Revised Syllabus (Effective from the Session 2026-27)

Gurukula Kangri (Deemed to be University), Haridwar
Faculty of Engineering & Technology

B. Tech. Electrical Engineering

Fourth Year **Semester-VII**

S. No	COURSE CODE	COURSE TITALE	PERIODS			EVALUATION SCHEME					SUBJECT TOTAL
						SESSIONAL EVALUATION				ESE	
THEORY											
			L	**T**	**P**	**CREDIT**	**CT**	**TA**	**TOTAL**		
1	BEE-C 711	Switchgear and Protection	3	0	0	3	20	10	30	70	100
2	BEE-P XXX	Program Elective-III	3	0	0	3	20	10	30	70	100
3	BEE-P XXX	Program Elective-IV	3	0	0	3	20	10	30	70	100
4	BEE-O XXX	Open Elective-III	3	0	0	3	20	10	30	70	100
5	BEE-P 762	Project Stage-I	0	0	6	3	20	10	30	70	100
PRACTICAL											
7	BEE-C 761	Switchgear and Protection Laboratory	0	0	2	1	10	05	15	35	50
8	BEE-S 752	Summer Training and Internship Program-II Mini Project (3-4 Weeks)				1	To be pursued during summer vacation, submit a certificate of completion in the department (In the summer break after VI semester exam and will be assessed during VII semester)				50
TOTAL			**12**	**0**	**8**	**17**	**110**	**55**	**165**	**385**	**600**

Program Elective-III		**Program Elective-IV**
1	BEE-P 712 Power System Reconstructing and Deregulation	1. BEE-P 714 Advanced Electrical Drives
2	BEE-P 713 Electrical Standards and Engineering Practices	2. BEE-P 715 Switch Mode Power Supply
	Open Elective-III	
1	BEE-O 716 Introduction to Energy Management Systems.	3. BEE-O718 Introduction to Robotics Engineering
2	BEE-O 717 Fundamental of IOT	4. BEE-P 719 Utilization of Electrical Energy

L	**Lecture**	**T**	Tutorial	**C**	Discipline Specific Course

CT	Cumulative Test	**TA**	Teacher Assessment	**ESE**	End Semester Examination
BEE	Electrical Code	**O**	Open Elective	**P**	Program Elective

Course Code: BEE-C 711
Course Name: Switchgear and Protection

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Basic Electrical Engineering, Power System-I, Power System-II
Objectives:	1. Basic concept of Arcing phenomena, Circuit Breaker 2. Classification of Circuit Breaker and relays 3. Study of Protection equipment 4. Study of line Protection and protection against high voltages
Course Coordinator	Mr. Gajendra Singh Rawat

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

UNIT	Module	Course Content	No. of Hours	POs Mapped	PSOs Mapped
UNIT-1	Module-I Theory of Arc Quenching, Circuit Breakers	Arcing phenomena and arc quenching, circuit breaker rating, RRRV, current chopping and capacitance current breaking, characteristics of HRC fuses, d.c. circuit breaking. Bulk oil and oil minimum circuit breakers, air blast circuit breakers, vacuum and SF6 circuit breaker, Rating, speed of operation, selection and testing of circuit breakers.	09	PO1/ PO6/PO7/PO8/PO9/PO10/PO12	PSO1/ PSO3
UNIT-2	Module-II Relays and Relay Characteristics and Relaying Schemes	Basic ideas of short circuit currents and concepts of relay protection, basic terminology, essential qualities of a protective relay, classification of protective relays and protective schemes, operation relays, directional over current relays, distance relays, differential relays, negative sequence relays, earth fault protection, reverse power protection, electromagnetic and solid state relays.	08 –	PO1/ PO2/PO6/PO7/PO8/PO9/PO10/PO12	PSO1/ PSO3
UNIT-3	Module-III Distance Protections	Introduction, impedance relay, operating principle and characteristics of an impedance relay, protective scheme using impedance relay, Reactance relay: electromagnetic reactance relay, static reactance relays, Admittance	08	PO1/ PO2/PO3/PO4/PO5/PO6/PO7/PO8/PO9/PO10/PO12	PSO1/ PSO2/PSO3

		relay: Electromagnetic MHO relay, static MHO relays, sampling comparator, effect of arc resistance and power surges on distance relay. Principle of out of step tripping, effect of line length and source impedance on distance relays, selection of distance relay.			
UNIT-4	Module-IV Apparatus and Line Protection	Application of over current relays and distance relays to feeder protection, ring main protection, bus bar protection, carrier current protection of transmission Lines, protection of generators and transformers.	07	PO1/ PO2/PO3/P O4/PO5/P O6/PO7/P O8/PO9/P O10/PO12	PSO1/ PSO2/PS O3
UNIT-5	Module-V Protection Against Over Voltages	Over voltages due to Lightning and switching, arcing grounds, Peterson Coil, methods of protection against over voltages, ground wires, surge absorber and diverters, Power System earthing, Earth resistance, Neutral Earthing, basic ideas of insulation coordination.	08	PO1/ PO2/PO3/P O4/PO5/P O6/PO7/P O8/PO9/P O10/PO12	PSO1/ PSO2/PS O3
Total No. of Hours			**40**		

Course Outcomes:	1. To Explain the Arcing phenomena and arc quenching, circuit breaker rating, RRRV, current chopping and capacitance current breaking, characteristics of HRC fuses,d.c. circuit breaking, Basic ideas of short circuit currents and concepts of relay protection, basic terminology, essential qualities of a protective relay, over voltages due to Lightning and switching, arcing grounds, Peterson Coil. 2. To Extend the impedance relay, operating principle and characteristics of an impedance relay, protective scheme using impedance relay, Reactance relay: electromagnetic reactance relay, static reactance relays, Admittance relay: Electromagnetic MHO relay, static MHO relays, sampling comparator, effect of arc resistance and power surges on distance relay. Principle of out of step tripping, effect of line length and source impedance on distance relays, selection of distance relay. 3. To Illustrate the Bulk oil and oil minimum circuit breakers, air blast circuit breakers, vacuum and SF6 circuit breaker, Rating, classification of protective relays and protective schemes, operation relays, directional overcurrent relays, distance relays, differential relays, negative sequence relays, earth fault protection, reverse power protection, electromagnetic and solid state relays. 4. To Apply the speed of operation, ring main protection, busbar protection, carrier current protection of transmission lines, protection of generators and transformers. 5. To Analyze the selection and testing of circuit breakers, Application of over current relays and distance relays to feeder protection, methods of protection against over voltages, ground wires-surge absorber and diverters, Power System earthling, Earth resistance, Neutral Earthing, basic ideas of insulation coordination.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	Badri Ram Vishwakarma, & D.N., Power System Protection and Switchgear, Tata-McGraw Hill publishing company Ltd.	1995
2.	Uppal. S.L., Electrical power, Khanna publication, Delhi.	1976
3.	Ravindranath, B.,Chander, N., Power Systems Protection and Switchgear, New Age	2018

	International Publishers.	
4.	D N Vishwakarma, Badri Ram, Soumya R Mohanty, Power System Protection And Switchgear, MC Graw Hill	2022

Course Code: BEE-P 712
Course Name: Power System Restructuring and Deregulation

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Power Systems-I, Power Systems-II
Objectives:	1. To provide fundamental knowledge of power sector restructuring and the concept of deregulation in electricity markets. 2. To enable students to understand market models, pricing mechanisms, and system operation in deregulated environments. 3. To analyze the roles of various entities such as GENCOs, TRANSCOs, DISCOMs, system operators, and regulators in competitive electricity markets. 4. To develop the ability to apply optimization and decision-making techniques in power system operation and planning under deregulated conditions. 5. To familiarize students with Indian and global practices of power system restructuring and prepare them for careers in evolving energy markets.
Course Coordinator	Dr. Ashish Dhamanda

