Jabalpur Engineering College, Jabalpur

(Declared Autonomous by MP Govt., Affiliated to RGPV, Bhopal)

(AICTE Model Curriculum Based Scheme)

Bachelor of Technology (B.Tech.) V Semester (Electrical Engineering)

w.e.f. July 2023

S.No.	Subject Code	Category Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours Per Week			Total Credits
				Theory			Practical						
				End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work		L	T	P	
1	EE51	PEC	Professional Elective Course-I	70	20	10	-	-	100	3	1	-	4
2	EE52	PCC	Control System	70	20	10	30	20	150	3	-	2	4
3	EE53	PCC	Electrical Machine-II	70	20	10	30	20	150	3	-	2	4
4	EE54	PCC	Power Electronics-I	70	20	10	30	20	150	3	-	2	4
5	EE55	PCC	Power Sysem-II	70	20	10	-	-	100	3	1	-	4
Total				**350**	**100**	**50**	**90**	**60**	**650**	**15**	2	**6**	**20**
6	EE56	DLC	Self-Learning Presentation (SWAYAM/NPTEL/MOOC)	-	-	-	-	-	-	-	-	-	8
7	EE57	MC	NSS/NCC/Swatchhata Abhiyan/Rural Outreach	Qualifier									
Additional Course for Honours or Minor Specialization				Permitted to opt for maximum 8 credits against additional MOOC courses in subject code EE56 for the award of Honours (Minor Specialization).									

Note: 01. Departmental BOS will decide list of three/four optional subjects those are available in MOOC as well for PEC.

02. MOOC/NPTEL subjects shall be taken with permission of HOD/Coordinator.

Professional Elective Course-I		
S.No.	**Subject Code**	**Subject Name**
1	EE51A	Fundamental of IoT
2	EE51B	Electrical Energy Conservation & Auditing
3	EE51C	Signal & Systems

1 hour lecture (L) = 1 credit | 1 hour Tutorial (T) = 1 credit | 2 hour Practical (P) = 1 credit

PEC: Professional Elective Course, PCC: Professional Core Course, DLC: Distance Learning Course, MC: Mandatory Course,

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		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE51A	Fundamentals of Internet of Things (IoT)	70	20	10	-	-	100	3	1	-	4

FUNDAMENTALS OF INTERNET OF THINGS (IoT)

Module-I:
Introduction: Definition, Characteristics of IoT, IoT Conceptual framework, IoT Architectural view, Physical design of IoT, Logical design of IoT, Application of IoT.

Module-II:
Machine-to-machine (M2M), SDN (software defined networking) and NFV (network function virtualization) for IoT, data storage in IoT, IoT Cloud Based Services

Module-III:
Design Principles for Web Connectivity: Web Communication Protocols for connected devices, Message Communication Protocols for connected devices, SOAP, REST, HTTP Restful and Web Sockets. Internet Connectivity Principles: Internet Connectivity, Internet based communication, IP addressing in IoT, Media Access control.

Module-IV:
Sensor Technology, Participatory Sensing, Industrial IoT and Automotive IoT, Actuator, Sensor data Communication Protocols, Radio Frequency Identification Technology, Wireless Sensor Network Technology.

Module-V:

IoT Design methodology: Specification -Requirement, process, model, service, functional & Operational view. IoT Privacy and security solutions, Raspberry Pi & arduino devices, IoT Case studies: smart city streetlights control & monitoring.

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Text Books:

1. V. Madisetti and A. Bahga, "Internet of things (A-Hand-on-Approach)", Universal Press, First Edition.
2. Rajkamal, "Internet of Things", Tata McGraw Hill publication, Second Edition.
3. A. Pajankar and A. Kakkar, "Raspberry Pi by Example", Packet Publishing Ltd,First Edition.

Reference Books:

1. F. Dacosta, "Rethinking the Internet of things: A Scalable Approach to Connecting Everything", Apress publications, First Edition.
2. D. Norris, "The Internet of Things: Do-It-Yourself Projects with Arduino, Raspberry Pi,and BeagleBone Black", McGraw-Hill Education, First Edition.
3. P. Raj and A.C. Raman, "The Internet of Things", CRC Press (T&F Group), First Edition.

Course Code : EE51A
Course Category: PEC
Course Name : Fundamentals of Internet of Things (IoT)

After completion of this course students will be able to-

CO1: Known basic protocols in sensor networks.

CO2: Program and configure Arduino boards for various designs.

CO3: Python programming and interfacing for Raspberry Pi.

