Prerequisite: Basic knowledge of MATLAB/Simulink, power quality

Course Outcomes (CO): Students will be able to

CO1	Interpret the impact of non-linear loads on power quality, including harmonics, neutral current and voltage variations.
CO2	Apply simulation tools to analyze voltage sag, swell, interruptions and harmonic distortion using FFT.
CO3	Analyze the performance of filters, DSTATCOM and DVR for power quality improvement.
CO4	Evaluate the effectiveness of UPQC and other mitigation techniques under different load conditions.

Course Contents		CO
Implementation of following concepts		
Experiment 1	Effect of non-linear loads on power quality.	**CO1**
Experiment 2	Simulation and Analysis of Voltage Sag, Swell, and Interruption	**CO2**
Experiment 3	Demonstrate voltage and current distortion / harmonics. (experimental / simulation based)	**CO2**
Experiment 4	Simulation of impulsive and oscillatory transients and classification based on IEEE power quality standards.	**CO2**
Experiment 5	Harmonic Analysis of Non-Linear Loads Using FFT	**CO2**
Experiment 6	Effect of load on neutral current. (experimental / simulation based)	**CO2**
Experiment 7	DSTATCOM for mitigation of harmonics.	**CO3**
Experiment 8	DVR for mitigation of voltage quality.	**CO3**
Experiment 9	UPQC for mitigation of harmonics.	**CO4**
Experiment 10	Mitigation of harmonics using filters. (active, passive, hybrid)	**CO4**
	Minimum number of Experiments: 08 (Should cover all CO's)	

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	–	–	1	–	-	1	1	–	2	2	1
CO 2	2	3	–	2	3	–	1	2	2	–	2	3	2
CO 3	2	3	2	3	3	1	1	1	1	–	2	3	3
CO 4	2	3	3	3	3	2	2	2	2	–	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Avg
Task I	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25

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Task I	Proactive Attentiveness
Task II	Core Competency
Task III	Submission/ Neatness/ Writing skills

(Tasks can be decided by course coordinator)

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3839: FACTS Lab (Program Elective- IV Lab)				
Laboratory Scheme:			**Examination Scheme:**	
Practical	02 Hrs/week		ISE	25
Total Credits	01		ESE	--
Prerequisite: Basic knowledge of MATLAB/Simulink, FACTS, Power Electronics				
Course Outcomes (CO): Students will be able to				
CO1	Simulate shunt FACTS controllers for reactive power compensation and voltage control.			
CO2	Analyze the performance of advanced shunt controllers such as STATCOM for fast dynamic VAR support under varying load conditions.			
CO3	Analyze the impact of series FACTS controllers on power flow control and damping of power oscillations.			
CO4	Evaluate the effectiveness of combined FACTS controllers for simultaneous control of voltage, impedance and power flow.			

Course Contents		CO
Implementation of following concepts using MATLAB Simulink.		
Experiment 1	Model a TCR and analyze reactive power control by varying firing angle under different load conditions.	**CO1**
Experiment 2	Simulation of TSC operation to study stepwise reactive power compensation and voltage regulation.	**CO1**
Experiment 3	Simulation of FC–TCR configuration and evaluation of dynamic reactive power control and voltage profile improvement.	**CO1**
Experiment 4	Model combined TSC–TCR system and study smooth reactive power control characteristics.	**CO1**
Experiment 5	Simulation of SVC operation using TCR/TSC and evaluation of system voltage regulation.	**CO2**
Experiment 6	Model STATCOM using VSI and study fast dynamic reactive power support and voltage control.	**CO2**
Experiment 7	Simulation of GCSC to analyze controllable series compensation and power flow control.	**CO3**
Experiment 8	Modeling of TCSC and evaluation of continuous power flow control and damping of power oscillations.	**CO3**
Experiment 9	Model SSSC using VSI and analyze series reactive power injection and power flow control.	**CO4**
Experiment 10	Simulation of UPFC to control voltage, impedance, and phase angle for comprehensive VAR and power flow control.	**CO4**
	Minimum number of Experiments: 08 (Should cover all CO's)	

