Curriculum for UG & PG Programmes

(2024-25 Onwards)

असतो मा सद्गमय

Swami Keshvanand Institute of Technology, Management & Gramothan

(An Autonomous Institute, Affiliated to Rajasthan Technical University, Kota)

(Accredited by NAAC with A ++ Grade)

Approved by AICTE, Ministry of Education, Government of India

Recognized by UGC under Section 2(f) of the UGC Act, 1956

B.Tech. in Electrical Engineering

B. Tech. (Electrical Engineering) 3rd Year V Semester

Sr. No.	Course Code	Course Name	Category	Teaching Scheme			Exam Hrs.	Marks			Credit
				L	T	P		CIE	SEE	Total	
1	EEUL501	Transmission & Distribution of Electrical Power	PCC	3	0	0	3	40	60	100	3
2	EEUL502	Control System	PCC	3	0	0	3	40	60	100	3
3	EEUL503	Microprocessor & Microcontroller	PCC	2	0	0	3	40	60	100	2
4	EEUL504	Advanced Power Electronics	PCC	3	0	0	3	40	60	100	3
5	EEUL511/512/513 (Any One)	Smart Grid Technology	PEC	3	0	0	3	40	60	100	3
6		Electrical Materials									
7		Introduction to Electric and Hybrid Vehicles									
8	EEUL560.1	Fundamentals of Electrical Power Systems	OEC	3	0	0	3	40	60	100	3
	EEUL560.2	Energy Audit and Demand Side Management									
9	EEUP520	Power Electronics Lab	PCC	0	0	2	3	60	40	100	1
10	EEUP521	Control System Lab	PCC	0	0	2	3	60	40	100	1
11	EEUP522	Microprocessor & Microcontroller Lab	PCC	0	0	2	3	60	40	100	1
12	EEUP523	Computer Based Power System Lab	PCC	0	0	2	3	60	40	100	1
13	EEUT530	Industrial Training	PSIT	0	0	2	3	60	40	100	2
14	EEUA500	SODECA	SODECA	-	-	-	-	-	-	100	0.5
15	NU99.X	Disaster Management and Preparedness /Constitution of India	NC	-	-	-	3	-	-	100	0

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Transmission and Distribution of Electrical Power	**Course Code**: EEUL501	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisites	1
2	**Basic Concepts of Power Systems:** Structure of a power system, Various types of transmission and distribution systems, Effect of system voltage on size of conductor and losses, feeder, distributor and service mains. Comparison of conductor costs in various systems., Synchronous grids and asynchronous (DC) interconnections. Concept of Power Factor Improvement. Present day scenario in power systems, Indian power grids, basics of substation layout, Introduction to microgrids and distributed generation.	8
3	**Mechanical Design of Overhead Lines:** Conductor material and types of conductor, Types of line support, Conductor arrangements and spacing, Calculation of sag and tension, supports at different levels, Effect of wind and ice loading, Stringing chart and sag template, Conductor vibrations and vibration dampers, Sag line mitigator (SLiM). **Insulators**: Types of insulators, Voltage distribution and Methods of equalizing the potential across an insulator string.	8
4	**Design Parameters of Transmission Lines:** Resistance, inductance and capacitance of overhead lines, Geometric mean radius and distance, Skin and proximity effects, Inductance and capacitance of line with symmetrical and unsymmetrical spacing (Single and Three Phase lines), line transposition. **Corona**: Electric stress between parallel conductors. Disruptive critical voltage and visual critical voltage, Factors affecting corona, Corona power loss. Effects of corona.	10
5	**Performance Analysis of Transmission Lines:** Classification of Overhead Transmission Lines, Steady state representation of Lines: Short, medium and long lines, Nominal π and T circuits, Determination of Generalized Constants for transmission lines, Voltage regulation & efficiency, Ferranti Effect, Interference with communication circuits, Propagation constant, Wavelength and velocity of propagation, Characteristics impedance, Surge impedance loading, Power Transfer Capability of Transmission Line, Series and shunt compensation of Transmission Lines.	10
6	**Underground Cables:** Introduction to Underground Cables, Construction of Underground Cables, Insulation Materials and Ratings, Electrical Characteristics of Underground Cables, Grading of Cables, Losses in Underground Cables, Laying of Underground Cables.	8
Total		**45**

Dr. Ankush Tandon
Convener, BOS-EE and Head (EE)

Text Books:

1. Electrical Power Systems, C. L. Wadhwa, 8th Edition (2022), New Age International.
2. Electrical Power Systems, Ashfaq Husain, 5th Edition (2018), PHI Learning Pvt. Ltd.

Reference Books:

1. Power System Analysis, Hadi Saadat, 3rd Edition (2011), McGraw-Hill Education.
2. Modern Power System Analysis., I. J. Nagrath, D. P. Kothari, 5th Edition (2022), McGraw-Hill Education
3. Power System Analysis, J. J. Grainger & W. D. Stevenson, 2nd Edition (2016)**,** McGraw-Hill Education.
4. Power System Analysis and Design, B. R. Gupta, 5th Edition (2015), S. Chand Publishers.
5. Power System Analysis: Theory and Practice, A. Chakrabarti, Sunita Halder, 3rd Edition (2018), PHI Learning
6. Power Generation, Operation, and Control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé, 3rd Edition (2013), Wiley.
7. Electrical Power Systems, D. Das, 3rd Edition (2015)**,** New Age International (P) Ltd.

Prerequisites:

Students should have prior knowledge of:

1. **Basic Electrical Engineering-** Electrical quantities, AC fundamentals, magnetic circuits.
2. **Circuit Analysis topics**
   Network theorems, single-phase and three-phase circuits, complex power, phasor analysis.
3. **Generation of Electrical Power** - Conventional power plants.
4. **Electrical Machine**
   fundamentals of DC machines**,** transformers, synchronous generators, and induction machines.
5. **Fundamentals of Electromagnetic Fields (Basics)**
   Electric field, magnetic field, inductance and capacitance concepts relevant to transmission lines)

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL501.1	Comprehend the fundamental principles and emerging advancements in modern power systems.	2
EEUL501.2	Illustrate the mechanical design aspects affecting the strength of overhead transmission lines.	3
EEUL501.3	Apply analytical methods to compute the electrical parameters of overhead transmission lines.	3
EEUL501.4	Analyze the performance of overhead transmission lines.	4
EEUL501.5	Analyze underground cable characteristics to assess their impact on system performance.	4

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Control System	**Course Code**: EEUL502	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**INTRODUCTION:** Objective, scope and outcome of the course.	1
2	**Introduction to Control Systems:** Basic concepts of open-loop and closed-loop control systems, Examples of control systems, Feedback characteristics and their effects, Brief Idea of Multi variable Control Systems, **Mathematical modeling of Physical Systems:** Electrical, mechanical (translational & rotational), and electromechanical systems, Transfer function and block diagram representation, Signal flow graphs and Mason's gain formula	9
3	**Time Domain Analysis:** Standard test signals: step, ramp, parabolic, and impulse**,** Time response of first-order and second-order systems**,** Performance indices: Rise time, Peak time, Settling time, Overshoot**,** Introduction to Steady-state error and error constants.	9
4	**Stability Analysis of Control System :**Concept of stability**,** Absolute and Relative Stability**,** Routh-Hurwitz stability criterion**,** Root locus technique :Construction rules**,** Effects of addition of poles and zeros on root locus**,** Relationship between time and frequency response specifications, Polar plot and Nyquist stability criterion, Bode plot: construction and interpretation, Gain margin and phase margin, Effects of addition of poles and zeros on Bode plot and Nyquist plot.	9
5	**Controller Design:** Brief idea of Proportional, Derivative, Integral, PI,PD and PID Controllers and their designing using time and frequency domain Techniques, **Compensator Design:** Introduction to lag, lead and lag lead compensator networks and their designing using time and frequency domain Techniques	9
6	**State Space Analysis:** State variables and state-space representation**,** Conversion between transfer function and state model**,** Phase and Physical Variable Forms, State transition matrix and solution of state equations**,** Controllability and Observability**,**	8
Total		**45**

Dr. Ankush Tandon
Convener, BOS-EE and Head (EE)

Textbooks:

1. Control Systems Engineering – I.J. Nagrath and M. Gopal, 6th Edition, 2021, New Age International Publishers
2. Modern Control Engineering – Katsuhiko Ogata, 5th Edition, 2020, Pearson Education
3. Automatic Control Systems – Benjamin C. Kuo and Farid Golnaraghi, 10th Edition, 2017, Wiley India Pvt. Ltd.

Reference Books:

1. Control Systems: Principles and Design – M. Gopal, 4th Edition, 2012, Tata McGraw Hill Education
2. Feedback Control of Dynamic Systems – Gene F. Franklin, J. Da Powell, Abbas Emami-Naeini, 8th Edition, 2021, Pearson Education
3. Linear Control Systems – B.S. Manke, 5th Edition, 2019, Khanna Publishers
4. Modern Control Systems – Richard C. Dorf and Robert H. Bishop, 13th Edition, 2022, Pearson Education

Prerequisite:

1. Basic Electrical and Mechanical Engineering Concepts – Understanding of circuits, mechanical systems, and basic laws (Ohm's law, Newton's laws).
2. Signals and Systems – Familiarity with concepts like signals, systems, convolution, and Laplace transforms.
3. Mathematics – Proficiency in linear algebra, differential equations, and complex variables.
4. Basic Electronics – Understanding of operational amplifiers, sensors, and basic electronic devices.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL502.1	Apply the concepts of open-loop and closed-loop control systems and develop mathematical models of electrical, mechanical, and electromechanical systems using transfer functions, block diagrams, and signal flow graphs.	3
EEUL502.2	Analyze the time-domain response of first-order and second-order control systems for standard test signals and compute performance indices and steady-state error constants.	4
EEUL502.3	Analyze the stability of control systems using Routh–Hurwitz criterion, Root Locus technique, and frequency-response methods such as Bode, Nyquist, and Polar plots.	4
EEUL502.4	Evaluate and design PID controllers and lead, lag, and lag–lead compensators using time-domain and frequency-domain techniques to meet specified performance requirements.	5
EEUL502.5	Analyze control systems using state-space modeling, determine state transition matrices, and evaluate controllability and observability of dynamic systems.	4

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Microprocessor & Microcontroller	**Course Code**: EEUL503	**Credit**: 2
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (30) + TW & SL(30) =60 hrs. per semester	

Module No.	Contents	Hrs.
1	**INTRODUCTION:** Objective, scope and outcome of the course.	1
2	**BASICS OF MICROPROCESSOR & 8085**: Fundamentals of microprocessors and microcontrollers, concept of embedded systems and applications in electrical engineering. Architecture, pin diagram and operation of 8085, instruction set and programs.	7
3	**INTERFACING DEVICES**: Programmable Peripheral Interface (8255), Programmable Interval Timer (8254), Programmable Interrupt Controller (8259A), Interfacing techniques and applications in electrical control systems.	4
4	**8051 MICROCONTROLLER:** Overview of 8051 Family, Pin and Architecture Diagram, CPU, ALU, working registers and Special Function Register (SFRs), Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Organization, Data and Program Memory,	5
5	**INSTRUCTION SET AND PROGRAMMING OF 8051:** Addressing modes, Instruction set of 8051, Timers and Counters, External Hardware Interrupts, Assembly language programming examples. Applications of microcontrollers: industrial automation and process control, consumer electronics, medical and instrumentation systems application.	7
6	**ARM AND ESP32 MICROCONTROLLER BASICS**: History and features of ARM, basic architecture overview, simple programming concepts (registers, GPIO basics). Applications in modern electrical and embedded systems. Introduction to ESP32, Basic GPIO and peripherals.	7
Total		**30**

Textbooks:

- Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh S. Gaonkar, Revised International Edition (2017), Penram International Publishing.
- The 8051 Microcontroller and Embedded Systems Using Assembly and C, Muhammad Ali Mazidi, Rolin D. McKinlay, and Janice Gillispie Mazidi, 2nd Edition (2019), Pearson Education.

Reference Books:

- Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8051 and ARM, Krishna Kant, Revised Edition (2017), PHI Learning Pvt. Ltd.
- 8051 Microcontroller & Embedded System, Sampath K. Venkatesh, 2025, 2nd Edition, S.K. Kataria & Sons
- Advanced Microprocessors and Microcontrollers, Dr. N. K. Srinath, Revised Edition (2019), New Age International Publishers.
- Microprocessor and Microcontroller (8085 and 8051) Architecture, Programming and Interfacing, V. P. Jain and Rajesh Singh, 1st Edition (2021), BPB Publications.