CO4: Design IoT applications in different domains

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Subject Code	Subject Name	Maximum Marks Allotted						Hours/ Week			Total Credits
		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE51B	Electrical Energy Conservation & Auditing	70	20	10	-	-	100	3	1	-	4

ELECTRICAL ENERGY CONSERVATION & AUDITING

Module-I

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.

Module-II

Energy Efficiency in Electrical Systems: Electricity billing, Electrical load management and maximum demand Control, Maximum demand controllers; Power factor improvement, Automatic power factor controllers, efficient operation of transformers, energy efficient motors, Soft starters, Variable speed drives; Performance evaluation of fans and pumps, Flow control strategies and energy conservation opportunities in fans and pumps, Electronic ballast, Energy efficient lighting and measures of energy efficiency in lighting system.

Module-III

Energy auditing: Introduction, Elements of energy audits, different types of audit, energy use profiles, measurements in energy audits, presentation of energy audit results.

Module-IV

Electricity Vs Other Commodities: Distinguishing features of electricity as a commodity, Four pillars of market design: Imbalance, Scheduling and Dispatch, Congestion Management, Ancillary Services. Framework of Indian power sector and introduction to the availability based tariff (ABT).

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Module-V

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.

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.

Text Books:

1. W.C. Turner John Wiley and Sons, "Energy Management Handbook", Sixth Edition.
2. H.E. Jordan, "Energy Efficient Electric Motors and Applications" Plenum Pub. Corp, Second Edition.
3. W. R. Murphy G. Mckay, "Energy Management", Butterworth's, Second Edition.

Reference Books:

1. J. Andrews, N. Jelley, "Energy Science Principles", Technologies and Impact Oxford University Press, Fourth Edition.
2. Shahedepour M., Yamin H., Zuyi Li., "Market operations in power systems: Forecasting, Scheduling, and Risk Management", John Wiely & Sons, New York.
3. Dr. P. Dwivedi Dr. P.Diwan, "Energy Conservation", P. Pentagon Press, Seventh Edition.

Course Code : EE51B
Course Category : PEC
Course Name : Electrical Energy Conservation & Auditing

After the completion of the course, the students will be able to-

CO-1: Discuss load management techniques and energy efficiency.

CO-2: Understand the need of energy audit and energy audit methodology.

CO-3: Understand various pillars of electricity market design.

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		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE51C	Signal & Systems	70	20	10	-	-	100	3	1	-	4

SIGNAL & SYSTEMS

Module-I:
Dynamic Representation of Systems: systems Attributes, Causality linearity, time-in variance. special signals, complex exponential, singularity functions (impulse and step functions). Linear Time-Invariant systems: Differential equation representation cone solution integral. Discrete form of special functions. Discrete Convolution and its properties. Realization of LTI system (differential and difference equations).

Module-II:
Fourier Analysis of Continuous Time Signals and Systems: Fourier Series, Fourier Transform and properties, Parseval's theorem, Frequency response of LTI systems. Sampling Theorem, reconstruction of Signal from its samples, sampling in the frequency domain.

Module-III:
Fourier Analysis of Discrete Time Signals & Systems: Discrete-Time Fourier Series, Discrete- time Fourier Transform (including DFT) and properties, Frequency response of discrete time LTI systems.

Module-IV:
Laplace Transform: Laplace Transform and its inverse: Definition, existence conditions, Region of Convergence and properties, Application of Laplace transform for the analysis of continuous time LTI system (stability etc.) Significance of poles & zeros.

Z Transform: Z Transform and its inverse: Definition, existence, Region of convergence and properties. Application of Z-Transform for the analysis of discrete time LTI systems, Significance of poles and zeros, sampling to discrete-time signals.

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Module-V:

Linear Feedback System: Introduction, Linear Feedback systems, Application and consequences of Feedback, Root - Locus Analysis of Linear Feedback systems.

Sampling: For Continuous Time Signal, Sampling Theorem, Interpolation, Aliasing for Discrete Time Signals.

Text Books:

1. B.P.lathi, "Principles of Linear Systems and Signals", Oxford university, Second edition.
2. P Ramakrishna Rao, "Signal & Systems", TMH, Second Edition.
3. K Gopalan, "Introduction to Signal & system Analysis", International student Edition, Sixth Edition.

Reference Books:

1. I.J. Nagrath and S.N. Sharan, Rakesh Ranjan, "Signals and Systems", Second Edition.
2. Matthew N. O. Sadiku Warssme H. Ali, "Signals and Systems", First Edition.
3. K.Deergha Rao, "Signals & Systems", Birkhauser, Second Edition.