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	2	2	2	3	–	-	-	-	–	2	3	1
CO 2	2	3	–	3	3	1	-	1	1	–	2	3	2
CO 3	2	3	–	3	3	1	1	1	1	–	2	3	3
CO 4	2	3	3	3	3	2	2	2	2	–	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Avg
Task I	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25

Task I	Proactive Attentiveness
Task II	Core Competency
Task III	Submission/ Neatness/ Writing skills

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Government College of Engineering, Karad					
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering					
EE3849: Design of Energy efficient machines Lab (Program Elective- IV Lab)					
Laboratory Scheme:			**Examination Scheme:**		
Practical	02 Hrs/week		ISE	25	
Total Credits	01		ESE	--	

Prerequisite: Basic knowledge of MATLAB/Simulink, electrical machines

Course Outcomes (CO): Students will be able to

CO1	Determine efficiency, losses, and life-cycle cost of electrical machines using energy efficiency principles.
CO2	Examine the influence of magnetic, conducting, and insulation materials along with thermal design on machine performance.
CO3	Compare and justify design features of energy-efficient induction and special electrical machines.
CO4	Assess motor-drive systems for energy savings and conformity with IS/IEC efficiency standards in industrial applications.

Course Contents		CO
Implementation of following concepts		
Experiment 1	Evaluation of Loss Components and Efficiency of Electrical Machines Using MATLAB	**CO1**
Experiment 2	Comparative Study of Conventional and Energy-Efficient Induction Motors Based on IE Efficiency Classes	**CO1**
Experiment 3	Finite Element Analysis of Magnetic Materials for Loss Reduction in Electrical Machines Using ANSYS (4hrs)	**CO2**
Experiment 4	Thermal Analysis and Cooling Design of Energy-Efficient Electrical Machines Using ANSYS (4hrs)	**CO2**
Experiment 5	Design Optimization of Induction Motor Parameters for Improved Energy Efficiency Using MATLAB	**CO3**
Experiment 6	Performance Analysis of Permanent Magnet Synchronous Motor (PMSM) for Energy-Efficient Applications	**CO2**
Experiment 7	Simulation-Based Comparative Study of BLDC Motor and Switched Reluctance Motor for Energy Efficiency (4 hrs)	**CO3**
Experiment 8	Energy Saving Analysis of Induction Motor Drives Using Variable Frequency Drive (VFD) in MATLAB/Simulink.	**CO4**

Mapping of COs and POs

PO → CO ↓	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO 1	3	3	–	2	2	2	-	-	-	–	2	3	1
CO 2	3	2	2	2	2	1	-	1	1	–	2	3	2
CO 3	2	3	3	2	2	1	1	1	1	1	2	3	2
CO 4	2	3	3	2	2	3	1	1	1	3	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Assessment Pattern:

Skill Level (as per CAS Sheet)	Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Exp 6	Exp 7	Exp 8	Avg
Task I	15	15	15	15	15	15	15	15	15
Task II	05	05	05	05	05	05	05	05	05
Task III	05	05	05	05	05	05	05	05	05
ISE	25	25	25	25	25	25	25	25	25

Task I	Proactive Attentiveness
Task II	Core Competency
Task III	Submission/ Neatness/ Writing skills

(Tasks can be decided by course coordinator)

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-2-Academic) B. Tech. Electrical Engineering				
EE3810: Major Project				
Laboratory Scheme:			**Examination Scheme:**	
Practical	08 Hrs/week		ISE	25
Total Credits	04		ESE	75

Course Outcomes (CO): Students will be able to

CO1	Analyze societal, industrial, and environmental needs to identify and define a relevant engineering problem using modern approaches.
CO2	Design and propose optimized solutions for complex engineering problems through systematic modelling, component selection, and methodological planning.
CO3	Evaluate the developed system with respect to financial feasibility, power consumption, technical performance, sustainability, flexibility, and market relevance.
CO4	Develop a functional prototype and communicate technical outcomes through standard documentation, presentations, and research publications using modern engineering tools.