Prerequisite:

1. Digital Electronics
2. Fundamentals of Programming

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL503.1	Explain the fundamentals of microprocessors, microcontrollers, embedded systems, and describe the architecture, operation, and instruction set of 8085.	2
EEUL503.2	Apply the instruction set of 8085 to develop simple assembly language programs for arithmetic and logical operations.	3
EEUL503.3	Explain and apply interfacing techniques of peripheral devices (8255, 8254, 8259A) in electrical control systems.	3
EEUL503.4	Analyze the architecture, memory organization, instruction set, and develop programs using timers, counters, and interrupts in 8051 microcontroller.	4
EEUL503.5	Understand the basic architecture and programming concepts of ARM and ESP32 microcontrollers and their applications in modern embedded systems.	2

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Advanced Power Electronics	**Course Code**:EEUL504	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**AC Voltage Controllers**: Principle of On-Off Control, Principle of Phase control, Single Phase Bi-directional Controllers with Resistive Loads, Single Phase Controllers with Inductive Loads, Three Phase full wave AC controllers, AC Voltage Controller with PWM Control.	9
3	**Cyclo-converters:** Basic principle of operation, single phase to single phase, three-phase to three-phase and three-phase to single phase cyclo-converters. Output equation, Control circuit.	8
4	**Inverters:** Principle of Operation, Single-phase bridge inverters. Three phase VSI Inverters: 180 and 120 degrees of conduction. Introduction to CSI. Voltage control of Single Phase and Three Phase Inverters, Harmonic reduction by pulse width modulation technique.	9
5	**Power Supplies:** Switched Mode DC Power Supplies, fly-back converter, push-pull converter, half and full bridge converter, resonant DC power supplies, bi-directional power supplies. Resonant AC power supplies, bidirectional AC power supplies.	9
6	**Resonant Pulse Inverters & Advanced Inverters:** Series resonant inverter with unidirectional switches, parallel resonant inverter, L-type and M-type ZCS resonant converter, ZVS resonant converter. Multilevel Inverters: Introduction and Multilevel Concept. Advanced Inverters for Grid Integration of Renewable Energy: Grid-tied inverters.	9
Total		**45**

Text Books:

- Power Electronics, P. S. Bimbhra, Edition (2022), Khanna Publishing.
- Power Electronics, M. D. Singh and K. B. Khanchandani, 2nd Edition (2015), McGraw Hill Education.
- Power Electronics: Converters, Applications and Design, Ned Mohan, Tore M. Undeland and William P. Robbins, 3rd Edition (2022), Wiley India.
- Power Electronics - Circuits, Devices and Applications, Muhammad H. Rashid, 4th Edition (2017), Pearson Education.

Reference Books:

- Power Electronics – Devices, Converters and Applications, 2nd Edition (2017), Vedam Subramanyam, New Age International Publishers.
- Power Electronics, P. C. Sen, 2nd Edition (2014), McGraw Hill Education.
- Modern Power Electronics and AC Drives, B. K. Bose, 1st Edition (Indian Reprint-2010), Prentice Hall India.
- Power Electronics: Devices, Circuits and Industrial Applications, V.R. Moorthi, 14th Impression-1st Edition (2013), Oxford University Press.
- Grid Converters for PV and Wind Power Systems, R. Teodorescu et al., 1st Edition (2011), Wiley-IEEE Press.

Prerequisite:

1. Basic Electrical & Electronics Engineering (Fundamentals of circuits, semiconductor devices, and basic electrical machines)
2. Fundamentals of Power Electronics (Basic power semiconductor devices such as diodes, SCRs, MOSFETs, IGBTs, and basic converter circuits)
3. Engineering Mathematics (Fourier Series and basic Laplace Transform concepts)

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL504.1	Explain the concepts of AC voltage controllers.	2
EEUL504.2	Analyze the operation of single-phase and three-phase cyclo-converters.	4
EEUL504.3	Analyze the working of single-phase and three-phase inverters, under different conduction modes and voltage control techniques.	4
EEUL504.4	Examine configurations for switched mode and resonant DC/AC power supplies.	4
EEUL504.5	Evaluate the performance of resonant inverters, multilevel inverters, and grid-tied inverters for efficient power conversion and renewable energy integration.	5

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Smart Grid Technology	**Course Code**: EEUL511	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, Scope and Outcome of the Course	1
2	**Introduction to Smart Grid:** Evolution of electric grid, concept and definition of smart grid, need and drivers, functions and benefits, difference between conventional and smart grid, resilient and self-healing grids, international policies and global initiatives, Smart Grid initiatives in India	8
3	**Smart Grid Technologies-I:** Smart meters, real-time pricing, smart appliances, automatic meter reading (AMR), outage management system (OMS), plug-in hybrid electric vehicles (PHEV), vehicle-to-grid (V2G), smart sensors, home & building automation.	9
4	**Smart Grid Technologies-II:** Smart substations and substation automation, feeder automation, GIS, intelligent electronic devices (IEDs), synchrophasors, phasor measurement units (PMUs), principles of synchrophasor measurement, wide area measurement systems (WAMS), applications of PMUs in stability monitoring, protection, and control, energy storage technologies (battery, SMES, pumped hydro).	10
5	**Microgrids & Distributed Energy Resources (DERs):** Introduction and background of microgrids, motivation and need, AC/DC and hybrid microgrids, formation and modes of operation (grid-connected and islanded), interconnection issues, protection and control strategies, integration of DERs including solar PV, wind, fuel cells, microturbines, and captive power plants. Islanding Detection Techniques.	9
6	**Power Quality & Management in Smart Grid:** Power quality (PQ) issues and mitigation techniques, Electromagnetic compatibility (EMC) in smart grid, PQ issues of grid-connected DERs, PQ conditioners, web-based PQ monitoring	8
Total		**45**

Textbooks:

1. Smart Grid Fundamentals, Anurag K. Srivastava & Sayonsom Chanda, 1st Edition (2023), McGraw-Hill Education
2. Smart Grid: Fundamentals, Design, Technology, Applications, Communication and Security — An Indian Adaptation, Wiley Editorial Team, 1st Edition (2021), Wiley India
3. Smart Grids for Smart Cities, Volume 1, O.V. Gnana Swathika, K. Karthikeyan, & Sanjeevikumar Padmanaban, 1st Edition (2023), Wiley
4. Smart Grids for Smart Cities, Volume 2, O.V. Gnana Swathika, K. Karthikeyan, & Sanjeevikumar Padmanaban, 1st Edition (2023), Wiley
5. *Power Quality: Problems and Mitigation Techniques*, Bhim Singh, Ambrish Chandra & Kamal Al-Haddad, 1st Edition (2015), Wiley

Reference Books:

1. Smart Grid Resilience: Extreme Weather, Cyber-Physical Security, and System Interdependency, Junjian Qi, 1st Edition (2023), Springer
2. Smart Grids—Renewable Energy, Power Electronics, Signal Processing, and Communication Systems Applications, Alfeu J. Sguarezi Filho et al., 1st Edition (2023), Springer
3. Smart Grid: Fundamentals, Design, Technology, Applications, Communication and Security – An Indian Adaptation, Wiley Editorial, 1st Edition (2021), Wiley India

Prerequisite:

1. Concepts of electrical power generation, transmission and distribution
2. Basic concepts of Performance parameters in context of power quality

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL511.1	Elucidate the evolution, concepts, and smart grid initiatives in India and globally.	2
EEUL511.2	Apply cutting edge smart grid technologies (smart meters, automation systems, and intelligent devices) in modern power networks.	3
EEUL511.3	Investigate synchrophasor-based measurement systems (PMUs and WAMS) for monitoring, protection, and control of power systems.	5
EEUL511.4	Analyze microgrids and distributed energy resources with respect to integration, protection, and control challenges.	4
EEUL511.5	Evaluate power quality management techniques and mitigation methods in smart grid environments.	5

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Electrical Materials	**Course Code**: EEUL512	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, Scope and Outcome of the Course	1
2	**Elementary Materials Science Concepts:** Bonding and types of solids, Crystalline state and their defects, Classical theory of electrical and thermal conduction in solids, temperature dependence of resistivity, skin effect, Hall effect.	8
3	**Dielectric Properties of Insulators in Static and Alternating field:** Dielectric constant of mono-atomic gases, poly-atomic molecules and solids, Internal field in solids and liquids, Properties of Ferro-Electric materials, Polarization, Piezoelectricity, Frequency dependence of Electronic and Ionic Polarizability, Complex dielectric constant of non-dipolar solids, dielectric losses, Liquid & Gaseous Insulators, Transformer Oil Properties, Testing, Natural Ester, SF_6, Air Insulation & Breakdown Characteristics.	9
4	**Magnetic Properties and Superconductivity:** Magnetization of matter, Magnetic Material Classification, Ferromagnetic Origin, Curie-Weiss Law, Common Magnetic materials: Soft & Hard, stainless steel, Sheet Steel, Silicon steel, Ni-Fe Alloys, Soft ferrites, Superconductivity and its origin, Zero resistance and Meissner Effect, critical current density, Applications in electrical machines and power devices	9
5	**Conductivity of metals:** Ohm's law and relaxation time of electrons, collision time and mean free path, electron scattering and resistivity of metals, Conducting materials and alloys used in electrical systems, Applications in busbars, windings, and transmission lines	9
6	**Advanced & Emerging Electrical Materials:** Thermal properties and heat dissipation in electrical equipment, Insulating varnishes, resins, and composites, Smart materials and Nano-materials, High frequency materials, Refractory materials, Structured materials, Trends in materials for EVs, renewable energy systems, and smart grids.	9
Total		**45**

Textbooks:

1. Solid State Electronic Devices, Ben G. Streetman & Sanjay Banerjee, 7th Edition (2023), Pearson
2. Principles of Electronic Materials and Devices, S.O. Kasap, 4th Edition (2020), McGraw Hill Education
3. New Age Solid State Physics, S. O. Pillai, 10th Edition (2024), New Age International Publishers

Reference Books:

1. Solid-State Chemistry: A Modern Approach, Ashok Kumar Jha, 1st Edition (2023), Apple Academic Press
2. Innovations in Electronic Materials: Advancing Technology for a Sustainable Future (Conference Proceedings ICEAMST 2024), Editors M. S. Vijaya Kumar, K. Srujan Raju, K. Rajakumar, S. Saravanakumar, 1st Edition (2025), Springer
3. Manufacturing Engineering and Materials Science, Saini A, 1st Edition (2024), Taylor & Francis

Prerequisite:

1. Basic Physics Fundamentals
2. Fundamentals of Electrical Engineering
3. Mathematics Skills
4. Introductory Chemistry/Material Concepts

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL512.1	Explain bonding mechanisms, types of solids, crystal structures, defects, and basic electrical and thermal conduction phenomena in electrical engineering materials.	2
EEUL512.2	Analyze dielectric behavior of insulating materials under DC and AC electric fields, including polarization mechanisms, dielectric losses, and applications.	4
EEUL512.3	Interpret magnetic properties of materials and explain superconductivity phenomena for applications in electrical machines and power devices.	2
EEUL512.4	Apply electrical conductivity concepts to evaluate metals and alloys for bus-bars, windings, and transmission line applications.	3
EEUL512.5	Analyze advanced and emerging electrical materials such as insulating varnishes, composites, smart materials, and nano-materials for EVs, renewable energy systems, and smart grids.	4

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Introduction to Electric and Hybrid Vehicles	**Course Code**: EEUL513	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	Introduction: Objective, scope and outcome of the course.	1
2	Vehicle Dynamics and Fundamentals: Overview of EVs, need for electric mobility, environmental impact, and comparison with IC engine vehicles. History and classification of EVs (BEV, HEV, PHEV, FCEV). Vehicle performance parameters. Vehicle dynamics: rolling resistance, aerodynamic drag, grade resistance, tractive effort. Driving cycles (IDC, FTP, WLTP) and energy consumption. Power and energy requirement calculations, powertrain sizing, basics of regenerative braking.	9
3	Energy Storage Systems: Battery fundamentals: energy density, power density, C-rate.Battery types: Lead-acid, NiMH, Lithium-ion and comparison. Battery characteristics, charging/discharging, thermal effects. Battery Management System (BMS), SOC and SOH estimation. Supercapacitors and fuel cells (basic concepts).	8
4	Electric Propulsion Systems: Requirements of EV propulsion systems. Electric motors: DC, Induction, PMSM, BLDC, SRM (working and characteristics).Comparison and selection of motors. Transmission systems and drivetrain basics. Regenerative braking implementation.	8
5	Power Electronics and Control: Role of power electronics in EVs. DC-DC converters and inverters (VSI/CSI, PWM). Motor drive control (scalar and vector basics). Regenerative braking using converters. Vehicle control strategies, hybrid energy management, Controller Area Network (CAN) basics, thermal management.	9
6	Vehicle Drivetrain, Charging and Future Trends: EV drivetrain design and hybrid architectures (series, parallel, power-split). Charging methods (AC/DC), charging levels and standards. Grid integration and V2G concept. Emerging technologies: wireless charging, solid-state batteries, autonomous EVs. Case studies and environmental impact.	10
Total		**45**