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

UNIT	Module	Course Content	No. of Hours	POs Mapped	PSOs Mapped
UNIT-1	Module-I Introduction	Basic concept and definitions, Privatization, Restructuring, Transmission open access, Wheeling, Deregulation, Components of deregulated system, advantages of competitive system.	04	PO1/ PO6/ PO7/ PO8/ PO10/PO12	PSO1
	Module-II Power System Restructuring	An overview of the restructured power system, Difference between integrated power system and restructured power system -explanation with suitable practical examples.	03	PO1/ PO6/ PO7/ PO8/ PO10/PO12	PSO1
UNIT-2	Module-III Deregulation of Power Sector	Benefits of deregulation, Overview of deregulated industry, Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, Multilateral trade model, Independent system operator (ISO) - functions and responsibilities, classification of ISO types, retail electric providers.	09	PO1/PO2/ PO4/ PO6/ PO7/ PO8/ PO10/PO12	PSO1/PSO3
UNIT-3	Module-IV Competitive electricity market	Independent System Operator (ISO) activities in pool market, Wholesale electricity market characteristics, Central auction, single auction power	08	PO1/PO2/ PO4/ PO6/ PO7/ PO8/	PSO1/PSO3

		pool, Double auction power pool, Market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services.		PO10/PO12	
UNIT-4	Module-V Open Access Same Time Information System (OASIS)	Introduction, structure, functionality, implementation, posting of information, uses.	08	PO1/ PO6/ PO7/ PO8/ PO10/PO12	PSO1
	Module-VI Congestion Management	Congestion management in normal operation, explanation with suitable example, total transfer capability (TTC), Available transfer capability (ATC), Transmission Reliability Margin (TRM), Capacity Benefit Margin (CBM), Existing Transmission Commitments (ETC).		PO1/PO2/ PO4/ PO6/ PO7/ PO8/ PO10/PO12	PSO1/PSO3
UNIT-5	Module-VII Different Experiences in deregulation	U.S.A, Canada, U.K, Japan, Switzerland, Australia, Sweden, Germany and Indian power system.	08	PO1/PO6	PSO1/PSO3
Total No. of Hours			40		

Course Outcomes:	1. To define the Basic concept and definitions, Privatization, Restructuring, Transmission open access, Wheeling, Deregulation, Components of deregulated system, advantages of competitive system. 2. To explain an overview of the restructured power system, Difference between integrated power system and restructured power system -explanation with suitable practical examples, Introduction, structure, functionality, implementation, posting of information, uses. 3. To extend the Benefits of deregulation, Overview of deregulated industry, Separation of ownership and operation. 4. To illustrate the Deregulated models, pool model, pool and bilateral trades model, Multilateral trade model, Independent system operator (ISO) - functions and responsibilities, classification of ISO types, retail electric providers. 5. To interpret the auction, single auction power pool, Double auction power pool, Market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading, Ancillary services.Congestion management in normal operation, explanation with suitable example, total transfer capability (TTC), Available transfer capability (ATC), Transmission Reliability Margin (TRM), Capacity Benefit Margin (CBM), Existing Transmission Commitments (ETC). 6. To summarize the U.S.A, Canada, U.K, Japan, Switzerland, Australia, Sweden, Germany and Indian power system.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	Loi Lei Lai, Power System Restructuring and Deregulation, John Wiley & Sons Ltd.	2001
2.	Lorrin Philipson and H. Lee Willis, Understanding Electric Utilities and Deregulation by Marcel Dekker Inc, New York, CRC Press.	1997

3.	Marijallic, Francisco Galiana and Lestor Fink, Power System Restructuring Engineering & Economics, Academic Publisher, USA.	1998
4.	M. Shahidehpour, H. Yamin and Z Li "Market Operations in Electrical Power System" New york, IEEE/ Wiley Inter science.	2002
5.	D. S. Kirschen and G. Strbac, Fundamentals of Power System Economics, John Wiley & Sons.	2004
6.	Geoffrey Rothwell, Tomas Gomez (Eds.), "Electricity Economics Regulation and Deregulation", IEEE Press Power Engineering Series, John Wiley & Sons.	2003

Course Code: BEE-P 713
Course Name: Electrical Standards and Engineering Practices

MM:100 **Time:4 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit: 0**

Prerequisites:	Basic Electrical Engineering, Electrical Machines, and Power System.
Objectives:	1. To familiarize students with the importance of standardization in electrical engineering and its role in ensuring quality, safety, and reliability. 2. To impart knowledge of national and international standards (BIS, IEC, IEEE, ISO, NEC, etc.) relevant to electrical systems and installations. 3. To train students in proper engineering practices for wiring, grounding, installation, and protection systems in compliance with standards. 4. To develop the ability to apply inspection, testing, and maintenance practices in industrial and commercial electrical systems. 5. To prepare students for modern industry requirements by introducing emerging practices in smart grids, renewable integration, and energy efficiency standards.
Course Coordinator	Mr. Lokesh Bhardwaj

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

UNIT	Module	Course Content	No. of Hours	Pos mapped	PSOs mapped
UNIT-1	Module-I Introduction to Electrical Standards	Need and role of standardization in engineering, Introduction to BIS, IEEE, IEC, ISO, NEMA, ANSI, and NEC standards, Standard symbols used in electrical diagrams (IS:2032, IS:8289), Standard rating and specification of electrical apparatus	08	PO1/PO2/PO6/PO10	PSO1
UNIT-2	Module-II Wiring Codes and Safety Standards	IS 732 (Code of Practice for Electrical Wiring Installations), Earthing standards: IS 3043 and IEEE Std. 80, Types of earthing: Plate, Pipe, Strip, Chemical, Electrical shock prevention and first aid, Electrical safety in hazardous environments	08	PO1/PO6/PO7/PO8	PSO2/PSO3
UNIT-3	Module-III Installation and Inspection Practices	Electrical installation design practices per IS & IEC, Load estimation and selection of conductors/cables, Inspection, Testing, and Commissioning practices, Insulation resistance, continuity, and earth tests, Periodic maintenance and safety audits	08	PO1/PO2/PO4/PO10	PSO2
UNIT-4	Module-IV Protection Systems and Quality Assurance	Standard practices in selection of fuses, MCBs, MCCBs, relays, Short circuit calculations and standard protection schemes, Importance of quality control in electrical projects, ISO 9001 for quality management, Documentation and report generation as per IEEE/ISO	08	PO2/PO6/PO8/PO11	PSO2
UNIT-5	Module-V Emerging Practices and	Smart grid standardization, Renewable energy standards, Energy efficiency standards, Case studies: Best practices	08	PO6/PO7/PO8/PO12	PSO1/PSO3

	Smart Standards	from industry audits and field inspections, Role of engineers in policy and code development			
Total No. of Hours			**40**		

Course Outcomes:	1. Understand the necessity and classification of electrical standards and codes. 2. Apply proper installation and safety practices as per BIS/IEEE norms. 3. Evaluate quality assurance techniques in electrical engineering projects. 4. Analyze emerging standards in renewable, smart grids, and energy efficiency. 5. Demonstrate competence in using standards to ensure safe and sustainable engineering designs.

Suggested Books:

S. No.	Name of Authors/Books/Publisher	Year of Publication
1.	Bureau of Indian Standards, IS 732, IS 3043, IS 1255	Latest
2.	IEEE Standards Collection – Power and Energy	IEEE
3.	Surjeet Singh, Electrical Estimating and Costing, Dhanpat Rai	2015
4.	Jain and Gupta, Testing, Commissioning, Operation and Maintenance, Katson	2012
5.	BEE Manual, Energy Efficiency Guidelines, Bureau of Energy Efficiency	Latest
6.	ISO and IEC Handbooks on Electrical Installations	Latest

Course Code: BEE-P 714
Course Name: Advanced Electrical Drives

MM:100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit:3**

Prerequisites:	Knowledge on the Power converters for AC motor drives and DSP based motion control.
Objectives:	1. To provide an in-depth understanding of advanced electrical drive systems, their components, and control techniques. 2. To enable students to analyze the dynamic behavior and performance characteristics of various electric drives. 3. To familiarize students with modern power electronic converters and their role in drive control. 4. To develop the ability to design, model, and simulate advanced drive systems for industrial applications. 5. To expose students to emerging technologies in electrical drives such as vector control, direct torque control, and sensorless drives. 6. To prepare students for solving complex engineering problems in the areas of automation, robotics, and renewable energy integration using advanced drive technologies.
Course Coordinator	Mr. Aviral Awasthi

Note:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) marks each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Unit	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Power converters for AC drives	PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, SVM for 3 level inverter, PWM converter as line side rectifier, current fed inverters with self –commutated devices, control of CSI.	08	PO1/PO2/PO6/PO10	PSO1
UNIT-2	Module-II Induction Motor Drives	Modelling of induction machines, voltage fed inverter control –v/f control, vector control, direct torque and flux control (DTC).	08	PO1/PO6/PO7/PO8	PSO2/PSO3
UNIT-3	Module-III Synchronous Motor Drives	Modelling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.	08	PO1/PO2/PO4/PO10	PSO2
UNIT-4	Module-IV Permanent Magnet Motor	Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and	08	PO2/PO6/PO8/PO11	PSO2

	Drives	torque control in BLDC and PMSM.			
UNIT-5	Module-V Switched Reluctance Motor Drives	Evolution of switched reluctance motor, various topologies for SRM drives, closed loop speed and torque control of SRM. DSP based motion controls: Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.	08	PO6/PO7/PO8/PO12	PSO1/PSO3
Total No. of Hours			40		

Course Outcomes:	1. Explain the principles, characteristics, and control strategies of modern electrical drives. 2. Analyze the dynamic performance of DC and AC drives under various operating conditions. 3. Apply advanced power electronic converters and control techniques for precise motor control. 4. Evaluate the suitability of different drive systems for industrial, traction, and renewable energy applications. 5. Design and simulate advanced electrical drive systems using modern tools and assess their efficiency and reliability.