Course Contents

Guidelines for Project Work:

1. Conceptualization of project theme (during winter vacation)
2. Learning state-of-the-art related to project idea through literature review /survey/visits/interactions (2 weeks)
3. Designing of project theme and selection of components (2weeks)
4. Procurement of components (1week)
5. Assembly and Fabrication of project work (3 weeks)
6. Testing and modifications (2 weeks)
7. Report writing and conference ready paper/ participation in project exhibition based on project work (2 weeks)
8. Presenting project in front of departmental committee.
9. Submission of hard bound project report copy.
10. Project Diary (Mandatory): Hardcopy diary maintained groupwise with weekly activity record signed by the Guide. Need to be presented during the End Semester Examination (ESE).

Rubrics / Assessment Pattern (CO-wise)

Internal Semester Evaluation (ISE – 25 Marks)

Sr. No.	Evaluation Component	Marks	CO
1	Analyse of societal, industrial, and environmental needs; problem identification and justification	05	CO1
2	Summarize literature review (last 5 years) and gap analysis	05	CO1
3	Evaluate the developed system with respect to block diagram, architecture, flowcharts, algorithms, and requirement specification, Component selection, cost estimation, feasibility analysis, and methodological planning	10	CO2
4	Exhibit professionalism, ethical conduct, and teamwork throughout the project duration and maintain project diary and weekly documentation. (interim review).	05	CO2
	Total	25	

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End Semester Examination (ESE – 75 Marks)

Sr. No.	Evaluation Component	Marks	CO
1	Integrate hardware and software components to develop a fully functional system.	20	CO4
2	Implement the project solution with a focus on quality, reliability, and adherence to design specifications.	15	CO3
3	Evaluate the performance of the developed system in terms of power consumption, cost-effectiveness, and operational efficiency.	15	CO3
4	Compile a complete project report that includes all relevant technical details, analyses, and supporting evidence.	10	CO4
5	Present the project and its contributions through participation in technical conferences, seminars, or project exhibitions.	05	CO4
6	Exhibit comprehensive technical knowledge and problem-solving abilities during project demonstration and viva-voce assessment.	05	CO2
7	Maintain a project diary that accurately records project activities, progress, challenges, and achievements.	05	CO4
	Total	75	

Mapping of COs and POs

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CO 2	2	2	3	2	2	1	1	1	1	1	1	3	3
CO 3	2	2	1	1	1	1	2	1	1	2	3	3	2
CO 4	2	2	2	2	2	1	1	1	3	3	2	3	3

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-1-Internship) B. Tech. Electrical Engineering				
EE3811: MOOC-I				
Teaching Scheme			**Examination Scheme**	
Lectures	-		MSE	-
Tutorials	-		ISE	-
Total Credits	3		ESE	100
			Duration of ESE	

Guidelines

- Students must enroll **only in approved MOOC** available on **SWAYAM/NPTEL** platforms.
- The department will provide a **list of eligible and recommended courses** for **7th semester.**
- **Prior approval from the BoS Chairman/ HOD** is mandatory before course enrollment.
- The **final list of enrolled MOOC** will be approved and recorded by the department **before course commencement**.
- Each MOOC must have a **duration of 8–12 weeks**.
- Students may select any **one specialization area** from the following:
  - Power System
  - Electrical Machines and Drives
  - Robotics and Control Systems
  - Power Electronics and Renewable Energy Systems
  - Artificial Intelligence and Machine Learning
  - Any other Emerging Technology

- **Students must:**

Attend/view all lecture videos regularly.
Complete and submit all assignments and quizzes on time
Appear for and pass the **final proctored examination** conducted by the MOOC platform.