Textbooks:

1. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, 3rd Edition (2018), CRC Press
2. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, 3rd Edition (2021), CRC Press

Reference Books:

1. Electric Vehicle Technology Explained, James Larminie and John Lowry, 2nd Edition (2012), Wiley
2. Modern Electric Vehicle Technology, C.C. Chan and K.T. Chau, 1st Edition (2001), Oxford University Press

Prerequisite:

- Electrical Machines – Fundamentals of DC and AC motors, torque-speed characteristics.
- Power Electronics – Basics of converters, inverters, and switching devices.
- Electrical Circuits and Networks – Voltage/current laws, power and energy calculations.
- Engineering Physics / Fundamentals of Energy – Basic knowledge of energy sources and efficiency.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL513.1	Analyze the dynamic behavior of EVs under varied drive cycles to determine powertrain power ratings and total energy consumption requirements.	4
EEUL513.2	Design and justify the selection of energy storage systems (batteries, supercapacitors, and fuel cells) by benchmarking their performance, efficiency, and suitability for diverse engineering applications.	5
EEUL513.3	Design a suitable electric powertrain by analyzing and matching propulsion system performance with vehicle traction requirements.	5
EEUL513.4	Design and analyze high-efficiency converter and inverter topologies to control electric motor drives using CAN communication protocols.	5
EEUL513.5	Evaluate and propose innovative drivetrain architectures, charging systems, and smart technologies to accelerate the transition to sustainable electric mobility.	5

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Power Electronics Lab	**Course Code**: EEUP520	**Credit**: 1
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 3 Hrs	**Teaching Scheme:** LI (30) hrs. per semester	

Module No.	Contents
1	To compare the ratings and applications of power electronic devices such as Power Diode, Power Transistor, Thyristor, DIAC, TRIAC, and GTO.
2	To plot the V–I characteristics of an SCR and experimentally determine the latching current and holding current under gate triggering conditions.
3	To analyze the V–I characteristics of TRIAC and DIAC devices.
4	To investigate the transfer and output characteristics of a MOSFET.
5	To examine the transfer and output characteristics of an IGBT.
6	To observe the output characteristics of a step-down DC chopper and study the variation of output voltage with duty cycle.
7	To implement and test SCR firing circuits using R, RC, and UJT triggering methods.
8	To obtain and interpret the output waveforms of a single-phase half-wave controlled rectifier with and without filters and examine the variation of output voltage with respect to firing angle.
9	To demonstrate and analyze the operation of a single-phase fully controlled bridge converter with R and RL loads and illustrate rectification and inversion modes with and without a freewheeling diode.
10	To demonstrate the working of a single-phase voltage source inverter using PWM and observe output voltage waveforms.

Text Books:

1. Power Electronics: Devices, Circuits and Industrial Applications, V.R. Moorthi, 14th Impression-1st Edition (2013), Oxford University Press.
2. Power Electronics, P. C. Sen, 2nd Edition (2014), McGraw Hill Education.
3. Power Electronics, P. S. Bimbhra, Edition (2022), Khanna Publishing.

Reference Books:

1. Power Electronics, M. D. Singh and K. B. Khanchandani, 2nd Edition (2015), McGraw Hill Education.
2. Power Electronics - Circuits, Devices and Applications, Muhammad H. Rashid, 4th Edition (2017), Pearson Education.
3. Power Electronics – Devices, Converters and Applications, 2nd Edition (2017), Vedam Subramanyam, New Age International Publishers.
4. Modern Power Electronics and AC Drives, B. K. Bose, 1st Edition (Indian Reprint-2010), Prentice Hall India.

Prerequisites:

1. Basic Electrical & Electronics Engineering
   Fundamental electrical circuits and basic electronic devices
2. Power Electronics
   Operation of power semiconductor devices and basic converters
3. Advanced Power Electronics (introductory exposure)
   Basic understanding of advanced converters and control concepts

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUP520.1	Describe the operation and applications of power electronic devices and their applications.	2
EEUP520.2	Analyze the static characteristics of SCR, DIAC, TRIAC, MOSFET, IGBT, and UJT.	4
EEUP520.3	Demonstrate the operation of SCR firing circuits.	3
EEUP520.4	Analyze the operation and output characteristics of single-phase controlled rectifiers.	4
EEUP520.5	Illustrate the operation of a single-phase PWM voltage source inverter.	3

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Control System Lab	**Course Code**: EEUP521	**Credit**: 1
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** LI (30) hrs. per semester	

Module No.	Contents
1	To compute Laplace and inverse Laplace transforms (including residue method) using MATLAB.
2	To determine poles, zeros, and gain of a transfer function and to obtain the overall transfer function for series, parallel, and feedback interconnections using MATLAB.
3	To study a first-order RC system by deriving its transfer function, obtaining step/impulse/ramp/parabolic responses, and verifying the same using MATLAB with time-domain specifications.
4	To study a second-order RLC system (undamped, underdamped, critically damped, overdamped) by obtaining step/impulse/ramp/parabolic responses, plotting input–output responses for arbitrary inputs, and evaluating time-domain specifications using MATLAB.
5	To plot the root locus of a given transfer function using MATLAB and comment on stability.
6	To plot the Nyquist plot of a given transfer function using MATLAB and comment on stability.
7	To plot the Bode plot of a given transfer function using MATLAB and determine gain margin and phase margin.
8	To design a PID controller for a given system using analytical method and MATLAB, and compare step response with and without controller.
9	To design a lead/lag (lag–lead) compensator for a given system using analytical method and MATLAB, and compare step response and Bode plot with and without compensator.
10	To represent a given system in state-space form, convert between transfer function and state-space model using MATLAB, and analyze basic state-space characteristics such as state response, controllability, and observability.

Textbooks:

1. Modern Control Engineering, Katsuhiko Ogata, Pearson Education, 5th Edition, 2010.
2. Automatic Control Systems, Benjamin C. Kuo and Farid Golnaraghi, Wiley, 10th Edition, 2017.
3. Control Systems Engineering, Norman S. Nise, Wiley India, 7th Edition, 2015.

Reference Books:

1. Feedback Control of Dynamic Systems, Gene F. Franklin, J. D. Powell, and Abbas Emami-Naeini, Pearson Education, 8th Edition, 2019.
2. Modern Control Systems, Richard C. Dorf and Robert H. Bishop, Pearson Education, 13th Edition, 2017.
3. MATLAB for Control Engineers, Katsuhiko Ogata, Pearson Education, 1st Edition, 2011.
4. Control System Toolbox User's Guide, The MathWorks Inc., 2020.

Prerequisite:

1. Basic Electrical Engineering – Understanding of electrical circuit fundamentals, transients, and system behavior.
2. Mathematics for Engineers – Knowledge of Laplace transforms, differential equations, and complex frequency domain analysis.
3. Control System Theory – Familiarity with open-loop and closed-loop systems, feedback principles, and system modeling concepts.
4. Fundamentals of MATLAB Programming – Basic ability to use MATLAB commands, create scripts, and perform numerical computations.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUP521.1	Model and represent dynamic systems in MATLAB using transfer function and state-space forms, and identify system parameters such as poles, zeros, gain, and order.	3
EEUP521.2	Analyze and interpret time-domain responses (step, impulse, ramp) of first and second order systems and compute performance indices using MATLAB.	4
EEUP521.3	Evaluate system stability using Root Locus, Bode, and Nyquist methods, and correlate frequency-domain and time-domain performance.	5
EEUP521.4	Design and simulate classical controllers (P, PI, PID) in MATLAB and Simulink, tune parameters, and compare system performance improvements.	6
EEUP521.5	Design and analyze compensators (Lead, Lag, Lead–Lag) to meet desired transient and steady-state specifications, and validate the results through simulation.	4
EEUP521.6	Determine controllability and observability of systems using MATLAB, and interpret their implications for feedback control design.	6

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Microprocessor & Microcontroller Lab	**Course Code**: EEUL522	**Credit**: 1
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 3 Hrs.	**Teaching Scheme** LI (30) hrs. per semester	

Module No.	Contents
1	Write a program for Multiplication and Division of two 8-bit numbers
2	Write a program for Sorting of array in: (a) Ascending order (b) Descending order
3	Write a program to generate a Software Delay. (a) Using a Register (b) Using a Register Pair
Following exercises has to be Performed on 8051	
4	Write a program for LED interfacing and delay generation.
5	Write a program to find Largest and Smallest Numbers among set of numbers.
6	Write a program to interfacing of LCD to 8051
7	Write a program to interface of Stepper motor and DC motor to 8051.
Following exercises have to be Performed on ARM Cortex-M microcontroller	
8	Write a program for LED control and switch interfacing using ARM Cortex-M.
9	Write a program for LCD interfacing and displaying data using ARM Cortex-M.

Textbooks:

- Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh S. Gaonkar, Revised International Edition (2017), Penram International Publishing.
- The 8051 Microcontroller and Embedded Systems Using Assembly and C, Muhammad Ali Mazidi, Rolin D. McKinlay, and Janice Gillispie Mazidi, 2nd Edition (2019), Pearson Education.

Reference Books:

- Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8051 and ARM, Krishna Kant, Revised Edition (2017), PHI Learning Pvt. Ltd.
- 8051 Microcontroller & Embedded System, Sampath K. Venkatesh, 2025, 2nd Edition, S.K. Kataria & Sons
- Advanced Microprocessors and Microcontrollers, Dr. N. K. Srinath, Revised Edition (2019), New Age International Publishers.
- Microprocessor and Microcontroller (8085 and 8051) Architecture, Programming and Interfacing, V. P. Jain and Rajesh Singh, 1st Edition (2021), BPB Publications.

Prerequisite:

1. Digital Electronics
2. Fundamental of Programming

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUP522.1	Develop and execute assembly language programs for arithmetic operations, sorting, and delay generation using 8-bit microprocessors.	4
EEUP522.2	Implement embedded programs using 8051 microcontroller for LED interfacing, delay generation, and data processing tasks such as finding largest and smallest numbers.	4
EEUP522.3	Analyze peripheral devices like LCD, stepper motor, and DC motor with 8051 microcontroller for real-time control applications.	4
EEUP522.4	Develop programs for ARM Cortex-M microcontroller to perform LED control and switch interfacing.	4
EEUP522.5	Implement LCD interfacing and data display operations using ARM Cortex-M microcontroller for embedded system applications.	4

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Computer based Power System Lab	**Course Code:** EEUP523	**Credit**: 1
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** LI (30) hrs. per semester	

Module No.	Contents
1.	To analyze the effect of shunt capacitors on a system for power factor improvement using MATLAB.
2.	Simulate sag and tension evaluation of overhead transmission lines using MATLAB and analyze sag under normal, wind and ice loading conditions with equal and unequal supports.
3.	Develop MATLAB script to compute AC and DC resistance of transmission lines and study the effect of temperature and skin effect on line resistance.
4.	Write MATLAB program to determine inductance of single-phase and three-phase transmission lines for symmetrical and unsymmetrical spacing including the effect of transposition.
5.	Develop MATLAB program to calculate capacitance of single-phase and three-phase transmission lines and analyze the influence of conductor spacing and height.
6.	Simulate short transmission line model using MATLAB to determine sending-end and receiving-end quantities along with voltage regulation and efficiency.
7.	Develop MATLAB based simulation of medium transmission line using T and π models and compare their performance using ABCD parameters.
8.	Write MATLAB program to analyze performance of long transmission line using generalized transmission line equations and demonstrate Ferranti effect.
9.	Develop MATLAB program to determine disruptive critical voltage, visual critical voltage and corona loss and study variation of corona with system parameters.
10.	Write MATLAB program to compute reactive power compensation required for power factor improvement and analyze system performance before and after compensation.