Course Code : **EE51C**
Course Category : **PEC**
Course Name : **Signals & Systems**

After completion of this course student will be able to-

CO1: Classify different signals and systems.

CO2: Determine Fourier analysis of continuous and discrete time signals.

CO3: Apply Laplace transform and Z transform for the analysis of continuous and discrete time LTI systems.

CO4: Basics of feedback system & sampling.

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		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE52	Control System	70	20	10	30	20	150	3	-	2	4

CONTROL SYSTEM

Module - I
Modeling of dynamic systems: Electrical, Mechanical and hydraulic systems, Concept of transfer function, Laplace Transform, State space description of dynamic systems: Open and closed loop systems, Signal flow graph, Mason's formula, Components of control systems: Error detectors (Synchronous & Potentiometer), Servomotors (AC & DC), tacho-generators, power amplifier, stepper motors.

Module - II
Time – domain analysis of closed loop systems: Test signals, time response of first and second order systems, Time domain performance specifications, Steady state error & error constants, Feedback control actions: Proportional, derivative and integral control.

Module - III
Concept of Stability, Necessary condition for stability, Routh-Hurwitz stability criterion, relative stability analysis, root locus technique.

Module - IV
Frequency response analysis and stability in frequency domain: Correlation between time and frequency response analysis. Polar Plots, Bode plots, Effect of adding pole and zeros, Nyquist stability criterion, gain margin and phase margin, relative stability from Nyquist plot, frequency domain compensation, lead, lag, lag-lead compensation.

Module - V
State Space Analysis: Concept of state, state space representation of systems, block diagram for state equation, transfer function decomposition, solution of state equation, concept of controllability and observability.

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Text Books:

1. D. Roy, Chaudhary, "Modern Control Systems", PHI India, Second Edition.
2. S. Salivahanan, R. Rengaraj, G.R. Venkatakrishnan, "Control System Engineering", Pearson, First Edition.
3. Stefani Shahian Savant,Hostetter, "Design of feedback control systems" Oxford, Fouth Edition.
4. B.S.Manke, "Control system engineering", Khanna Publishers, Twelfth Edition.

References Books:

1. B.C. Kuo and Farid Golnaraghi, "Automatic Control Systems", Wiley India, Eighth Edition.
2. M. Gopal, "Control system engineering", McGraw Hill, Fifth Edition.

List of Experiments:

1. MATLAB Based Experiments.

Course Code : EE52
Course Category : PCC
Course Name : Control System

After completion of this course students will be able to-

CO1: Model the electrical, mechanical and hydraulic system to obtain their transfer function.

CO2: Determination of time response and frequency response.

CO3: Estimate stability & state space analysis.

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Subject Code	Subject Name	Maximum Marks Allotted						Hours/ Week			Total Credits
		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE53	Electrical Machines -II	70	20	10	30	20	150	3	-	2	4

ELECTRICAL MACHINES - II

Module - I: Basic Principles of Three Phase Induction Motor:
Constructional details, types – squirrel cage, slip ring, principle of operation, production of rotating magnetic field, speed / slip, rotor current and voltage, torque developed, condition for max. Torque, torque/slip and torque/speed characteristics, induced emf in stator and rotor winding

Module - II: Performance Analysis of Three Phase Induction Motor:
Rotor circuit model, stator circuit motor, complete equivalent circuit, referred to stator, approximate equivalent circuit, power flow diagram, circle diagram, no load & block rotor test, starters used with three phase induction motor- DOL, auto-transformer, star delta starter, effect of space harmonics on performance of three phase induction motor, cogging and crawling, different methods of speed control, pole changing, stator voltage control, variable frequency control.

Module - III: Synchronous Machine (Alternator)
Constructional details, advantages of rotating field, excitation system, EMF equation, armature winding coil span/pitch factor, distribution or breadth factor, armature leakage reactance, armature reaction in synchronous machine. Synchronous impedance, equivalent circuit and phasor & equivalent Circuit diagram of synchronous generator, voltage regulation, emf method, mmf method, ZPFC/potier delta method, two reaction theory, torque angle characteristic of salient pole synchronous machine determination of Xd & Xq, parallel operations of alternator, process of synchronization, significance of synchronizing power coefficient, transient condition of alternator, SCR cooling of synchronous machine.

Module - IV: Synchronous Machine (Motor)
Construction, principle of operation, main features of synchronous motor, torque developed, power flow equation for synchronous motor, phasor diagram, effect of varying field current, V & inverted V curves, starting of Synchronous motor, Hunting or phase swinging, Damper winding, Application of synchronous motor.