Suggested Books:

S. No.	Name of Authors /Books / Publisher	Year of Publication
1.	B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia.	2003
2.	P. C. Krause, O. Wasynczuk and S. D. Sudhoff "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons.	2013
3.	H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press.	2003
4.	R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press.	2009
5.	G.K.Dubey, Fundamentals of Electrical Drives, Narosa	2002

Course Code: BEE-P 715
Course Name: Switch Mode Power Supply

MM:100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit:3**

Prerequisites:	Power Electronics, Analog Electronics, and Basics of Electrical Circuits.
Objectives:	1. To introduce the fundamental concepts of Switch Mode Power Supplies (SMPS). 2. To study the operation and design of various DC-DC, AC-DC, and isolated converters. 3. To analyze control techniques, performance, and efficiency of SMPS circuits. 4. To expose students to EMI/EMC issues, thermal management, and protection techniques. 5. To prepare students for practical applications of SMPS in industrial, consumer, and renewable energy systems.
Course Coordinator	Mr. Aviral Awasthi

Note:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) marks each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Unit	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Introduction to SMPS	Concept of switched-mode power conversion vs linear power supply, Advantages and disadvantages of SMPS, Applications of SMPS in consumer, industrial, and renewable energy systems, Functional blocks of SMPS: rectifier, filter, switch, controller, and output stage, Performance parameters: efficiency, regulation, ripple, and noise	08	PO1/PO 6	PSO1
UNIT-2	Module-II DC–DC Converters	Step-down (buck), step-up (boost) , Cuk, SEPIC, and Zeta converters, Continuous conduction and discontinuous conduction modes, Inductor and capacitor design considerations, Efficiency analysis and practical limitations	08	PO1/PO 2/PO4	PSO2
UNIT-3	Module-III Isolated SMPS Converters	Flyback converter: operation and design, Forward converter: principle and applications, Push-pull, half-bridge, and full-bridge converters, Transformer design for isolated SMPS, Design examples and case studies	08	PO2/PO 4/PO10	PSO1/PS O3
UNIT-4	Module-IV Control and Protection in SMPS	Pulse Width Modulation (PWM) control techniques: voltage mode and current mode, Feedback regulation and loop compensation, Soft-start, over-voltage, over-current, and thermal protection	08	PO2/PO 4/PO6/P O10	PSO2/PS O3

		methods, EMI/EMC issues and suppression techniques.			
UNIT-5	Module-V Applications and Trends in SMPS	Computer power supplies and consumer electronics applications, SMPS for renewable energy systems: solar PV and wind energy integration, Electric vehicle chargers and battery management systems, Resonant converters and digital control of SMPS, Future trends: high-frequency magnetics, GaN/SiC devices in SMPS	08	PO6/PO7/PO8/PO12	PSO1/PSO3
Total No. of Hours			40		

Course Outcomes:	1. Explain the principles, operation, and advantages of switch mode power supplies. 2. Design and analyze non-isolated DC–DC converter topologies (buck, boost, buck-boost, etc.). 3. Evaluate the operation and design of isolated SMPS converters including flyback and forward types. 4. Apply control strategies and protection techniques to ensure safe and efficient SMPS operation. 5. Analyze real-world applications of SMPS in industries, renewable systems, and emerging technologies.

Suggested Books:

S. No.	Name of Authors /Books / Publisher	Year of Publication
1.	Abraham I. Pressman, Switching Power Supply Design, McGraw-Hill	2009
2.	Ned Mohan, Power Electronics: Converters, Applications, and Design, Wiley	2011
3.	Daniel W. Hart, Power Electronics, McGraw-Hill	2010
4.	Muhammad H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson	2017
5.	Simon Ang & Alejandro Oliva, Power-Switching Converters, CRC Press	2005
6.	Erickson & Maksimovic, Fundamentals of Power Electronics, Springer	2001

Course Code: BEE-O 716
Course Name: Introduction to Energy Management Systems

MM:100 **Time:4 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit: 0**

Prerequisites:	Power Systems, Electrical Machines, Basics of Energy Auditing.
Objectives:	1. To introduce students to the principles, scope, and importance of energy management in engineering and industry. 2. To develop analytical skills for monitoring, targeting, and optimizing energy consumption. 3. To impart knowledge of energy-efficient technologies and demand-side management strategies. 4. To familiarize students with energy audit procedures, regulatory frameworks, and international standards. 5. To prepare students to design, evaluate, and implement sustainable and cost-effective energy management systems.
Course Coordinator	Mr. Lokesh Bhardwaj

Note:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) marks each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

UNIT	Module	Course Content	No. of Hours	Pos mapped	PSOs mapped
UNIT-1	Module-I Fundamentals of Energy Management	Basics of energy and energy resources, Concept and scope of Energy Management, Energy Management Strategies: Supply Side vs Demand Side, Energy performance indicators and benchmarking, Duties and roles of an energy manager	08	PO1/PO6/PO 8/PO11	PSO2
UNIT-2	Module-II Energy Monitoring and Targeting	Importance of monitoring and targeting (M&T), Data collection, measurement, and instrumentation, Key Performance Indicators (KPIs) and reporting, Setting targets, deviations and corrective actions, Load curve analysis and demand forecasting	08	PO2/PO4/PO 10	PSO1/PSO2
UNIT-3	Module-III Electrical Energy Management	System approach and end use analysis, Energy-efficient technologies in lighting, HVAC, and motors, Power factor improvement and load management, Demand-side management (DSM) strategies, Case studies in electrical energy savings	08	PO1/PO2/PO 6/PO8	PSO1/PSO3
UNIT-4	Module-IV Energy Audit and Standards	Energy Audit: objectives, types, methodology, Tools and instruments for audit, Compliance with Energy Conservation Act, BEE regulations,	08	PO4/PO6/PO 7/PO11	PSO2

		ISO 50001 – Energy Management System standards, Economic analysis: Payback period, IRR, NPV			
UNIT-5	Module-V Automation and Smart Energy Systems	Introduction to EMS hardware and software, Role of SCADA, IoT, and AI in EMS, Smart metering infrastructure, Home and building energy management systems (HEMS/BEMS), Renewable integration and energy storage management	08	PO2/PO6/PO 8/PO12	PSO1/PSO3
Total No. of Hours			40		

Course Outcomes:	1. Understand the fundamentals and scope of energy management systems. 2. Analyze energy consumption data for performance monitoring and targeting. 3. Apply techniques for efficient utilization of electrical energy in systems. 4. Conduct energy audits and ensure compliance with relevant energy standards. 5. Demonstrate knowledge of automation technologies in smart energy management.