Text Books:

1. Power System Analysis, Hadi Saadat, 3rd Edition (2011), McGraw-Hill Education.
2. Power System Analysis and Design, J. Duncan Glover, Thomas Overbye, Mulukutla S. Sarma, 6th Edition (2017), Cengage Learning.

Reference Books:

1. Modern Power System Analysis., I. J. Nagrath, D. P. Kothari, 5th Edition (2022), McGraw-Hill Education
2. Power System Analysis: Theory and Practice, A. Chakrabarti, Sunita Halder, 3rd Edition (2018), PHI Learning
3. Power Generation, Operation, and Control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé, 3rd Edition (2013), Wiley
4. MATLAB for Engineers – Applications in Power Systems, Ashfaq Husain, 1st Edition (2014), Pearson India

Prerequisite:

1. Fundamental knowledge of power system components such as transmission lines, insulators, overhead line supports, and basic substation elements, acquired through prior coursework in Basic Electrical Engineering and introductory Power System studies.
2. Understanding of basic power system analysis concepts including per-unit system, electrical parameters of transmission lines, voltage regulation, efficiency, corona, and reactive power concepts studied in Power System–I.
3. Basic proficiency in engineering mathematics and numerical computation techniques necessary for solving line parameter calculations, voltage regulation, efficiency evaluation, and analytical modeling of transmission lines.
4. Working knowledge of computer-based analytical tools or programming environments, preferably MATLAB or equivalent, including familiarity with basic programming structure, data handling, mathematical operations, and interpretation of computational results.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUP523.1	Develop suitable computational approach to improve power factor and reactive power compensation in power system network.	4
EEUP523.2	Assess sag and tension of overhead transmission lines under varied loading and support conditions.	4
EEUP523.3	Analyze the occurrence of corona phenomenon in overhead transmission lines with respect to system and environmental parameters.	4
EEUP523.4	Evaluate transmission line parameters for their impact on power system performance and operational studies.	5
EEUP523.5	Evaluate and compare the electrical performance of short, medium, and long transmission lines.	5

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Fundamentals of Electrical Power Systems	**Course Code**: EEUL560.1	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Conventional Energy Generation: Thermal Power plants**: Basic schemes and working principle. Base load and peak load plants. **Gas Power Plants**: open cycle and closed cycle gas turbine plants, combined gas & steam plants-basic schemes. **Hydro Power Plants**: Classification of hydroelectric plants. Basic schemes of hydroelectric and pumped storage plants. **Nuclear Power Plants**: Nuclear fission and nuclear fusion. Fissile and fertile materials. Basic plant schemes with boiling water reactor, heavy water reactor and fast breeder reactor. Efficiencies of various power plants	9
3	**Solar Power Plant:** Solar Photovoltaic energy conversion and utilization, solar power generation systems a) off-grid systems b) grid connected systems c) power control and management systems, economics of solar photovoltaic systems, World Energy Requirement, Energy and Role of Photovoltaic, Types of PV Installation, Common Systems type, GRID-TIED System, Hybrid Systems, Photovoltaic in Energy Supply, **Wind Energy**: Basic Principles of Wind Energy Conversion. Wind energy estimation, site selection, components and classification of wind energy conversion systems, their advantages and disadvantages.	9
4	**Other Non-Conventional Energy Sources**: Ocean Energy-Ocean Thermal Energy Conversion (OTEC), Tidal Energy, Wave Energy, Magneto Hydro Dynamic Power Generation- Principles, MHD Systems. Grid integration of RES, Energy storage system, Micro-grid	8
5	**Transmission & Distribution of Electrical Power** Structure of a power system, Various types of Transmission and distribution Systems, Overhead and Under Ground Systems, effect of system voltage on size of conductor and losses, feeder, distributor and service mains, Types of Conductor Materials, Transmission and Distribution Network in India, Present-Day Scenario in Power systems, Indian Power Grids, basic substation layout, Introduction to microgrids, Smart Grid and Distributed Generation Technology, Power factor correction in distribution system	9
6	**Introduction to Power System Protection:** Principles of Power System Protection, Different types of Relays: Directional, differential and distance relays. Instrument transformers, different types of Circuit Breakers.	9
	Total	**45**

Dr. Ankush Tandon
Convener, BOS-EE and Head (EE)

Text Books:

1. Electrical Power Systems, C. L. Wadhwa, 8th Edition (2022), New Age International.
2. Electrical Power Systems, Ashfaq Husain, 5th Edition (2018), PHI Learning Pvt. Ltd.
3. Power System Analysis and Design, B. R. Gupta, 5th Edition (2015), S. Chand Publishers.
4. G. D. Rai, *Non-Conventional Energy Sources*, 4th Edition, (2013) Khanna Publishers,.
5. Badri ram , Power System Protection and Switchgear, 2nd Edition (2017) TMH.

Reference Books:

1. Power Generation, Operation, and Control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé, 3rd Edition (2013), Wiley
2. Electrical Power Systems, D. Das, 3rd Edition (2015), New Age International (P) Ltd.

Prerequisite:

1. Basic concepts of kinetic and potential energy, thermal energy, wind and hydro dynamics and nuclear energy.
2. Basic concepts of current, voltage, power and energy managements.
3. Basic concepts of electromechanical energy conversion.
4. Basic concepts of Types of electrical power as active, reactive and apparent power.
5. Economic considerations – types of costs, tariff and consumers.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL560.1.1	Explain the working principles and basic layout of conventional power plants such as thermal, hydro, gas, and nuclear power stations.	**2**
EEUL560.1.2	Describe various renewable and non-conventional energy sources and outline their basic components, advantages, and limitations.	**2**
EEUL560.1.3	Explain the concepts of energy conversion, energy storage, and grid integration of renewable energy systems including micro-grids.	**2**
EEUL560.1.4	Describe and identify different transmission and distribution systems, components, and recent developments such as smart grid and distributed generation.	**2**
EEUL560.1.5	Explain the basic principles of power system protection and identify relays, circuit breakers, and protection equipment used in power systems.	**2**

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: V
Course Name: Energy Audit & Demand Side Management	**Course Code**: EEUL560.2	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**INTRODUCTION:** Objective, scope and outcome of the course.	1
2	**Energy Scenarios:** Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Clean Development Mechanism. **Types of Energy Audits and Energy-Audit Methodology:** Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training.	8
3	**Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data – Acquisition System, Thermal Basis. **Electrical-Load Management:** Electrical Basics, Electrical Load Management, Variable- Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses. **Energy Audit of Motors:** Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling	10
4	**Energy Audit of Lighting Systems:** Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities. **Energy Audit Applied to Buildings:** Energy Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy Savings Tips Applicable to New as well as Existing Buildings.	9
5	**Demand side Management:** Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM, customer acceptance, implementation issues, Implementation strategies, DSM and Environment.	8
6	**Energy Conservation:** Motivation of energy conservation, Principles of Energy conservation, Energy conservation planning, Energy conservation in industries, EC in SSI, EC in electrical generation, transmission and distribution, EC in household and commercial sectors, EC in transport, EC in agriculture, EC legislation.	9
	Total	**45**

Dr. Ankush Tandon
Convener, BOS-EE and Head (EE)

Textbooks:

1. Handbook on Energy Audit, Sonal Desai, 2nd Edition (2019), McGraw Hill Education.
2. Energy Management and Conservation, Amit Kumar Tyagi, 2nd Edition (2018), CRC Press / Taylor & Francis.
3. Energy Conversion Systems, Rakosh Das Begamudre, 2nd Edition (2018), New Age International Publishers.
4. Energy Economics: Concepts, Issues, Markets and Governance, Subhes C. Bhattacharyya, 2nd Edition (2019), Springer.
5. Energy Efficiency and Management in Industry, Mohan Munasinghe and Wilfrido Castillo, 1st Edition (2018), Elsevier.
6. Electrical Energy Utilization and Conservation, C. L. Wadhwa, 3rd Edition (2016), New Age International Publishers.

Reference Books:

1. Energy Auditing and Management, Y. P. Abbi and Shashank Jain, 2nd Edition (2021), CRC Press.
2. Handbook of Energy Audits, Albert Thumann, William J. Younger, Terry Niehus, 10th Edition (2020), CRC Press.
3. Guide to Energy Management, Barney L. Capehart, Wayne C. Turner, William J. Kennedy, 8th Edition (2020), Fairmont Press.
4. Energy Management Systems: ISO 50001 and Beyond, Giovanni Petrecca, 1st Edition (2014), Springer.
5. Industrial Energy Management, K. C. Arora and S. Domkundwar, 2nd Edition (2017), Khanna Publishers.
6. Sustainable Energy Systems Engineering, Francis Vanek and Louis Albright, 2nd Edition (2016), McGraw Hill Education.

Prerequisite:

1. Basic understanding of electrical and mechanical systems.
2. Knowledge of electrical circuits, power systems, and energy generation.
3. Familiarity with measurements and instrumentation.
4. Awareness of industrial processes and building energy usage.
5. Fundamental knowledge of mathematics for energy analysis and financial calculations

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL560.2.1	Understand and explain energy scenarios, energy security, energy strategy, and the Clean Development Mechanism, along with the importance of energy conservation and audits.	2
EEUL560.2.2	Apply different types of energy audits and audit methodologies, including financial and sensitivity analysis, project financing, and energy monitoring techniques.	4
EEUL560.2.3	Use survey instrumentation and measurement techniques to assess electrical, thermal, lighting, and speed-related energy parameters in industrial and building systems.	3
EEUL560.2.4	Perform energy audits of motors, lighting systems, and buildings, identify energy saving opportunities, and recommend measures based on efficiency, BEE ratings, and best practices.	3
EEUL560.2.5	Analyze demand-side management strategies, energy conservation techniques, and legislation, and evaluate their impact on industries, households, transport, agriculture, and the environment.	4

B. Tech (Electrical Engineering) 3rd Year VI Semester

Sr. No.	Course Code	Course Name	Category	Teaching Scheme L	Teaching Scheme T	Teaching Scheme P	Exam Hrs.	Marks CIE	Marks SEE	Marks Total	Credit
1	EEUL601	Power System Engineering	PCC	3	-	-	3	40	60	100	3
2	EEUL602	Switchgear and Protection	PCC	2	-	-	3	40	60	100	2
3	EEUL603	Artificial Intelligence Techniques	ESC	3	-	-	3	40	60	100	3
4	EEUL611/612/613 (Any One)	Smart Mobility & EV Infrastructure	PEC	3	-	-	3	40	60	100	3
5		Modern Control Theory									
6		Electrical Machine Design									
7	EEUL614/615/616 (Any One)	Renewable Energy Engineering	PEC	3	-	-	3	40	60	100	3
8		Power System Planning									
9		Electrical Energy Conservation and Audit									
10	EEUL660.1	Elements of Smart Grid System	OEC	3	-	-	3	40	60	100	3
	EEUL660.2	Non-conventional Energy Sources									
11	EEUP620	Power System Design lab	PCC	-	-	3	3	60	40	100	1.5
12	EEUP621	Energy Systems Lab	PCC	-	-	3	3	60	40	100	1.5
13	EEUP622	Embedded System and IOT Lab	PCC	-	-	3	3	60	40	100	1.5
14	EEUP623	Python Lab	PCC	-	-	3	3	60	40	100	1.5
15	EEUA600	SODECA	SODECA	-	-	-	-	-	-	100	0.5
16	NU99.X	Disaster Management and Preparedness /Constitution of India	NU	-	-	-	3	-	-	100	-

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Power System Engineering	**Course Code**: EEUL601	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Per Unit System:**Introduction to Per unit system, per unit impedance of a transformer, per unit quantities in three-phase systems, per unit load impedances, advantages of per unit and single line diagram.	6
3	**Load Flow Analysis:**Load Flow Problem, Formation of bus admittance matrix, modification of an existing Y-bus, development of load flow equations, bus classification, Methods of Load flow solution, Gauss-Seidel, Newton-Raphson and fast decoupled methods for complete load flow solution, Comparison of load flow analysis methods.	10
4	**Fault Analysis:**Short circuit model of a synchronous machine at no load, short circuit model of a loaded synchronous machine. Equivalent circuits of synchronous machine under sub transient, transient and steady state conditions. Selection of circuit breakers, Algorithm for formation of Bus Impedance Matrix. Analysis of three-phase fault. Fortescue theorem, symmetrical components of an unbalanced three phase system, Sequence impedance of synchronous machine, transmission lines and transformers, Analysis of single-line-to-ground fault, line-to-line fault and double-line-to-ground fault using symmetrical components method.	10
5	**Rotor Angle Stability:**Introduction to power system stability, rotor angle stability. Swing equation and analysis of swing curves. Steady state stability analysis. Transient stability, equal-area criterion for transient stability analysis. Methods of improving transient and steady state stability. Introduction to Dynamic Stability.	10
6	**Optimal Dispatch of Generation:**Introduction, Thermal Characteristic Curves of Generators, Operating Cost of a Thermal Plant, Economic Dispatch Neglecting Losses and No Generator Limits, Economic Dispatch Neglecting Losses and Including Generator Limits, Economic Dispatch Including Losses.	8
Total		**45**

Text Books:

1. Power System Analysis, HadiSaadat, 3rd Edition (2011), McGraw-Hill Education.
2. Modern Power System Analysis., I. J. Nagrath, D. P. Kothari, 5th Edition (2022), McGraw-Hill Education
3. Electrical Power Systems, C. L. Wadhwa, 8th Edition (2022), New Age International.