- **Upon completion**

Submit the **MOOC completion certificate** to the Departmental MOOC Coordinator.
The Co-ordinator will **verify authenticity** and maintain semester-wise records.
Verified certificates will be **forwarded to the Controller of Examinations (COE), GCE Karad.**

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-1-Internship) B. Tech. Electrical Engineering				
EE3812: MOOC-II				
Teaching Scheme			**Examination Scheme**	
Lectures	-		MSE	-
Tutorials	-		ISE	-
Total Credits	3		ESE	100
			Duration of ESE	

Guidelines

- Students must enroll only in approved MOOC available on SWAYAM/NPTEL platforms.
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- The final list of enrolled MOOC will be approved and recorded by the department before course commencement.
- Each MOOC must have a duration of 8–12 weeks.
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    - Power System
    - Electrical Machines and Drives
    - Robotics and Control Systems
    - Power Electronics and Renewable Energy Systems
    - Artificial Intelligence and Machine Learning
    - Any other Emerging Technology
- **Students must:**
    - Attend/view all lecture videos regularly.
    - Complete and submit all assignments and quizzes on time
    - Appear for and pass the final proctored examination conducted by the MOOC platform.
- **Upon completion**
    - Submit the MOOC completion certificate to the Departmental MOOC Coordinator.
    - The Coordinator will verify authenticity and maintain semester-wise records.
    - Verified certificates will be **forwarded to the Controller of Examinations (COE), GCE Karad.**

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Government College of Engineering, Karad				
Final Year (Sem – VIII-Mode-1-Internship) B. Tech. Electrical Engineering				
EE3813: Internship				
Teaching Scheme			**Examination Scheme**	
Lectures	-		MSE	-
Tutorials	-		ISE	250
Total Credits	12		ESE	250
			Duration of ESE	

Course Outcomes (CO): Students will be able to

CO1	Apply theoretical and technical knowledge to solve practical problems encountered in industry or research environments.
CO2	Analyze professional challenges and implement appropriate engineering solutions.
CO3	Develop effective teamwork, communication, and project management skills through hands-on experience.
CO4	Demonstrate professional ethics, discipline, and adaptability in real-world engineering contexts.

Guidelines for Semester VII (Mode–2 Internship)

The internship under **Mode–2** is applicable to students opting for a six-month internship during **Semester VII** of the B. Tech program. This provision facilitates early industry or research engagement immediately after the completion of the VI semester. Students must choose either Mode–1 or Mode–2 at the beginning of the semester.

The internship shall be of one full semester duration. Students can undertake their internship at:

- Recognized industries or Organizations relevant to their specialization.
- Research institutions or government organizations such as DRDO, ISRO, BARC, CDAC, or reputed universities.
- Start-ups and innovation centers working in areas like power system, control system, electrical machines, power electronics and drives.
- Authorized training centers or industrial partners having a Memorandum of Understanding (MoU) with the institute.

All internships shall be undertaken with prior approval as per the Institution's Internship Policy. The internship is mandatory and shall be treated as a head of passing for the award of the B.Tech degree. It aims to provide experiential learning, professional exposure, and practical application of theoretical knowledge to real-world scenarios.

A guide from college is allotted to monitor progress and guide must do 3 visits to company/ industry within 200km radius of college campus.

Mode of Internship

a) Research Internship

- Location: Reputed research Organizations, R&D laboratories, Centers of Excellence, or Incubation Centers.
- Objective: To gain exposure to research methodologies, advanced tools, and analytical techniques.
- Expected Outcome: Development of analytical reasoning, experimental proficiency, and technical writing skills for higher research or academic progression.

b) Industry Internship

- Location: Recognized industries, MSMEs, start-ups, or technology-driven companies.
- Objective: To gain hands-on experience in industrial environments and apply engineering knowledge to solve professional challenges.
- Expected Outcome: Strengthened professional competencies, teamwork, adaptability, and real-world problem-solving abilities.

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CO 2	-	3	2	2	-	-	-	-	-	-	-	-	2	3
CO 3	-	-	2	-	-	-	-	2	3	3	2	-	2	2
CO 4	-	1	-	-	-	2	3	3	-	2	2	2	-	-

1: Slight(Low) 2: Moderate(Medium) 3: Substantial(High)

Assessment Pattern (with revised Bloom's Taxonomy)

Knowledge Level	ISE	ESE
Remember	25	25
Understand	50	75
Apply	75	75
Analyse	75	75
Evaluate	25	-
Create	-	-
TOTAL	250	250

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