Suggested Books:

S. No.	Name of Authors/Books/Publisher	Year of Publication
1.	Guidebook on Energy Management Systems, BEE, Govt. of India	Latest
2.	C.B. Smith, Energy Management Principles, Pergamon Press	2015
3.	Wayne C. Turner, Energy Management Handbook, Fairmont Press	2016
4.	Dr. Sonal Desai, Handbook of Energy Audit, McGraw-Hill	2021
5.	ISO 50001 Manual, Bureau of Energy Efficiency	Latest
6.	IEEE/IEC/IS Codes related to Energy Efficiency	Latest

Course Code: BEE-P 717
Course Name: Fundamentals of Internet of Things (IoT)

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Basic knowledge of Computer Networks, Embedded Systems, and Communication Technologies.
Objectives:	1. To introduce students to the concept, architecture, and applications of IoT. 2. To provide knowledge of sensors, actuators, and embedded devices used in IoT systems. 3. To familiarize students with communication protocols and networking for IoT. 4. To develop skills in data acquisition, storage, and cloud integration for IoT. 5. To prepare students to design and analyze IoT-based solutions for real-world applications.
Course Coordinator	Dr. Brijesh Kumar

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Introduction to IoT	Definition, need, and characteristics of IoT, Evolution of IoT and enabling technologies, IoT architecture: perception, network, and application layers, IoT reference models and standards, Applications in smart homes, healthcare, agriculture, and industry	08	PO1/PO6/PO7	PSO1
UNIT-2	Module-II IoT Hardware and Sensors	Sensors: temperature, humidity, motion, pressure, image, etc., Actuators and their types, Embedded systems for IoT: Arduino, Raspberry Pi, ESP32, Power management in IoT devices, Interfacing sensors and actuators with controllers	08	PO1/PO2/PO4	PSO2
UNIT-3	Module-III IoT Communication and Networking	IoT communication protocols: MQTT, CoAP, AMQP, Wireless technologies: Wi-Fi, Bluetooth, ZigBee, LoRa, NB-IoT, IPv6 and 6LoWPAN for IoT, Edge computing and Fog computing concepts, Device-to-Device and Device-to-Cloud communication	08	PO2/PO6/PO8/PO11	PSO2/PSO3
UNIT-4	Module-IV IoT Data and Cloud Integration	IoT cloud platforms: AWS IoT, Google IoT Core, Microsoft Azure IoT, Data acquisition, storage, and processing, IoT analytics: big data and real-time analytics, Security and privacy in IoT systems, Blockchain for IoT security (introductory concepts)	08	PO2/PO6/PO8/PO11	PSO2/PSO3

UNIT-5	Module-V IoT Applications and Case Studies	Smart cities: traffic, waste management, and environment monitoring, Smart grid and energy management, Industrial IoT (IIoT) and automation, Agriculture and healthcare IoT solutions, Future trends: AI-enabled IoT, autonomous IoT systems	08	PO6/PO7/PO8/PO12	PSO1/PSO3
Total No. of Hours			**40**		

Course Outcomes:	1. Explain the architecture, evolution, and enabling technologies of IoT. 2. Identify and integrate IoT hardware components such as sensors, actuators, and controllers. 3. Apply suitable communication protocols and networking technologies in IoT systems. 4. Utilize cloud platforms and data analytics for IoT-based solutions while addressing security concerns. 5. Analyze and evaluate real-world IoT applications in various domains.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw-Hill	2017
2.	Arshdeep Bahga & Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press	2014
3.	Adrian McEwen & Hakim Cassimally, Designing the Internet of Things, Wiley	2013
4.	Dieter Uckelmann et al., Architecting the Internet of Things, Springer	2011
5.	Hanes, Salgueiro, Grossetete, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases, Cisco Press	2017

Course Code: BEE-O 718
Course Name: Introduction to Robotics Engineering

MM:100 **Time: 4 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit: 0**

Prerequisites:	Basic knowledge of control systems, mechanics, electronics, and microcontrollers.
Objectives:	1. To provide foundational knowledge of robotics, its history, classifications, and importance in engineering applications. 2. To introduce the mechanical, electrical, and control components that form the building blocks of robotic systems. 3. To develop an understanding of robotic kinematics, dynamics, and control strategies. 4. To expose students to sensing, perception, and decision-making techniques used in robotics. 5. To prepare students for applying robotics concepts in industrial automation, healthcare, defense, and research applications.
Course Coordinator	Mr. Lokesh Bhardwaj

Note:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) marks each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

UNIT	Module	Course Content	No. of Hours	Pos Mapped	PSOs Mapped
UNIT-1	Module-1 Fundamentals of Robotics	Definition and classification of robots, History and evolution of robotics, Basic components of a robot, Degrees of freedom (DOF), workspace, and configuration, Overview of industrial, mobile, and service robots	08	PO1/PO6/PO12	PSO1
UNIT-2	Module-2 Mechanical Systems and Actuators	Links, joints, frames, and end-effectors, Types of actuators: electric, pneumatic, hydraulic, Stepper and servo motors: principles and applications, Transmission systems: gears, belts, chains, and pulleys, Robot structure design considerations	08	PO1/PO2/PO4/PO10	PSO1/PSO2
UNIT-3	Module-3 Sensors and Perception	Types of sensors: proximity, ultrasonic, vision, force/torque, encoders, Internal vs external sensors, Signal conditioning and sensor integration, Basics of machine vision systems, Feedback and sensor-based control	08	PO2/PO4/PO6/PO10	PSO1/PSO3
UNIT-4	Module-4 Kinematics and Control of Robots	Forward and inverse kinematics of robotic arms, Homogeneous transformation matrices, Jacobian and differential motion, Control strategies: open loop, closed loop, PID control, Trajectory planning and interpolation	08	PO2/PO4/PO10/PO12	PSO1/PSO2
UNIT-5	Module-5 Applications	Industrial robots: welding, painting, assembly, pick & place, Mobile robots	08	PO6/PO7/PO8/PO12	PSO3

	and Trends in Robotics	and autonomous vehicles, Robotic surgery and assistive devices, Military and disaster response robots, Introduction to AI and machine learning in robotics			
Total No. of Hours			**40**		

Course Outcomes:	1. Understand the foundational principles and structure of robotic systems. 2. Identify and analyze actuators and mechanical elements in robot design. 3. Utilize sensors for robotic perception and feedback control. 4. Apply kinematic principles and control strategies for robot motion. 5. Explore various real-world applications and emerging trends in robotics.

Suggested Books:

S. No.	Name of Authors/Books/Publisher	Year of Publication
1.	S. K. Saha, Introduction to Robotics, McGraw-Hill	2015
2.	Mikell P. Groover, Industrial Robotics: Technology, Programming, and Applications, McGraw-Hill	2016
3.	John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson Education	2021
4.	Fu, Gonzalez & Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill	2017
5.	R.K. Mittal and I.J. Nagrath, Robotics and Control, Tata McGraw-Hill	2003
6.	Niku S.B., Introduction to Robotics: Analysis, Control, Applications, Wiley	2010

Course Code: BEE-P 719
Course Name: Utilization of Electrical Energy

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :3**

Prerequisites:	Basics of Electrical Machines, Power Systems, and Electrical Measurements.
Objectives:	1. To introduce students to various methods of utilization of electrical energy in industry, transportation, and domestic applications. 2. To provide knowledge of electrical heating, welding, and illumination systems. 3. To familiarize students with electric traction systems and their modern advancements. 4. To study energy-efficient practices and applications of electricity in different fields. 5. To prepare students for professional roles in industries, utilities, and transport sectors through practical understanding of utilization techniques.
Course Coordinator	Mr. Yogesh Kumar

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Electrical Heating	Classification of heating methods: resistance, induction, dielectric heating, Design and operation of resistance ovens and furnaces, Induction heating: core-type and coreless furnaces, applications, Dielectric heating and its industrial uses, Comparison with conventional heating methods	08	PO1/PO6	PSO1
UNIT-2	Module-II Electrical Welding	Principles of arc welding and resistance welding, Electric arc welding: AC and DC systems, equipment, and applications, Resistance welding: spot, seam, butt, and projection welding, Welding power sources and their characteristics, Merits and limitations of electrical welding methods	08	PO1/PO2/PO4	PSO2
UNIT-3	Module-III Illumination and Lighting Systems	Nature of light and terms used in illumination (luminous flux, intensity, efficiency, etc.), Laws of illumination and lighting calculations, Design of indoor and outdoor lighting systems, Electric lamps: incandescent, fluorescent, sodium vapor, mercury vapor, and LED lighting, Energy-efficient lighting practices	08	PO2/PO4/PO10	PSO1/PSO3

UNIT-4	Module-IV Introduction to traction systems	Steam, diesel, and electric traction, Advantages of electric traction, Systems of track electrification: DC and AC. Mechanics of train movement, speed-time curves, Traction motors: characteristics and control methods	08	PO2/PO4/PO6/PO10	PSO2/PSO3
UNIT-5	Module-V Electrochemical and Miscellaneous Applications	Electrolysis and electroplating, Battery charging methods and applications, Electric drives for industrial applications (pumps, compressors, rolling mills, elevators), Electro-chemical processes in industries, Energy-efficient utilization of electricity in modern systems	08	PO6/PO7/PO8/PO12	PSO1/PSO3
Total No. of Hours			**40**		