Reference Books:

1. Power System Analysis, J. J. Grainger & W. D. Stevenson, 2nd Edition (2016), McGraw-Hill Education.
2. Power System Analysis: Theory and Practice, A. Chakrabarti, SunitaHalder, 3rd Edition (2018), PHI Learning
3. Power Generation, Operation, and Control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé, 3rd Edition (2013), Wiley
4. Power System Analysis and Design, B. R. Gupta, 5th Edition (2015), S. Chand Publishers.
4. Electrical Power Systems, D. Das, 3rd Edition (2015), New Age International (P) Ltd.
5. Electrical Power Systems, Ashfaq Husain, 5th Edition (2018), PHI Learning Pvt. Ltd.

Prerequisites:

1. **Basic Electrical Engineering -** Electrical quantities, AC fundamentals, magnetic circuits.
2. **Circuit Analysis**
   Network theorems, single-phase and three-phase circuits, complex power, phasor analysis.
3. **Generation of Electrical Power -** Conventional power plants.
4. **Electrical Machine**
   Fundamentals of DC machines, transformers, synchronous generators, and induction machines.
5. **Fundamentals of Electromagnetic Fields (Basics)**
   Electric field, magnetic field, inductance and capacitance concepts relevant to transmission lines)
6. **Engineering Mathematics**
   Matrix algebra, linear equations, and their properties.
7. **Control Systems (Basic Concepts)**
   Elementary knowledge of conventional and modern control systems.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL601.1	Apply the per unit system and single line diagrams for modeling and analysis of interconnected power systems.	3
EEUL601.2	Analyze power flow and losses in power systems using Gauss–Seidel, Newton–Raphson, and Fast Decoupled load flow methods.	4
EEUL601.3	Model and analyze symmetrical and unsymmetrical faults in power systems using bus impedance matrix and symmetrical components.	4
EEUL601.4	Analyze rotor angle stability of power systems under steady-state and transient conditions using swing equation and equal-area criterion.	4
EEUL601.5	Analyze economic dispatch of generation to evaluate the impact of generator limits and transmission losses on optimal operating cost.	4

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Switchgear and Protection	**Course Code**: EEUL602	**Credit**: 2
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (30) + TW & SL(30) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**System Protection:**Protective system: Necessity, functions and components, Normal and abnormal conditions. Evolution of protective relays, Zones of protection, Primary and Back–up protection, Essential qualities of protection, Classification of protective schemes, Current transformer and Potential transformer for protection, Basic relay terminology.	6
3	**Relays:**Electromagnetic type Attracted armature and Induction relays, Thermal relay, Overcurrent relay, IDMT relay, Plug Setting Multiple (PSM), Time Multiplier Setting (TMS), Directional relay, Feeder Protection, Relay Coordination. Distance relays, Three zone Impedance/MHO relay, Effect of arc resistance and power swings on distance relay. Differential relay, under-frequency relay, df/dt relay, under-voltage and overvoltage relays, Buchholz relay construction and its operation.	6
4	**Protection of Components:**Introduction to Overcurrent protection and Differential protection, Generator protection, Transformer protection, Buszone protection, Transmission line protection, Pilot relaying schemes, Carrier current protection.	6
5	**Circuit Breaking:**Properties of arc, Arc extinction theories, Re-striking Voltage, Recovery voltage, Resistance switching, Current chopping, Capacitive current interruption, Circuit breaker ratings, Classification of circuit breakers, Constructional features and operation of different types of circuit breakers, Selection of circuit breakers, Rating of circuit breakers, Testing of circuit breakers.	6
6	**Modern Trends in Protection:**Static Relays: Comparison with electromagnetic relay, Classification and their description, Static relays functional circuits: Comparators, Level detectors, Logic and training circuits, Microprocessor and Computer based protection schemes, Software development for protection, Security and reliability.	5
Total		**30**

Textbooks:

1. Switchgear Protection and Power Systems, S. S. Rao, 14th Edition (2025), Khanna Publishers
2. Power System Protection and Switchgear, B. Ram and D.N Vishwakarma, 3rd Edition (2023), McGraw Hill Education
3. Power system Protection and Switchgear, B. Ravindranath and M. Chander, 4th Edition (2020), New Age International Publishers

Reference Books:

1. Power System Protection, P.M. Anderson, 1st Edition (1999), IEEE Press
2. Power System Protection & Switchgear, B.A. Oza, N.C. Nair, R.P. Mehta, et al., 1st Edition (2010), Tata McGraw Hill
3. Protection of power system, U. A. Bakshi and M. V Bakshi, 1st Edition (2009), Technical publications
4. Protection and Switchgear, B. Bhalja, R.P. Maheshwari, and N.G. Chothani, 1st Edition (2011), Oxford Higher Education
5. Power System Protection Static Relays with microprocessor applications, T S M Rao, 2nd Edition (2008), Tata McGraw Hill

Prerequisite:

1. Basic Electrical Engineering
2. Electrical Measurement & Instrumentation
3. Power System

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL602.1	Understand the fundamentals of power system protection, including protective relays, protection schemes, current and potential transformers.	2
EEUL602.2	Apply the principles of various types of relay for power system protection.	3
EEUL602.3	Demonstrate the application of protection schemes for power system components.	3
EEUL602.4	Analyze the operational mechanisms, testing methodologies, and diverse classifications of circuit breakers.	4
EEUL602.5	Evaluate contemporary advancements and emerging paradigms in power system protection.	5

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Artificial Intelligence and Techniques	**Course Code**: EEUL603	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**INTRODUCTION:** Objective, scope and outcome of the course.	1
2	**Introduction to AI and Intelligent agent:** What is AI, Foundation of AI and its history, Agents and Environment, Ethics and Legal Issues in AI, Applications of AI to Electrical Engineering, Different Approach of AI.	8
3	**Knowledge and Reasoning**: Building a Knowledge Base: Propositional logic, first order logic, situation calculus. Theorem Proving in First Order Logic. Planning, partial order planning. Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks.	8
4	**Problem Solving:** Solving Problems by Searching, Uninformed search, BFS, DFS, Iterative deepening, Bi directional search, Hill climbing, Informed search techniques: heuristic, Greedy search, A* search, AO* search, constraint satisfaction problems. Learning: Learning from Observations, Forms of Learning, Inductive Learning, Learning Decision Trees, Why Learning Works, Learning in Neural and Belief networks.	10
5	**Artificial Neural Networks (ANN) for Control:** Introduction: History of Neural Networks, Structure and Functions of Biological and Artificial Neuron, Neural Network Architectures, Characteristics of ANN, Basic Learning Laws and Methods. Neuron models, multilayer networks, back propagation.	8
6	**Introduction to Green AI and Sustainable Computing**: Understanding the concept of Green AI, Exploring the intersection of artificial intelligence and sustainability Principles of sustainable computing, Environmental impacts of AI and computing technologies, Case studies highlighting the importance of green AI in various sectors	10
Total		**45**

Textbooks:

1. Artificial Intelligence: A Modern Approach, *Stuart Russell and Peter Norvig, 3rd Edition, 2010, Pearson Education.*
2. Artificial Intelligence, *Elaine Rich, Kevin Knight, and Shivashankar B. Nair, 3rd Edition, 2009, McGraw Hill Education.*
3. Probability and Statistics for Machine Learning and Data Science, *Anirban DasGupta, 2011, Springer.*
4. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, *Trevor Hastie, Robert Tibshirani, and Jerome Friedman, 2nd Edition, 2009, Springer.*

Reference Books:

1. Intelligent Systems: Architecture, Design & Control – A. Ghosh – 2020 – McGraw Hill
2. An Introduction to Neural Networks – Kevin Gurney – 2018 – Routledge

Prerequisite:

- Engineering Mathematics
- Basics of Matrices and vectors
- Fundamentals of optimization
- Basic programming (MATLAB/Python preferred)

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL603.1	Understand principles and structures of artificial intelligence	2
EEUL603.2	Apply problem-solving techniques, search algorithms, and knowledge representation methods used in AI.	3
EEUL603.3	To develop an understanding of intelligent agents, reasoning under uncertainty, and decision-making processes.	3
EEUL603.4	To familiarize students with machine learning basics, including supervised and unsupervised learning techniques.	3
EEUL603.5	To apply AI techniques to real-world engineering and societal problems ethically and effectively	3

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Smart Mobility & EV Infrastructure	**Course Code**: EEUL611	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Smart mobility and intelligent transportation systems (ITS):** Concepts, evolution of transportation. Urban mobility challenges, Role of EVs in sustainable cities. Shared and connected mobility.	6
3	**EV Charging Infrastructure:** AC/DC charging, levels, standards (CCS, CHAdeMO, Bharat), station design, metering, protection and communication protocols,load impact on distribution systems.	8
4	**Smart Grid Integration and Energy Management:** Vehicle-to-Grid (V2G), Vehicle-to-Home (V2H), Vehicle-to-Building (V2B), renewable integration (solar, wind), energy management systems, optimization techniques, power system impact studies, ancillary services.	10
5	**Communication, Control & Cybersecurity**: Controller Area Network (CAN), Local Interconnect Network (LIN), Internet of Things (IoT), cloud-based monitoring, smart charging strategies, cybersecurity protocols, data analytics, AI-assisted EV energy management.	10
6	**Policy, Planning & Future Trends:** Government policies (India & global), economic models, planning and siting, cost/tariff analysis, emerging technologies (wireless charging, autonomous mobility, AI traffic systems), environmental & sustainability assessment.	10
Total		**45**

Textbooks:

1. 1.Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, 3rd Edition (2018), CRC Press
2. 2.Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, 3rd Edition (2021), CRC Press

Reference Books:

1. 1 Advanced Hybrid and Electric Vehicles: System Optimization and Vehicle Integration, Michael Nikowitz, 1st Edition (2016), Springer
2. 2.Electric Vehicle Technology Explained, James Larminie & John Lowry, 2nd Edition (2012), Wiley
3. 3.Modern Electric Vehicle Technology, C.C. Chan & K.T. Chau, 1st Edition (2001), Oxford University Press

Prerequisite:

- **Basic Electrical Engineering:** Understanding of power systems, circuits, and electrical machines.
- **Power Electronics:** Fundamentals of power converters and control.
- **Control Systems:** Basic concepts in control theory and system modeling.
- **Communication Networks:** Introduction to communication protocols and networking.
- **Renewable Energy Systems:** Basic knowledge of renewable energy integration.
- **Cybersecurity Fundamentals:** Basics of cybersecurity concepts for smart grids.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL611.1	Analyze smart mobility systems and evaluate the role of EVs in sustainable urban transportation.	4
EEUL611.2	Evaluate EV charging infrastructure, standards, station design, and impact on distribution systems.	5
EEUL611.3	Design and assess integration strategies of EVs with smart grids, including V2G/V2H, renewable energy, and energy management systems.	5
EEUL611.4	Apply communication, IoT, and cybersecurity techniques to EV infrastructure for monitoring, control, and AI-based optimization.	3
EEUL611.5	Assess policies, economic models, planning strategies, and emerging technologies for sustainable deployment of EVs and smart mobility systems.	5

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Modern Control Theory	**Course Code**: EEUL612	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**INTRODUCTION:** Objective, scope and outcome of the course.	1
2	**Introduction to Modern Control System:** Modern Vs conventional control theory, concept of state, state variable state vector, state space, state space equations, Writing state space equations of mechanical, Electrical systems, Analogous systems(both).	9
3	**State Space Representation:** State Space Representation using physical and phase variables. Block diagram and Signal flow graph representation of state model. Companion Forms of State Models State space representation using canonical variables. Diagonal matrix. Jordan canonical form, Derivation of transfer functions from state-model	10
4	**Solution of State Equations:** Eigenvalues and Eigen vectors Matrix. State transition matrix and its Properties. Computation of State transition matrix using infinite series, Laplace transform and Cayley-Hamilton Theorem Methods, Solution of State and Output Equations. Concepts of controllability &observability, Pole placement by state feedback and Ackermann's Formula	8
5	**Digital Control Systems:** Introduction, digital and sampled data control systems, signal reconstruction, difference equations. **The z-transform**, inverse Z-transform and its properties, z and s domain relationship, Block diagram analysis of sampled data systems.	8
6	**Stability of Digital Control Systems:** Modeling of sample-hold circuit, steady state accuracy, stability in z-plane and Jury stability criterion, bilinear transformation, Routh-Hurwitz criterion on s-planes, Design of digital PID controllers,	9
Total		**45**

Textbooks:

1. Modern Control Systems, Richard C. Dorf and Robert H. Bishop, 13th Edition (2017), Pearson Education.
2. Modern Control Engineering, Katsuhiko Ogata, 5th Edition (2010), Prentice Hall of India.
3. Control Systems Engineering, Norman S. Nise, 7th Edition (2015), Wiley India.
4. Modern Control Theory, William L. Brogan, 3rd Edition (2012), Pearson Education.