Course Outcomes:	1. Explain the principles and applications of electrical heating systems. 2. Demonstrate knowledge of electrical welding methods and their industrial uses. 3. Apply laws of illumination to design efficient lighting systems. 4. Analyze electric traction systems, speed-time curves, and traction motor characteristics. 5. Evaluate electrochemical processes, industrial drives, and energy-efficient utilization techniques.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	J.B. Gupta, Utilization of Electric Power and Electric Traction, Katson Books	2015
2.	H. Partab, Art and Science of Utilization of Electrical Energy, Dhanpat Rai & Sons	2016
3.	R.K. Rajput, Utilization of Electrical Power, Laxmi Publications	2012
4.	N.V. Suryanarayana, Utilization of Electric Power, Wiley Eastern	1990
5.	Soni, Gupta & Bhatnagar, A Course in Electrical Power, Dhanpat Rai	2008

SWITCHGEAR AND PROTECTION LAB LABORATORY
BEE-C 761

MM: 50 **Sessional: 15**
Time: 2 Hr **ESE: 35**
L T P **Credit: 1**
0 0 2

LIST OF EXPERIMENTS

1. To study the construction of under voltage relay and draw it's time vs. voltage characteristics.
2. To study the construction of over voltage relay and draw the following characteristics
   (a) Operating current & de-operating voltage of disc.
   (b) Voltage & operating time.
3. To study the construction of thermal relay and determine
   (a) Operational characteristics of the relay.
   (b) Time current characteristics of given fuse.
4. To study the construction of I.D.M.T. relay and determine
   (a) Operational characteristics of the relay for two time & current setting.
   (b) Reset ratio.
5. To study the construction of instantaneous over current relay and draw the following characteristics
   (a) Operating & de-operating current of the relay.
   (b) Current vs. time characteristics.
6. To study the construction of earth fault relay and determine operational characteristics of the relay for time & current setting.
7. To study the construction of percentage differential relay and determine
   (a) Operational characteristics of the relay.
   (b) Percentage bias & minimum operating current.
8. To study the different parts of Circuit Breaker.
9. To study performance of the different types of fuses.
10. To study performance of miniature circuit breaker (MCB).

Note: Below experiments are to be performed using Virtual Labs (An initiative of the Ministry of Education, Government of India). (5 Experiments are Compulsory)

1. To study the Synchronization of alternator with infinite bus bar.
2. To determine the direct axis reactance (X_d) and quadrature axis reactance (X_q) of synchronous machine.
3. To determine positive sequence, negative sequence and zero sequence reactances of an alternator.
4. To measure the dielectric Strength of transformer oil.
5. To Study the effect of different shape of electrodes on dielectric (air) breakdown.
6. To Study the gas actuated Buchholz relay for oil filled transformer.
7. To Study the over-current relay and the effect of PSM and TSM.
8. To determine the sub-transient (x_d''), transient (x_d') and steady state reactance (x_d) of a synchronous machine.
9. To Study the Ferranti Effect of a transmission line/cable.
10. To study the differential Protection of a three phase delta-delta connected transformer.
11. To study the Protection of a three phase Induction Motor using Numerical Relay.

Revised Syllabus (Effective from the Session 2026-27)

Gurukula Kangri (Deemed to be University), Haridwar
Faculty of Engineering & Technology

B. Tech. Electrical Engineering

Fourth Year **Semester-VIII**

S. No	COURSE CODE	COURSE TITALE	PERIODS			EVALUATION SCHEME				SUBJECT TOTAL
						SESSIONAL EVALUATION			ESE	
THEORY										
			L	T	P	CREDIT	CT	TA	TOTAL		
1	BEE-P XXX	Program Elective-V	3	0	0	3	20	10	30	70	100
2	BEE-P XXX	Program Elective-VI	3	0	0	3	20	10	30	70	100
3	BEE-O XXX	Open Elective-IV	3	0	0	3	20	10	30	70	100
4	BEE-O XXX	Open Elective-V	3	0	0	3	20	10	30	70	100
5	BEE-P 864	Project Stage-II	0	0	16	8	00	100	100	300	400
TOTAL			**12**	**0**	**16**	**20**	**80**	**140**	**220**	**580**	**800**

Program Elective-V	**Program Elective-VI**
1. BEE-P 811 High Voltage Engineering.	1. BEE-P 813 EHV AC and DC Transmission System
2. BEE-P 812 Introduction to Electrical Vehicle	2. BEE-P 814 Power System Operation and Control
Open Elective-IV	**Open Elective-V**
1. BEE-O 815 Renewable Energy System	1. BEE-O 817 Entrepreneurship Development
2. BEE-O 816 Biomedical Instrumentation	2. BEE-O 818 Testing and Commissioning of Electrical Equipment
	3. BEE-O 819 Introduction to Machine Learning

L	**Lecture**	**T**	Tutorial	**P**	Practical
CT	Cumulative Test	**TA**	Teacher Assessment	**ESE**	End Semester Examination
BEE	Electrical Code	**O**	Open Elective	**P**	Program Elective

Course Code: BEE-P 811
Course Name: High Voltage Engineering

MM: 100 **Time: 4 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :0**

Prerequisites:	Basic Electrical Engineering , Power System, Control System, Power Electronics, Electrical Measurement and Measuring Instrument
Objectives:	By the end of this section, you will be able sto: 1. Knowledge and study of the various types and causes of over voltages in power system and insulation coordination. 2. Study and Learn the generation of high voltages and currents 3. Study and knowledge of the measurement of high voltages and high currents 4. Analyze and Study the dielectric breakdown in gases, liquids and solids. 5. Study the testing of testing of high voltage and fault diagnostics.
Course Coordinator	Mr. Yogesh Kumar

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Breakdown in Gases	Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge.	09	PO1	PSO1
UNIT-2	Module-II Breakdown in liquid and solid Insulating materials	Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.	07	PO1/ PO2/ PO4/PO12	PSO1/PSO3
UNIT-3	Module-III Generation of High Voltages	Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.	09	PO1/ PO2/ PO4/PO12	PSO1/PSO3
UNIT-4	Module-IV Measurements of High Voltages and	Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of	07	PO1/ PO2/ PO4/PO12	PSO1/PSO3

	Currents	dielectric constant and loss factor, partial discharge measurements.			
UNIT-5	Module-V Lightning and Switching Over-voltages	Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching overvoltages, Protection against over-voltages, Surge diverters, Surge modifiers.	08	PO1/ PO2/ PO4/PO12	PSO1/PSO3
Total No. of Hours			40		

Course Outcomes:	1. To recall the Ionization processes and de-ionization processes, Types of Discharge, Charge formation in clouds, Lightning Surges. 2. To explain the Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages. 3. To extend the electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials. 4. To illustrate the Townsend's theory, Streamer mechanism, Corona discharge, generation of impulse currents, tripping and control of impulse generators. 5. To apply the Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements. 6. To analyze the Stepped leader, Dart leader, Switching over voltages, Protection against over-voltages, Surge diverters, Surge modifiers.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education.	2013
2.	C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers.	2007
3.	D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers.	1993
4.	E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication.	2000
5.	R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley & Sons.	2011

Course Code: BEE-P 812

Course Name: Introduction to Electrical Vehicle

MM: 100 **Time: 4 Hr.** **L T P** **3 0 0**	**Sessional:30** **ESE:70** **Credit :0**

Prerequisites:	Basics of Electrical Machines, Power Electronics, and Energy Storage Systems.
Objectives:	1. To introduce the fundamentals, architecture, and components of Electric Vehicles (EVs). 2. To study battery technologies, charging methods, and energy management in EVs. 3. To analyze electric drives, power electronics, and control strategies for EVs. 4. To familiarize students with EV infrastructure, policies, and standards. 5. To prepare students for careers and research in sustainable mobility and automotive engineering
Course Coordinator	Mr. Gajendra Singh Rawat