Reference Books:

1. State Space and Control Systems, C. T. Chen, 1st Edition (2018), Oxford University Press
2. Linear System Theory and Design, Chi-Tsong Chen, 4th Edition (2013), Oxford University Press.
3. Control Systems: Theory and Applications, SamarjitGhosh, 2nd Edition (2016), Pearson Education.
4. Feedback Control of Dynamic Systems, Gene F. Franklin, J. David Powell, Abbas Emami-Naeini, 7th Edition (2015), Pearson Education.
5. Digital Control of Dynamic Systems, Gene F. Franklin, J. David Powell, Michael L. Workman, 3rd Edition (2014), Pearson Education.

Prerequisite:

1. Basic understanding of **classical control theory** (transfer function approach, block diagrams, stability criteria).
2. Knowledge of **Laplace transforms**, **differential equations**, and **linear system analysis**.
3. Familiarity with **matrix algebra**, including determinants, eigenvalues, and eigenvectors.
4. Basic knowledge of **electrical and mechanical system modeling**.
5. Exposure to **signals and systems concepts** (time invariance, causality, linearity).

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL612.1	Understand the concepts of linear vector space, linearity, causality, time invariance, and the state-space approach in control system analysis.	2
EEUL612.2	Develop state-space models of electrical, mechanical, and analogous systems, and derive transfer functions from state equations.	3
EEUL612.3	Analyze system dynamics using state-space representation, state transition matrix, eigenvalues, and eigenvectors.	4
EEUL612.4	Evaluate controllability and observability of systems and design state feedback controllers using pole placement techniques.	4
EEUL612.5	Apply digital control concepts, including z-transform, stability analysis in z-plane, and design of digital controllers such as PID.	4

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name : Electrical Machine Design	**Course Code**: EEUL613	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**INTRODUCTION:** Objective, scope and outcome of the course.	1
2	**Design Considerations**: Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.	9
3	**Transformers:** Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, methods for cooling of transformers.	9
4	**Induction Motors:** Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly-phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.	9
5	**Synchronous Machines:** Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field MMF, design of field winding, , rotor design.	9
6	**Computer Aided Design (CAD):** Limitations (assumptions) of traditional designs, need for CAD-based analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation**,** introduction to FEM-based AD/CAE tools for electromagnetic and thermal analysis used in industry**.** PMSMs, BLDCs, SRM and claw-pole machines, overview of industrial applications of modern machines in EVs, renewable energy systems and automation**.**	8
Total		**45**

Textbooks:

1. A Course in Electrical Machine Design by A. K. Sawhney, 6th Edition, Dhanpat Rai & Co., 2016, ISBN-10: 8177001019, ISBN-13: 978-8177001013.
2. Design of Electrical Machines by K. G. Upadhyay, 1st Edition, New Age International (P) Ltd., 2018, ISBN-13: 978-8122422825.
3. Theory & Performance of Electrical Machine Design by N. K. Datta, 1st Edition, 2016 (Reprinted 2025), S.K. Kataria& Sons, ISBN-13: 978-9350145746.

Reference Books:

1. Design of Electrical Machines by V. N. Mittle& A. Mittal, 5th Edition, N.C. Jain / Standard Publishers Distributors, 2002, ISBN-10: 8180141268, ISBN-13: 978-8180141263.
2. Electrical Machine Design by V. S. Nagarajan, 1st Edition, Pearson Education, 2018, ISBN-13: 978-9332585577, ISBN-10: 9332585571.

Prerequisite:

1. Basic knowledge of electrical circuits and instrumentation.
2. Fundamentals of Electrical Machine I and Electrical Machine II.
3. Basic knowledge of Programming.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL613.1	Apply appropriate engineering material selection criteria and standard design considerations to electrical machines for given operating requirements.	3
EEUL613.2	Analyze the performance characteristics and operational requirements of a transformer using standard parameters, losses, and constraints.	4
EEUL613.3	Analyze the stator and rotor parameters of an induction motor by examining the associated electrical and mechanical characteristics based on given specifications.	4
EEUL613.4	Analyze the overall dimensions and detailed rotor parameters of a synchronous machine to evaluate their suitability in meeting the given specifications.	4
EEUL613.5	Analyze the assumptions and limitations of traditional electrical machine design methods and justify the need for CAD-based design tools.	4

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Renewable Energy Engineering	**Course Code**:EEUL614	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction to Renewable Energy & Global Sustainability Goals** Energy demand, fossil fuel depletion, climate change and environmental impacts; United Nations Sustainable Development Goals (SDGs) and global agreements, Environmental policies and frameworks: Kyoto Protocol, Paris Agreement, National Solar Mission & Policy, Bio-energy policy and waste-to-energy frameworks, National policy on Hydropower in India, Life cycle analysis and carbon footprint.	8
3	Solar Energy Systems Solar radiation and measurement, PV cell types, efficiency, system design, Energy storage: batteries, thermal storage, Economic viability and sustainability of solar systems, Solar case studies & recent innovations (Building-Integrated Photovoltaics, AI-based PV monitoring). Solar parks, green corridors for evacuating bulk power.	9
4	Wind and Hydropower Systems Wind energy fundamentals: wind profiles, site selection, performance characteristics, capacity factor, Design considerations, environmental and socio-economic impacts. Hydropower: Environmental impact assessments and social implications, case studies and innovations: wind farms / small hydropower plants.	9
5	Hybrid Systems, Smart Grids & Emerging Technologies Hybrid renewable systems: Solar-wind, Solar-biomass. Smart grid architecture, demand response, energy management. Energy storage: batteries, recent developments in batteries, pumped hydro, flywheels, supercapacitors. Role of AI and Machine Learning in energy optimization; IoT in smart renewable energy systems and microgrids. Cybersecurity concerns in renewable energy.	9
6	Policy, Economics & Future of Renewable Energy Techno-economic analysis of renewable energy systems, Levelized cost of energy (LCOE), payback period, subsidies, Financing models and public-private partnerships, Decentralized systems and energy access in rural areas, Future directions: Green hydrogen, carbon capture, bio-energy innovations.	9
Total		**45**

Textbooks:

1. Renewable Energy Engineering and Technology: Principles and Practice, V.V.N. Kishore, 2nd Edition (2021), TERI Press
2. Fundamentals of Renewable Energy Systems, D. Mukherjee and S. Chakrabarti, 2nd Edition (2018), New Age International Publishers

Reference Books:

1. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, 4th Edition (2019), Oxford University Press
2. Solar Energy: Principles of Thermal Collection and Storage, S.P. Sukhatme and J.K. Nayak, 4th Edition (2020), McGraw Hill Education
3. Smart Grids: Infrastructure, Technology, and Solutions, Stuart Borlase, 2nd Edition (2017), CRC Press

Prerequisite:

1. Basics of Electrical Machines
2. Basic principles and concepts of thermodynamics incorporating energy analysis, heat engines and pumps, thermodynamic cycles, and properties of working fluids.
3. Environmental Studies include energy resources, environmental impact assessment, sustainability, climate change, ecology, pollution control, and environmental laws.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL614.1	Elucidate the role of renewable energy in achieving sustainable development goals and mitigating climate change.	2
EEUL614.2	Design and evaluate solar, wind, and hydropower systems with respect to technical, economic, and environmental parameters.	5
EEUL614.3	Analyze hybrid energy systems, storage solutions, and smart grids for decentralized energy deployment.	4
EEUL614.4	Evaluate the integration of emerging technologies (AI and IoT) in renewable energy optimization.	5
EEUL614.5	Examine the role of policy, economics, and environmental regulations in the deployment of renewable energy systems.	3

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Power System Planning	**Course Code**: EEUL615	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**INTRODUCTION:** Objective, scope and outcome of the course.	1
2	**Introduction to Power Planning:** Overview of power system planning and planning principles. Planning process. National and regional power planning approaches. Structure of power systems: generation, transmission, distribution, and deregulated electricity markets. Planning tools and decision-support systems. Electricity regulation and policies.Load requirement and system load concepts. Electricity forecasting and modeling. Short-, medium-, and long-term forecasting techniques. Spatial load forecasting. Introduction to AI/ML-based load forecasting methods: ANN, regression, time-series, and hybrid models.	8
3	**Power System Reliability:** Definition and importance of reliability. Reliability, adequacy, and security. Causes of power system outages. Need for reliability planning. Reliability targets. Functional Zones, Planning reliability vs operational reliability. Power system security requirements. Reliability parameters: failure rate (λ), repair rate (μ), MTTF, MTTR, MTBF. Impact of renewable energy sources, disaster management, and peak demand on reliability planning.	9
4	**Generation Planning:** Objectives and factors affecting generation planning. Conventional and renewable energy sources. Integrated Resource Planning (IRP). Generation system modeling and capacity expansion planning. Generation reliability indices: load duration curve, LOLP, LOLE, EENS. Outage management, maintenance planning, interconnection of power systems, and regional coordination.	9
5	**Transmission & Distribution Planning:** Transmission planning objectives and methodologies. Right-of-way issues and reactive power (VAr) planning. Distribution system planning and expansion. Network reconfiguration: objectives, constraints, and benefits. Radial and meshed distribution networks. System and load-point reliability. Composite system reliability. Interruption indices: SAIFI, SAIDI, CAIDI. Urban distribution, rural electrification, and self-generation.	9
6	**Demand Side Planning & Environmental Impacts:** Demand-side planning concepts. Demand response programs and technologies. Environmental impact of electricity generation. Global environmental issues. Life-cycle analysis. Carbon trading and emission reduction mechanisms.	9
	Total	**45**

Textbooks:

1. Power System Planning, R. L. Sullivan, 2nd Edition (2022), Wiley–IEEE Press.
2. Modern Power System Planning, Xifan Wang, 1st Edition (2023), Springer.
3. Electric Power System Planning: Issues, Algorithms and Solutions, Mohammad Shahidehpour, HamedYamin, Zuyi Li, 2nd Edition (2022), Springer.
4. Power System Planning Technologies and Applications: Concepts, Solutions, and Management, FawwazElkarmi and Nazih Abu Shikhah, 1st Edition (2010), Wiley–IEEE Press.
5. Power System Reliability and Planning, RohitManglik, 1st Edition (2024), EduGorilla Publications.
6. Electric Power Distribution, A. S. Pabla, 6th Edition (2011), McGraw-Hill Education.

Reference Books:

1. Power Distribution Planning Reference Book, H. Lee Willis, 3rd Edition (2020), CRC Press.
2. Electric Power System Planning: Issues, Algorithms and Solutions, Mohammad Shahidehpour, HamedYamin, Zuyi Li, 2nd Edition (2022), Springer.
3. Distribution System Modeling and Analysis, William H. Kersting, 4th Edition (2018), CRC Press.
4. Smart Grid Planning and Implementation, James Momoh, 1st Edition (2019), Springer.
5. Reliability Evaluation of Power Systems, Roy Billinton and Ronald Allan, 2nd Edition (2013), Springer.
6. Power System Planning with Renewable Energy and Storage, Bikash Pal and BalarkoChaudhuri (Editors), 1st Edition (2021), IET Digital Library.