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Fundamentals of Electric Vehicles	Introduction to EVs: history, need, and importance, Classification of EVs: BEV, HEV, PHEV, FCEV, Comparison with conventional vehicles: energy efficiency, emissions, cost, EV architecture and subsystems, Global and Indian EV scenario	08	PO1/PO6/PO7	PSO1
UNIT-2	Module-II Electric Motors and Drives for EVs	Types of motors used in EVs: DC motor, BLDC motor, PMSM, Induction motor, SRM, Torque-speed characteristics and efficiency of motors, Power electronic converters for EV drives, Regenerative braking and energy recovery, Motor control strategies in EVs	08	PO1/PO2/PO4	PSO2
UNIT-3	Module-III Energy Storage Systems	Battery technologies: lead-acid, Li-ion, NiMH, solid-state batteries, Battery modeling and management systems (BMS), Supercapacitors and hybrid storage, Battery charging methods: slow, fast, and wireless charging, Safety issues and lifecycle of batteries	08	PO1/ PO2/ PO4/PO12	PSO1/PSO3
UNIT-4	Module-IV EV Infrastructure	EV charging infrastructure: levels, connectors, and communication protocols, Grid integration of EVs	08	PO2/PO4/PO6/PO10	PSO2/PSO3

	and Standards	(V2G, G2V concepts), Policies, regulations, and standards for EVs (BIS, IEC, ISO, SAE), Government initiatives and subsidies for EV adoption in India, Environmental and economic impacts of EV adoption			
UNIT-5	Module-V Emerging Trends in Electric Mobility	Hybrid EVs and Plug-in Hybrid EVs, Fuel cell EVs: hydrogen storage, fuel cell stacks, and operation, Autonomous EVs and AI integration, EVs in smart cities and smart grids, Future challenges: cost reduction, range anxiety, recycling of batteries	08	PO6/PO7/PO 8/PO12	PSO1/PS O3
Total No. of Hours			40		

Course Outcomes:	1. Explain the fundamentals, architecture, and classification of EVs. 2. Analyze electric motors, drives, and power electronics used in EVs. 3. Evaluate different energy storage systems, batteries, and charging technologies. 4. Interpret EV infrastructure requirements, policies, and standards. 5. Assess emerging trends and challenges in electric mobility and sustainable transport.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	James Larminie & John Lowry, Electric Vehicle Technology Explained, Wiley	2012
2.	Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press	2016
3.	Mehrdad Ehsani, Yimin Gao, Sebastian E. Gay, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press	2018
4.	C.C. Chan & K.T. Chau, Modern Electric Vehicle Technology, Oxford University Press	2001
5.	Rao, Electric Vehicle Technology, Khanna Publishers	2020
6.	BIS/IEC/ISO Standards on EVs and Charging Systems	Latest

Course Code: BEE-P 813
Course Name: EHV AC and DC Transmission System

MM:100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit:3**

Prerequisites:	Knowledge on the high voltage transmission lines and knowledge on the FACTs devices.
Objectives:	1. To introduce the need, importance, and applications of Extra High Voltage (EHV) AC and DC transmission systems. 2. To provide an understanding of EHV AC transmission line parameters, voltage gradients, and insulation design. 3. To develop knowledge of EHV DC transmission principles, converters, and control techniques. 4. To analyze performance, reliability, and economic aspects of EHV transmission systems. 5. To prepare students for solving real-world challenges in power transmission and equip them for professional practice in power utilities, research, and consultancy.
Course Coordinator	Mr. Aviral Awasthi

Note:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) marks each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus.

Unit	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I EHV AC Transmission, Bundled Conductors	Need of EHV transmission lines, power handling capacity and surge impedance loading. Problems of EHV transmission. Geometric mean radius of bundle, properties of bundle conductors, Corona loss, audio and radio noise.	08	PO6/PO 7/PO11	PSO2
UNIT-2	Module-II Load Frequency Control, Method of Load Frequency Control	Introduction to control of active and reactive power flow, turbine speed governing system. Flat frequency, flat tie line and tie line load bias control. Automatic generation control (description of block diagram only).	08	PO1/PO 2/PO6/P O10	PSO1/PS O2
UNIT-3	Module-III Voltage Control	No load receiving end voltage and reactive power generation. Methods of	08	PO2/PO 4/PO6/P	PSO1/PS O3

		voltage control. Shunt capacitors and reactors, Thyristorised static VAR compensators- TCR and TSC.		O10	
UNIT-4	Module-IV FACTS	Introduction to FACTS controllers, types of FACTS controllers, Brief description of STATCOM, Thyristor controlled series capacitors and unified power flow controller	08	PO2/PO 4/PO6/P O8	PSO1/PS O3
UNIT-5	Module-V HVDC Transmission	Types of D.C. Links, advantages and disadvantages of HVDC transmission. Basic principles of DC link control. Application of HVDC transmission.	08	PO6/PO 8/PO11/ PO12	PSO2/PS O3
Total No. of Hours			40		

Course Outcomes:	1. Describe the comparison of EHVAC and HVDC transmission while understanding various issues related to transmission. 2. Calculate and study the corona loss and its impacts. 3. Calculate and study the load frequency control and understanding the methods of load frequency control. 4. Describe the various voltage control methods. 5. Explain the different types of FACTs devices.

Suggested Books:

S. No.	Name of Authors /Books / Publisher	Year of Publication
1.	E.W. Kimbark: Direct Current Transmission, Vol.1, Wiley Interscience.	1971
2.	K.R. Padiyar: HVDC Power Transmission System, Wiley Eastern Ltd.	1990
3.	K.R. Padiyar: HVDC Power Transmission System, New Age publication	1992
4.	J. Arrillaga: H.V.D.C Transmission, Peter Peeregrines.	1983
5.	S.Rao: HVAC and DC Transmission, 3rd Edition, Khanna Publishers	2001
6.	NarainG. Hingorani: Understanding FACTS, IEEE Press	2001

Course Code: BEE-P 814
Course Name: Power System Operation and Control

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit : 3**

Prerequisites:	Basic Electrical Engineering Power systems I, Power systems II
Objectives:	1. To understand real power control and operation 2. To know the importance of frequency control 3. To analyze different methods to control reactive power 4. To understand unit commitment problem and importance of economic load dispatch 5. To understand real time control of power systems
Course Coordinator	Mr. Gaurav Kumar

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Introduction	Approach adopted in utilities for providing reliable, quality and economic electric power supply-necessity for regulation of system frequency and voltage -p-f and Q- V control structure- Recent trends in real time control of power systems	06	PO1/PO2/ PO4/PO5/ PO6	PSO1/ PSO2/PS O3
	Module-II Load dispatching	System load characteristics- load curves chronological load curves- load duration curves- energy time curves- load factor- utilization factor- diversity factor- coincidence factor- demand factor- reserve requirements- installed reserve – spinning reserve- cold reserve- hot reserve- operational restrictions- load dispatching	04	PO1/ PO2/PO6	PSO1/PS O2
UNIT-2	Module-III Load forecasting	Components of system load- classification of base load- forecasting of the base load by method of least square fit- introduction to unit commitments- constraints on unit commitment- unit	06	PO1/ PO2/PO4/ PO6	PSO1/ PSO2/PS O3

		commitment using priority ordering.			
UNIT-3	Module-IV Local control	Power control mechanism of individual machine- mathematical model of speed governing mechanism -speed load characteristics of governing mechanism- regulation of two generators in parallel- System control- Division of power system into control areas- LFC control of a single area- static and dynamic analysis of controlled system- proportional plus integral control of a single area- LFC control of two area system – uncontrolled case- static and dynamic response- Tie line with frequency bias control of two area.	06	PO1/ PO2/PO5/ PO6	PSO1/PS O2
UNIT-4	Module-V Incremental cost curve	Co-ordination equations with loss neglected -solution by iteration- co-ordination equation with loss included (No derivation of Bmmco-efficients)- solution of coordination equations using Bmm co-efficients by iteration method- Base point and participation factors - Economic dispatch controller added to LFC.	05	PO1/PO4/ PO5/PO6	PSO1/ PSO2
UNIT-5	Module-VI Local control	Fundamental characteristics of excitation system- block diagram model of exciter System control-	08	PO1/PO5/ PO6	PSO1
	Module-VII Generation and absorption of reactive power	Method of voltage control-Injection of reactive power – static shunt capacitor/Inductor V AR compensator- Tap changing transformer.	05	PO1/PO5/ PO6	PSO1
Total No. of Hours			40		

Course Outcomes:	1. Understand operation and control of power systems. 2. Analyze various functions of Energy Management System (EMS) functions. 3. Identify whether the machine is in stable or unstable position. 4. Apply different techniques to maintain stability of power system. 5. Understand power system deregulation and restructuring. 6. Elaborate the concept of computer control of power systems and data acquisition.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	I.J. Nagrath & D.P. Kothari,“ Electrical Machines`**”, 4th ` Ed**, Tata McGraw Hill, ISBN- 0070699674	2010
2.	Irving L. Kosow, “Electric Machine and Transformers”,1ST “Prentice Hall of India”, “ISBN- 0132472058	1972

3.	M.G. Say, "The Performance and Design of AC machines", Pit man & Sons**",** **1st**Ed, ISBN	1958

Course Code: BEE-O 815
Course Name: Renewable Energy System

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit : 3**

Prerequisites:	Basic Electrical Engineering, Power Systems, and Energy Conversion.
Objectives:	1. To introduce students to the concepts and need of renewable energy sources. 2. To provide knowledge of different renewable energy technologies and their principles. 3. To analyze the design, performance, and applications of renewable energy systems. 4. To familiarize students with hybrid systems, grid integration, and energy storage. 5. To prepare students for sustainable engineering practices and research in renewable energy.
Course Coordinator	Dr. Brijesh Kumar

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Introduction to Renewable Energy	Global and Indian energy scenario, Limitations of conventional energy sources, Classification and potential of renewable energy resources, Environmental impacts and sustainability benefits, Renewable energy policies and programs in India	08	PO1/PO6/ PO7	PSO1
UNIT-2	Module-II Solar Energy Systems	Solar radiation and its measurement, Solar photovoltaic (PV) systems: principles, I–V characteristics, efficiency factors, Solar thermal systems: flat plate collectors, concentrating collectors, Standalone and grid-connected PV systems, Applications: solar pumping, lighting, and rooftop systems	08	PO1/PO2/ PO4	PSO2
UNIT-3	Module-III Wind and Biomass Energy Systems	Wind energy: wind characteristics, wind turbine types (HAWT, VAWT), Power coefficient, tip speed ratio, and performance analysis, Biomass: sources, properties, and conversion technologies, Biogas plants: types,	08	PO2/PO4/ PO10	PSO1/PS O3

		design, and applications, Cogeneration from biomass systems			
UNIT-4	Module-IV Other Renewable Energy Sources	Small hydroelectric power plants: site selection, classification, and operation, Geothermal energy: resources and utilization methods, Tidal and wave energy conversion technologies, Fuel cells and hydrogen energy systems, Comparative analysis of various renewable technologies	08	PO2/PO4/ PO6/PO10	PSO2/PS O3
UNIT-5	Module-VI Integration, Storage and Emerging Trends	Hybrid renewable energy systems (solar–wind, solar–biomass, etc.), Energy storage: batteries, pumped hydro, super capacitors, hydrogen storage, Grid integration challenges and smart grid applications, Economic evaluation of renewable energy projects, Future trends: floating solar, offshore wind, AI-enabled renewable systems	08	PO6/PO7/ PO8/PO12	PSO1/PS O3
Total No. of Hours			40		

Course Outcomes:	1. Explain the importance, classification, and potential of renewable energy resources. 2. Design and analyze solar energy systems for standalone and grid applications. 3. Evaluate wind and biomass energy conversion systems for practical applications. 4. Demonstrate knowledge of hydro, geothermal, tidal, and fuel cell systems. 5. Assess hybrid systems, storage technologies, and integration of renewable energy into the grid.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers	2011
2.	B.H. Khan, Non-Conventional Energy Resources, Tata McGraw-Hill	2016
3.	S.P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw-Hill	2017
4.	Godfrey Boyle, Renewable Energy: Power for a Sustainable Future, Oxford University Press	2012
5.	Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, PHI Learning	2015
6.	IEEE/IEC Standards for Renewable Energy Systems	Latest

Course Code: BEE-O 816
Course Name: Biomedical Instrumentation

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit : 3**

Prerequisites:	Basic Electronics, Sensors & Transducers, and Signal Processing.
Objectives:	1. To introduce students to the principles and applications of biomedical instrumentation. 2. To understand the working of biomedical sensors, transducers, and electrodes. 3. To study methods of recording and analyzing bioelectric signals. 4. To familiarize students with medical imaging systems and therapeutic equipment. 5. To prepare students for careers and research in healthcare technology, biomedical engineering, and medical equipment design.
Course Coordinator	Dr. Brijesh Kumar

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Introduction to Biomedical Instrumentation	Overview of biomedical instrumentation and its significance, Physiological systems and their parameters, Bioelectric signals and their characteristics, Safety aspects in biomedical instrumentation, Standards and regulations in medical devices	08	PO1/PO6/ PO7	PSO1
UNIT-2	Module-II Biomedical Sensors and Electrodes	Biomedical transducers: pressure, temperature, displacement, flow, and pH sensors, Electrodes for ECG, EEG, EMG: surface and needle types, Chemical and optical biosensors, Smart sensors for biomedical applications, Signal conditioning circuits for biomedical signals	08	PO1/PO2/ PO4	PSO2
UNIT-3	Module-III Diagnostic and Monitoring Instruments	ECG machine: principle, lead systems, and block diagram, EEG recording system and clinical significance, EMG instrumentation and applications, Blood pressure measurement devices: invasive and non-invasive methods, Patient	08	PO2/PO4/ PO10	PSO1/PS O3

		monitoring systems and wearable devices			
UNIT-4	Module-IV Therapeutic and Assistive Devices	Pacemakers: types, operation, and applications, Defibrillators: AC, DC, and implantable types, Ventilators and anesthesia machines, Physiotherapy and diathermy equipment, Prosthetics, orthotics, and assistive rehabilitation devices	08	PO2/PO4/ PO6/PO10	PSO2/PS O3
UNIT-5	Module-VI Medical Imaging Systems	X-ray imaging: principle, image intensifiers, and digital radiography, Computed Tomography (CT) scanners, Magnetic Resonance Imaging (MRI), Ultrasound imaging: modes (A, B, M) and Doppler techniques, Emerging trends: PET, hybrid imaging, AI in medical imaging	08	PO6/PO7/ PO8/PO12	PSO1/PS O3
Total No. of Hours			40		

Course Outcomes:	1. Explain the fundamental concepts and safety standards of biomedical instrumentation. 2. Demonstrate knowledge of biomedical sensors, transducers, and electrodes. 3. Analyze diagnostic instruments such as ECG, EEG, and EMG systems. 4. Apply the principles of therapeutic and assistive devices like pacemakers and defibrillators. 5. Evaluate medical imaging systems and identify their clinical applications.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	R.S. Khandpur, Handbook of Biomedical Instrumentation, McGraw-Hill	2014
2.	Leslie Cromwell, Biomedical Instrumentation and Measurements, PHI	2015
3.	Joseph J. Carr & John M. Brown, Introduction to Biomedical Equipment Technology, Pearson	2012
4.	John Webster, Medical Instrumentation: Application and Design, Wiley	2010
5.	Richard Aston, Principles of Biomedical Instrumentation and Measurement, Merrill	2009

Course Code: BEE-O 817
Course Name: Entrepreneurship Development

MM:100 **Time:4 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit: 0**

Prerequisites:	Basic knowledge of economics, industrial environment, and fundamentals of management.
Objectives:	1. To introduce students to the fundamentals of entrepreneurship and its role in economic and industrial development. 2. To develop entrepreneurial competencies, creativity, and innovation-oriented thinking among students. 3. To provide knowledge of institutional support, legal frameworks, and government policies for setting up enterprises. 4. To train students in project identification, feasibility analysis, business planning, and financial management. 5. To prepare students for launching, managing, and sustaining entrepreneurial ventures with ethical and sustainable practices.
Course Coordinator	Mr. Lokesh Bhardwaj

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus

UNIT	Module	Course Content	No. of Hours	Pos Mapped	PSOs Mapped
UNIT-1	Module-I Introduction to Entrepreneurship	Concept and characteristics of entrepreneurship, Role of entrepreneurship in economic development, Types of entrepreneurs – technical, non-technical, professional, first-generation, Entrepreneur vs Manager, Entrepreneurial competencies and motivation, Factors affecting entrepreneurship	08	PO6/PO7/PO8/PO11/PO12	PSO2/PSO3
UNIT-2	Module-II Institutional Support and Legal Aspects	Institutional support: DIC, NSIC, SIDBI, TCO, MSME, Start-Up India, Legal formalities in setting up an enterprise, Types of ownership: Proprietorship, Partnership, Pvt. Ltd., Ltd., Statutory requirements and clearances, IPR, patents, copyrights, and trademarks	08	PO6/PO7/PO8/PO10	PSO2
UNIT-3	Module-III Project Identification and Business Planning	Idea generation and opportunity assessment, Feasibility studies – market, technical, financial, environmental, Business Model Canvas (BMC), Project report preparation, Elements of business plan	08	PO1/PO2/PO4/PO6/PO10	PSO1/PSO3
UNIT-4	Module-IV	Sources of finance – debt vs equity,	08	PO2/PO4/P	PSO2