Prerequisite:

1. Basic Electrical Engineering
2. Power Systems Fundamentals
3. Electrical Machines
4. Control Systems & Optimization
5. Electrical Measurements & Instrumentation

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL615.1	Explain the fundamentals of power system planning, planning processes, regulatory framework, and electricity forecasting techniques including basic AI/ML-based load forecasting methods.	2
EEUL615.2	Analyze power system reliability concepts, adequacy and security requirements, reliability indices, and the impact of renewable integration, peak demand, and disasters on system reliability.	4
EEUL615.3	Apply generation planning concepts, integrated resource planning, capacity expansion methods, and generation reliability indices to evaluate power system adequacy.	3
EEUL615.4	Assess transmission and distribution planning methodologies, network reconfiguration techniques, reliability indices, and urban–rural electrification challenges.	5
EEUL615.5	Evaluate demand-side planning strategies, demand response programs, and environmental impacts of electricity generation including life-cycle analysis and carbon trading mechanisms.	5

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Electrical Energy Conservation and Audit	**Course Code**: EEUL616	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**INTRODUCTION:** Objective, scope and outcome of the course.	1
2	**Energy Scenario**: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features. Bureau of Energy Efficiency in India and its Role	8
3	**Basics of Energy and its Various Forms**: Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.	8
4	**Energy Management & Audit Definition**, energy audit, need, 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, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.	9
5	**Energy Efficiency in Electrical Systems**: Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.	10
6	**Energy Efficient Technologies in Electrical Systems**: Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.	9
Total		**45**

Textbooks:

1. Handbook on Energy Audit, Sonal Desai, 2nd Edition (2019), McGraw Hill Education.
2. Energy Management Handbook, Wayne C. Turner and Steve Doty, 8th Edition (2020), Wiley.
3. Energy Management and Conservation, Amit Kumar Tyagi, 2nd Edition (2018), CRC Press / Taylor & Francis.
4. Energy Conversion Systems, Rakosh Das Begamudre, 2nd Edition (2018), New Age International.
5. Energy Efficiency and Renewable Energy through Buildings, Boaz Beeri, 1st Edition (2019), Springer.
6. Energy Economics: Concepts, Issues, Markets and Governance, Subhes C. Bhattacharyya, 2nd Edition (2019), Springer.

Reference Books:

1. Handbook of Energy Audits, Albert Thumann, William J. Younger and Terry Niehus, 10th Edition (2020), CRC Press.
2. Guide to Energy Management, Barney L. Capehart, Wayne C. Turner, William J. Kennedy, 8th Edition (2020), Fairmont Press.
3. Industrial Energy Management, K. C. Arora and S. Domkundwar, 2nd Edition (2017), Khanna Publishers.
4. Energy Management Systems: ISO 50001 and Beyond, Giovanni Petrecca, 1st Edition (2014), Springer.
5. Sustainable Energy Systems Engineering, Francis Vanek, Louis Albright, 2nd Edition (2016), McGraw Hill Education.
6. Energy Auditing and Management, Y. P. Abbi and Shashank Jain, 2nd Edition (2021), CRC Press.

Prerequisite:

1. Basic understanding of electrical and mechanical systems.
2. Knowledge of electrical circuits, power systems, and energy generation.
3. Familiarity with measurements and instrumentation.
4. Awareness of industrial processes and building energy usage.
5. Fundamental knowledge of mathematics for energy analysis and financial calculations.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL616.1	Understand the national and global energy scenario, energy resources, and the importance of energy conservation and policies.	2
EEUL616.2	Apply the fundamentals of electrical and thermal energy systems for efficient energy utilization.	4
EEUL616.3	Conduct energy audits to analyze energy consumption and identify energy-saving opportunities.	4
EEUL616.4	Evaluate energy efficiency in electrical systems.	3
EEUL616.5	Recommend and adopt energy-efficient technologies and practices for sustainable energy management.	3

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Power System Design Lab.	**Course Code**: EEUP620	**Credit**: 1.5
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 3 Hrs	**Teaching Scheme:** LI(45) hrs. per semester	

Module No.	Contents
1.	To Perform load flow analysis on multi-bus power system using suitable software. Analyze bus voltages, power flows, and transmission losses to identify weak buses and assess system operating performance.
2.	To perform fault analysis on a given multi-bus power system test network. Analyze fault currents and fault MVA under different fault conditions to assess system security and equipment ratings.
3.	To solve the economic load dispatch problem for a given multi-generator thermal power system. Analyze generation sharing and total fuel cost under varying load demand and transmission loss conditions.
4.	To model a single-machine infinite bus (SMIB) system and apply a large disturbance. Analyze rotor angle and speed response to assess system transient stability limits.
5.	To develop a power system model with renewable energy integration and assess its influence on system performance parameters.
6.	To study and evaluate Voltage Enhancement at system buses using shunt capacitors.
7.	To simulate the IEEE 9-bus power system and assess its performance under steady-state operating conditions.
8.	To model and analyze the impact of FACTS devices on voltage profile, reactive power flow, transmission losses, and power transfer capability in a multi-bus power system.

Text Books:

1. Power System Analysis, HadiSaadat, 3rd Edition (2011), McGraw-Hill Education.
2. Power System Analysis and Design, J. Duncan Glover, Thomas Overbye, Mulukutla S. Sarma, 6th Edition (2017), Cengage Learning

Reference Books:

1. Modern Power System Analysis., I. J. Nagrath, D. P. Kothari, 4th Edition (2011), McGraw-Hill Education
2. Power System Analysis: Theory and Practice, A. Chakrabarti, SunitaHalder, 3rd Edition (2018), PHI Learning
3. Power Generation, Operation, and Control, Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé, 3rd Edition (2013), Wiley
4. Electrical Power Equipment Maintenance and Testing – Paul Gill, Second Edition, 2018, CRC Press.
5. MATLAB for Engineers – Applications in Power Systems, Ashfaq Husain, 1st Edition (2014), Pearson India

Prerequisite:

1. Fundamental knowledge of power system components such as generators, transformers, transmission lines, and loads, acquired through prior coursework in Electrical Machines and Basic Power Systems.
2. Understanding of power system analysis concepts, including per-unit system, network modeling, load flow, short circuit analysis, and basic stability concepts.
3. Basic proficiency in numerical methods and optimization fundamentals, relevant to solving economic load dispatch and unit commitment problems.
4. Working knowledge of MATLAB or equivalent simulation tools, including basic programming, matrix operations, and result interpretation.
5. Ability to read and interpret single-line diagrams and apply standard IEEE test system data for power system modeling and analysis.
6. Operation and characteristics of three-phase induction motors, Starting methods of induction motors (Star-Delta, DOL, R-DOL), Basic protection and maintenance practices of electrical equipment.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUP620.1	Evaluate steady-state performance of multi-bus power systems using load flow techniques, including renewable integration and FACTS devices.	5
EEUP620.2	Evaluate fault currents and fault MVA under various fault conditions in multi-bus power systems to assess system security and equipment ratings.	5
EEUP620.3	Assess economic load dispatch solutions for multi-generator power systems, considering varying load demand and transmission losses.	5
EEUP620.4	Assess transient stability performance of a single-machine infinite bus system by examining rotor angle and speed response under large disturbances.	5
EEUP620.5	Evaluate the steady-state performance of power systems by simulating standard test networks and analyze Voltage Enhancement at system buses to improve voltage profile and overall system performance.	5

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Energy Systems Lab	**Course Code**: EEUP621	**Credit**: 1.5
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** LI(45) hrs. per semester	

Module No.	Contents
1	To determine the I-V & P-V characteristics of a Solar PV module at different irradiances.
2	To determine the I-V & P-V characteristics of the Series and parallel configuration of PV modules.
3	To observe the shadowing effect and the diode-based solution on the Solar PV Module/Array.
4	To analyze the performance of the Maximum Power Point Tracking (MPPT) controlled DC–DC converter in PV system under different operating conditions.
5	To observe characteristics of wind velocity and generator power using wind turbine.
6	To analyze the effect of pitching (blade angles) on the performance of the wind turbine.
7	To analyze the performance of the MPPT charge controller in wind turbine system.
8	To model a wind turbine and analyze power output, system voltage profile, and overall system performance.
9	To simulate a hybrid wind-solar power generation system and analyze overall system performance.
10	To simulate a hybrid microgrid (PV + Battery + Wind) power system and analyze overall system performance.
11	To perform an Energy Audit of a small industry/ building, etc. and analyze the cost-benefit.

Textbooks:

1. Hybrid Renewable Energy Systems and Microgrids, ErsanKabalci, ISBN: 9780128217245, 2020, Academic Press.
2. Wind and Solar Energy Systems, KumariNamrata, R. P. Saini, D. P. Kothari, 2024, Springer.
3. Solar Hybrid Systems: Design and Application, AhmetAktas, YagmurKircicek, ISBN: 9780323885003, 2021, Academic Press.

Reference Books:

1. Integration of Renewable Energy Sources into the Power Grid ThroughPowerFactory, MortezaZareOskouei, BehnamMohammadi-Ivatloo, 2020, Springer.
2. Handbook of Energy Audits – 9th Edition, Albert Thumann, Terry Niehus& William J. Younger, ISBN: 9781003151722, 2020, Taylor & Francis.
3. Wind Energy Systems: Control, Optimization, and Market Strategies, Chun Wei, Dongliang Xiao, XiaoqingBai, Zhe Zhang, ISBN:9780443363535, 0443363536, 2025, Academic Press.

Prerequisite:

1. Basic electrical engineering concepts.
2. Fundamentals of Solar PV.
3. Fundamentals of wind energy and turbine characteristics.
4. Knowledge of hybrid systems and microgrids.
5. Basic ETAP/MATLAB simulation skills.
6. Basics of energy auditing.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL622.1	Analyze PV module characteristics under varying irradiance and configurations.	4
EEUL622.2	Apply MPPT control methods to operate a DC–DC converter and determine its performance.	3
EEUL622.3	Analyze wind turbine characteristics and variations in power output.	4
EEUL622.4	Assess simulated PV, wind, and hybrid systems for power flow and overall performance.	5
EEUL622.5	Evaluate energy audit data to determine consumption patterns and cost–benefit outcomes.	5

Syllabus

Name of the Program: B.Tech. in Electrical Engineering	**Year**: III Year	**Semester**: VI
Course Name: Embedded System and IOT Lab	**Course Code**: EEUP622	**Credit**: 1.5
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme** LI(45) hrs. per semester	

Module No.	Contents
1	To understand embedded system development environment and execute a basic microcontroller program using standard tools and hardware platforms.
2	To apply digital input output programming concepts by developing a microcontroller program to blink an LED with precise timing control.
3	To apply analog to digital conversion concepts for reading, processing, and analyzing sensor signals using microcontroller ADC peripherals.
4	To apply motor control principles by programming microcontroller interfaces for speed and position control of DC and servo motors.
5	To interface OLED or LCD displays with microcontrollers for displaying sensor data, messages, and system status information.
6	To implement UART, SPI, and I2C communication protocols for reliable data exchange between microcontrollers and peripheral devices.
7	To interface temperature and humidity sensors with IoT microcontrollers for real-time environmental monitoring applications.
8	To design sensor-based automation systems by controlling devices using light intensity or proximity sensor inputs.
9	To implement wireless appliance control systems using Wi-Fi enabled IoT modules and remote command interfaces.
10	To implement MQTT protocol for publishing and subscribing sensor data in IoT-based communication systems efficiently.
11	To log, analyze, and visualize IoT sensor data on cloud platforms for real-time monitoring and decision making.
12	To design an embedded system for monitoring and displaying electrical energy consumption or load parameters accurately.
13	To design and implement a mini IoT project integrating sensors, actuators, communication protocols, and cloud services.

Textbooks:

- Embedded Systems: A Contemporary Design Tool, James K. Peckol, 2nd Edition (2019), John Wiley & Sons.
- Getting Started with Arduino, Massimo Banzi& Michael Shiloh, 4th Edition (2024), LLC Publisher.
- Internet of Things: A Hands-On Approach, ArshdeepBahga& Vijay Madisetti, 1st Edition (2015), Universities Press.
- Internet of Things with ESP8266, Marco Schwartz, 1st Edition (2016), Packt Publishing Limited.