	Financial Management and Funding	Working capital and its management, Venture capital, angel investors, crowd funding, Government schemes and subsidies for entrepreneurs, Break-even analysis and cost-volume-profit analysis		O8/PO11	
UNIT-5	Module-V Innovation, Growth and Sustainability	Entrepreneurial innovation: concept, examples, and models, Design thinking and lean startup principles, Scaling the enterprise: strategies and challenges, Sustainable business practices and ethical entrepreneurship, Social entrepreneurship and women entrepreneurship	08	PO6/PO7/PO8/PO10/PO12	PSO1/PSO3
Total No. of Hours			40		

Course Outcomes:	1. Define entrepreneurship and explain its importance in economic development. 2. Recognize institutional and legal frameworks required to start a business. 3. Analyze feasibility of business ideas and prepare business plans. 4. Evaluate financial options and apply basic financial planning for business. 5. Apply innovation and sustainability principles for entrepreneurial grow

Suggested Books:

S. No.	Name of Authors/Books/Publisher	Year of Publication
1.	S.S. Khanka, Entrepreneurial Development, S. Chand	2012
2.	Vasant Desai, Dynamics of Entrepreneurial Development, Himalaya Publishing	2014
3.	David H. Holt, Entrepreneurship: New Venture Creation, Pearson Education	2001
4.	Bhide Amar V., The Origin and Evolution of New Businesses, Oxford University Press	2000
5.	Hisrich, Peters & Shepherd, Entrepreneurship, McGraw-Hill	2017

Course Code: BEE-O 818
Course Name: Testing and commissioning of Electrical Equipment

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit : 3**

Prerequisites:	Basic Electrical Engineering and Electrical Machines
Objectives:	1. Understand the procedures, standards, and documentation required for testing and commissioning of electrical equipment. 2. Acquire knowledge about tools, safety, and legal requirements related to commissioning of electrical installations 3. Develop skills in interpreting results and troubleshooting during commissioning. 4. Understand post-commissioning maintenance, reporting, and handover processes. 5. To be able to plan and perform testing and commissioning activities for various electrical installations and equipment.
Course Coordinator	Mr. Gaurav Kumar

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Introduction to Testing and Commissioning	Scope, objectives, standards, regulatory requirements, documentation, safety practices	08	PO1, PO6	PSO1/ PSO2/
	Module-II Tools and Techniques	Testing equipment, calibration, insulation tests, continuity, high voltage and earth resistance tests	04	PO1/ PO2/PO6	PSO1/PS O2
UNIT-2	Module-III Testing and Commissioning of Transformers	Inspection, pre-commissioning, routine tests, interpretation of results.	06	PO2/PO4/ PO5	PSO2/PS O3
UNIT-3	Module-IV Testing and Commissioning of Switchgear	Visual checks, mechanical and electrical tests, functional performance, troubleshooting.	06	PO1/ PO5/PO6	PSO1
UNIT-4	Module-V Testing and Commissioning of Electrical Machines	Induction motors, synchronous machines, routine and type tests	06	PO2/PO4/ PO5	PSO2

UNIT-5	Module-VI Reporting, Maintenance and Handover	Preparation of test reports, operation manuals, post-commissioning checks, handover process	10	PO1/PO2/ PO6	PSO1/PS O3
Total No. of Hours			40		

Course Outcomes:	1. Ability to plan and perform testing and commissioning activities for various electrical installations and equipment. 2. Knowledge of relevant standards, procedures, tools, and safety measures. 3. Skills in troubleshooting and rectification based on test results. 4. Preparedness for professional roles in industrial installation, maintenance, and quality assurance. 5. Capability to prepare reports, operation manuals and conduct handover procedures.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	S. Singh, "Testing, Commissioning and Maintenance of Electrical Equipment", Katson Publishing.	2013
2.	G.C. Garg, "Electrical Installation Testing", SK Kataria Publishing	2015
3.	S.S. Rao, "Testing, Commissioning, Operation and Maintenance of Electrical Equipment", KhannaPubulication	2011

Course Code: BEE-O 819
Course Name: Introduction to Machine Learning

MM: 100 **Time: 3 Hr.** **L T P** **3 0 0**	**Sessional: 30** **ESE: 70** **Credit : 3**

Prerequisites:	Basic knowledge of Probability & Statistics, Linear Algebra, Algorithms.
Objectives:	1. To introduce the fundamental concepts, models, and techniques of machine learning. 2. To develop the ability to preprocess data and apply ML algorithms for classification, regression, and clustering. 3. To provide knowledge of supervised, unsupervised, and reinforcement learning paradigms. 4. To expose students to real-world applications of ML in engineering, business, and healthcare. 5. To prepare students for higher studies, research, and careers in AI, data science, and intelligent systems.
Course Coordinator	Dr. Brijesh Kumar

NOTE:	The question paper shall consist of two sections (Section-A and Section-B). Section-A shall contain of ten (10) short answer type questions of six (06) mark each and student shall be required to attempt any five (05) questions. Section-B shall contain eight (08) long answer type questions of ten (10) marks each and student shall be required to attempt any four questions. Questions shall be uniformly distributed from the entire syllabus

UNIT	Module	Course Content	No. of Hours	POs mapped	PSOs mapped
UNIT-1	Module-I Introduction to Machine Learning	Definition, scope, and importance of ML, Categories of ML: supervised, unsupervised, reinforcement learning, Steps in building ML models: data collection, preprocessing, training, evaluation, Challenges in ML: over fitting, under fitting, bias-variance tradeoff, Applications of ML in various domains	08	PO1/PO6/ PO7	PSO1
UNIT-2	Module-II Supervised Learning	Linear regression and multiple regression models, Classification algorithms: logistic regression, k-Nearest Neighbor (k-NN), Decision Trees, Support Vector Machines (SVM), Model evaluation metrics: accuracy, precision, recall, F1-score, ROC curve, Case studies of supervised learning applications	08	PO1/PO2/ PO4	PSO2
UNIT-3	Module-III Unsupervised Learning	Clustering: k-means, hierarchical clustering, DBSCAN, Dimensionality reduction: PCA, LDA, Anomaly detection	08	PO2/PO4/ PO10	PSO1/PS O3

		techniques, Applications of unsupervised learning in data mining and pattern recognition, Case studies in engineering and healthcare			
UNIT-4	Module-IV Neural Networks and Reinforcement Learning	Introduction to perceptron and multilayer perceptron (MLP), Backpropagation algorithm and gradient descent, Basics of deep learning (CNN, RNN – overview), Reinforcement learning: agents, environments, rewards, policies, Applications in robotics, control, and autonomous systems	08	PO2/PO4/ PO6/PO10	PSO2/PS O3
UNIT-5	Module-VI Applications and Emerging Trends	ML in speech and image recognition, ML in predictive maintenance, smart grids, and healthcare, ML with IoT and Big Data integration, Ethical issues in ML: bias, fairness, interpretability, Future trends: AutoML, federated learning, explainable AI	08	PO6/PO7/ PO8/PO12	PSO1/PS O3
Total No. of Hours			40		

Course Outcomes:	1. Explain the fundamental concepts, categories, and applications of machine learning. 2. Apply supervised learning algorithms for regression and classification problems. 3. Implement unsupervised learning techniques for clustering and dimensionality reduction. 4. Demonstrate understanding of neural networks and reinforcement learning basics. 5. Analyze ML applications, ethical concerns, and emerging trends in intelligent systems.

Suggested Books:

S. No.	Name of Authors /Books /Publisher	Year of Publication
1.	Tom M. Mitchell, Machine Learning, McGraw-Hill	2017
2.	Ethem Alpaydin, Introduction to Machine Learning, MIT Press	2020
3.	Christopher Bishop, Pattern Recognition and Machine Learning, Springer	2016
4.	Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer	2017
5.	Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press	2016