Reference Books:

- The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Rolin D. McKinlay, Janice G. Mazidi, 2nd Edition (2007), Pearson Prentice Hall.
- Embedded C Programming and the Atmel AVR, Richard H. Barnett, Sarah Cox & Larry O'Cull, 2nd Edition (2006), Cengage Learning.
- Mastering Embedded Systems Programming, Frank Vahid, 1st Edition (2011), UniWorld Publishing.
- Programming Arduino: Getting Started with Sketches, Simon Monk, 3rd Edition (2019), Simon & Schuster Publisher.

Prerequisite

- Basic Electronics & Electrical Circuits – Understanding resistors, capacitors, voltage/current relationships.
- Digital Logic – Understanding logic gates, digital I/O.
- Programming Skills – Basics of C/C++/Python for microcontroller coding.
- Networking Basics – IP addressing, WiFi communication, MQTT concepts.
- Electrical Measurements – Using multimeter, current, and voltage sensors.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUP623.1	Apply microcontroller programming techniques to interface and operate sensors and actuators in embedded systems.	3
EEUP623.2	Analyze and design optimized embedded system solutions for real-time applications.	4
EEUP623.3	Analyze and integrate IoT modules for effective data acquisition and remote monitoring.	4
EEUP623.4	Evaluate and troubleshoot embedded systems using standard debugging techniques.	5
EEUP623.5	Evaluate and present experimental results through effective technical documentation.	5

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Python Lab	**Course Code**: EEUP623	**Credit**: 1.5
Max Marks: 100	**CIE:** 60	**SEE:** 40
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** LI(45) hrs. per semester	

Module No.	Contents
1	**Python Basics** 1. Write a Python program to print a) "Hello World" b) Student name, roll number, and branch. 2. Write a Python program to demonstrate the use of variables, different data types, arithmetic operators, and expressions. 3. Write a Python program to evaluate simple electrical expressions such as voltage, current, and power using given inputs. 4. Write a Python program using conditional statements (if–else) to check whether the given number is positive, negative, or zero. 5. Write a Python program using loops (for and while) to generate multiplication tables and number series. 6. Write a Python program to demonstrate the use of break and continue statements.
2	**Functions and Data Structures** 1. Write a Python program to define and use user-defined functions for basic mathematical operations. 2. Write a Python program to demonstrate module usage by importing the math module and performing trigonometric and power operations. 3. Write a Python program to perform operations on lists, such as creation, insertion, deletion, sorting, and searching. 4. Write a Python program to demonstrate tuple operations and tuple immutability. 5. Write a Python program to create and manipulate dictionaries for storing electrical quantities and their values. 6. Write a Python program to demonstrate set operations such as union, intersection, and difference.
3	**Numerical Computation and Plotting** 1. Write a Python program using NumPy to create arrays and perform basic matrix operations. 2. Write a Python program using NumPy to solve simultaneous linear equations. 3. Write a Python program to perform complex number operations relevant to AC circuit analysis. 4. Write a Python program using Matplotlib to plot a) Voltage waveform b) Current waveform c) Power waveform. 5. Write a Python program to plot phasor diagrams of voltage and current.

	6. Write a Python program to plot frequency response characteristics of a given system. 7. Write a Python program using SymPy to solve algebraic equations. 8. Write a Python program using SymPy to find derivatives and integrals of given mathematical expressions.
4	**Data Analysis and File Handling** 1. Write a Python program to read data from a text file and display its contents. 2. Write a Python program to read and write CSV files containing electrical measurement data. 3. Write a Python program using Pandas to analyze experimental data such as transformer load test or motor test results. 4. Write a Python program to compute statistical parameters (mean, median, standard deviation) using Pandas.
5	**Electrical Engineering Applications** 1. Write a Python program to analyze AC circuits by calculating impedance, admittance, power factor, and power. 2. Write a Python program to verify Thevenin's theorem using matrix-based solution. 3. Write a Python program to verify Norton's theorem using Python. 4. Write a Python program to verify Superposition theorem for a given electrical network. 5. Write a Python program to obtain transient response of RL and RC circuits using SciPy ODE solvers. 6. Write a Python program to analyze steady-state response of RLC circuits.
6	**Simulation and Control Applications** 1. Write a Python program to represent transfer functions of control systems. 2. Write a Python program to obtain step response of a given system using Python control library. 3. Write a Python program to plot Bode plots for a given transfer function. 4. Write a Python program to generate sinusoidal signals and compute Fourier Transform using NumPy and SciPy. 5. Write a Python program to implement basic filtering of signals.
7	**Mini Project** Project Ideas: • Simulation of single-phase AC to DC converter output using Python. • Load flow data visualization for a simple power system. • Analysis of sensor data from IoT devices using CSV input. • Energy consumption data analysis and visualization using Python.

Textbooks:

1. Python Programming: A Modern Approach, VamsiKurama, Pearson Education, 2018
2. Learning Python, Mark Lutz, O'Reilly Media, 2013
3. Python for Everybody, Charles R. Severance, 2016
4. Introduction to Computing and Problem Solving using Python, E. Balagurusamy, McGraw Hill Education, 2015

Reference Books:

1. Python Programming for Engineers, James S. Horowitz, Springer, 2017
2. Programming for Computations – Python, SveinLinge& Hans PetterLangtangen, Springer, 2017
3. Think Python: How to Think Like a Computer Scientist, Allen B. Downey, Green Tea Press, 2015
4. Python for Signal Processing, José Unpingco, Springer, 2015
5. Applied Numerical Methods with Python for Engineers and Scientists, Steven C. Chapra, McGraw Hill, 2018

Prerequisite:

1. Basic Computer Knowledge
2. Electrical Engineering Fundamentals

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUP624.1	Understand the fundamentals of Python programming including variables, data types, control structures, and functions..	2
EEUP624.2	Apply Python data structures and libraries such as NumPy, Matplotlib, and SymPy for numerical computation, plotting, and symbolic analysis.	3
EEUP624.3	Analyze and handle experimental or simulated data using file operations and Pandas for effective data visualization and interpretation.	4
EEUP624.4	Apply Python programming to solve and simulate basic electrical engineering problems such as AC circuit analysis, network theorems, and transient responses.	3
EEUP624.5	Examine and interpret control system and signal processing concepts using Python libraries for modeling, response analysis, and frequency-domain representation.	4
EEUP624.6	Design and implement mini-projects integrating Python tools to simulate and visualize real-world electrical systems or data-driven applications.	6

Syllabus

Name of the Programme: B.Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Elements of Smart Grid System	**Course Code**: EEUL660.1	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, Scope and Outcome of the Course	1
2	**Introduction to Smart Grid**: Basics of power systems, definition & need of smart grid, domains & enablers, priority areas, regulatory challenges, smart grid initiatives and activities in India.	8
3	**Smart Grid Architecture & Automation**: Smart grid architecture, standards & policies, control layers & elements, network architectures, IP-based systems, PLC, SCADA, AMI, transmission & distribution automation, renewable integration.	9
4	**Tools & Computational Techniques**: Static & dynamic optimization for power applications, economic load dispatch, computational intelligence, evolutionary algorithms, and AI applications in smart grid.	9
5	**Distributed Generation & Emerging Technologies**: Distributed energy sources, renewable energy integration, microgrids, storage technologies, electric vehicles & plug-in hybrids, environmental & economic issues.	9
6	**Communication & Smart City Applications**: Two-way digital communications, Phasor Measurement Units (PMUs), Wide Area Monitoring System (WAMS), IoT applications in smart grid, smart city pilot projects, active distribution networks, reliability & resiliency, decentralized operations, cyber security and resiliency.	9
	Total	**45**

Textbooks:

1. Smart Grid Fundamentals: Theory, Technologies, and Applications, Anurag K. Srivastava and SayonsomChanda, 1st Edition (2023), McGraw-Hill Education
2. Smart Grids for Smart Cities – Volume 1, O. V. GnanaSwathika, K. Karthikeyan, and SanjeevikumarPadmanaban, 1st Edition (2023), Wiley
3. Smart Grids for Smart Cities – Volume 2, O. V. GnanaSwathika, K. Karthikeyan, and SanjeevikumarPadmanaban, 1st Edition (2023), Wiley
4. Smart Grid: Fundamentals, Design, Technology, Applications, Communication and Security (Indian Adaptation), Wiley Editorial Team, 1st Edition (2021), Wiley India

Reference Books:

1. Smart Grids: Infrastructure, Technology and Solutions, Stuart Borlase, 1st Edition (2013), CRC Press
2. Smart Grid Resilience: Extreme Weather, Cyber-Physical Security, and System Interdependency, Junjian Qi, 1st Edition (2023), Springer
3. Smart Grids—Renewable Energy, Power Electronics, Signal Processing, and Communication Systems Applications, Alfeu J. SguareziFilho et al., 1st Edition (2023), Springer
4. Artificial Intelligence Applications in Smart Grid, Shahid Hussain and Ankit Goel (Editors), 1st Edition (2024), Elsevier

Prerequisite:

1. Basics of Analog and Digital Circuits
2. Basics of Electrical Engineering

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL660.1.1	Elucidate the evolution, concepts and smart grid initiatives.	2
EEUL660.1.2	Analyze smart grid performance enhancement automation technologies (SCADA, AMI)	4
EEUL660.1.3	Evaluate PMUs and WAMS for real-time monitoring of smart grids.	5
EEUL660.1.4	Investigate the integration challenges of DERs/ RES/EVs and its possible outcome.	4
EEUL660.1.5	Assess the applications of IoT and AI in developing active distribution networks and smart city systems	5

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**Year**: III	**Semester**: VI
Course Name: Non-conventional Energy Sources	**Course Code**: EEUL660.2	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction & Solar Radiation Principles:** Role and potential of new and renewable energy sources, Environmental impact of solar power, solar constant, Extra-terrestrial and terrestrial solar radiation, Solar radiation on tilted surfaces, Instruments for measuring solar radiation and sunshine, Interpretation of solar radiation data.	9
3	**Solar Energy Collection, Storage & Applications:** Flat plate and concentrating collectors, Classification of concentrating collectors, Orientation and thermal analysis, Advanced solar collectors, Energy storage methods: Sensible, latent heat, stratified Solar ponds, Solar applications: Solar heating and cooling techniques, Solar distillation and drying, Photovoltaic energy conversion.	9
4	**Wind and Biomass Energy** **Wind Energy**: Sources and potential, Horizontal and vertical axis wind turbines, Performance characteristics, Betz's limit **Biomass Energy**: Bio-conversion principles, Anaerobic/aerobic digestion, Biogas digesters – types and gas yield Combustion characteristics, Applications: cooking, IC engine operations, Economic considerations	9
5	**Geothermal and Ocean Energy** **Geothermal Energy**: Resource availability, Types of geothermal wells, Methods of energy extraction, Geothermal potential in India **Ocean Energy**: OTEC – Principles, plant setup, thermodynamic cycles, Tidal and wave energy – Conversion techniques, Mini-hydel plants – Overview and economic feasibility.	9
6	**Direct Energy Conversion** Need for direct energy conversion (DEC), Limitations of Carnot cycle, Principles and types of DEC systems, Thermoelectric converters, Thermionic converters, Fuel cells, Magneto-hydrodynamic generators.	8
Total		**45**

Textbooks:

1. Renewable Energy Resources, Tiwari and Ghosal, 2nd Edition (2008), McGraw Hill Company, New Delhi
2. Non-Conventional Energy Sources, G.D. Rai, 4th Edition (2009), Khanna Publishers, New Delhi

Reference Books:

1. Renewable Energy Sources, Twidell & Weir, 4th Edition (2009), Tata McGraw Hill Education Pvt. Ltd., New Delhi
2. Solar Energy, S.P. Sukhatme, 3rd Edition (2010), Tata McGraw Hill Education Pvt. Ltd., New Delhi

Prerequisite:

1. A strong understanding of basic thermodynamics enables analysis of energy conversion efficiency and system performance.
2. Engineering Physics: Physical principles behind energy generation and material selection.

Course Outcomes:

Course Code	Course Outcomes	Bloom's Level
EEUL660.2.1	Elucidate the fundamental principles of solar radiation and energy collection systems.	2
EEUL660.2.2	Analyze various solar energy storage methods and applications in real-world scenarios.	4
EEUL660.2.3	Evaluate the performance of wind and biomass energy systems.	5
EEUL660.2.4	Compare different ocean and geothermal energy systems in terms of feasibility and efficiency.	3
EEUL660.2.5	Interpret the working principles of direct energy conversion systems and their limitations.	3