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Module -V: Fractional kW Motors

Shaded pole motor, Commutator motor, AC series motor, Universal motor, Repulsion motor, Servo motors, stepper motor, Introduce EV Motor, Brushless DC Motor, and SRM Motor.

Text Book:

1. Nagrath & Kothari, "Electrical Machines", TMH Publication, Fifth Edition.

Reference Books:

1. P.S. Bhimbra, "Electrical Machinery", Khanna Publication, Seventh Edition.
2. Ashfaq Hussain, Dhanpat Rai Publication, "Electrical Machines", Second Edition.
3. A.S.Langsdorf, "Theory of Alternating Current Machinery", Tata McGraw-Hill, Second Edition.

List of Experiments:

1. To perform the load test on 3-phase induction motor & determine torque, output power, input power, efficiency, p.f. and slip.
2. To perform No-load & Block rotor test on 3-phase induction motor.
3. Study of starters used with 3-phase induction motor.
4. To determine regulation of alternator using synchronous impedance method.
5. To determine regulation of alternator using potier triangle method(ZPF)
6. To Synchronise an incoming alternator to busbar using bright and dark lamp method.
7. To determine V and inverted V curves of synchronous motor.
8. Study of stepper motor.
9. Study of PMBLDC motor.
10. Study of Switch Reluctance Motor.

Course Code : EE53
Course Category : PCC
Course Name : Electrical Machines- II

After completion of this course students will be able to-

CO1: Analyze the performance of three phase induction motor in details.

CO2: Evaluate the parameters and performance on poly phase synchronous electric motors.

CO3: Explain application of special machines.

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		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE54	Power Electronics-I	70	20	10	30	20	150	3	-	2	4

POWER ELECTRONICS-I

Module – I: Power Electronic systems
Introduction & history of power electronics development, power electronics as a revolution, goals and methods of energy conversion, PE systems and devices overview, introduction to converters, and applications, Introduction, Operation & Characteristics of Power Diode, UJT, Bipolar Junction Transistors, Power MOSFET, IGBT.

Module – II: Thyristor
Thyristors, working principle and operation of SCR, Static and dynamic characteristics, Two-transistor equivalent model, Series & Parallel operation, Ratings and SCR protection schemes, turn on & off techniques, firing methods and Commutation techniques. Overview of DIAC, TRIAC & GTO.

Module – III: Diode Rectifier Circuits
Working of half wave and full wave AC/DC uncontrolled bridge converter for R, RL and RLE load, Introduction of different performance parameters: Ripple Voltage, Ripple factor, Form factor, PIV, TUF and rectifier efficiency.

Module - IV: Controlled rectifier
Principle of phase controlled converter operation, single-phase thyristorised half wave, Full wave and semi converters for different loads and evaluation of Performance parameters, effects of load and source inductance in single phase converters.
Three phase half wave, Full wave and semi converters for different loads, Power factor improvement, Effects of load and source inductance.

Module – V: AC Controllers
Principle of phase control, single phase AC Voltage controllers with resistive and inductive loads. Three phase AC voltage controllers with resistive& inductive loads, Unity power factor controller,

Dual Converter: Working principle and Operation of Dual Converter with circulating current and non-circulating current mode.
Cyclo-Converter: Principles of operation of single and three phase cyclo-converters.

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Text Books:

1. Dr. P. S. Bimbhra, "Power Electronics", Khanna Publishers, Fourth Edition.
2. M.D.Singh, K.B.Khanchandani, "Power Electronics", TMH, Delhi, Second Edition.
3. M.H.Rashid, "Power Electronics Circuit, Devices & Applications", Person publication, Third Edition.
4. Jai P. Agrawal, "Power Electronics Systems, "Fourth Indian Reprint, Pearson Education, Second Edition.

References Books:

1. Robert W. Ericksion Dragan Maksimovic, "Fundamentals of Power Electronics", Springer Third Edition.
2. Daniel W. Har, "Power Electronics", McGraw-Hill Publication,First Edition.
3. P.C.Sen, "Power Electronics", TMH publication.
4. Chakravarti A., "Fundamental of Power Electronics and Drives", Dhanpat Rai& Co.
5. VedamSubramanyam, "Power Electronics" New Age International Revised,Second Edition
6. Philip T. Krein, "Elements of Power Electronics", Oxford University Press, First Edition.

List of Experiments:

1. Verification of SCR,MOSFET & IGBT characteristics
2. Verification of DIAC &TRIAC characteristics.
3. To study the different triggering circuits for thyristor.
   (a) Resistor triggering circuit. (b) R-C triggering circuit (c) UJT triggering circuit.
4. AC voltage control by using TRIAC & DIAC
5. Analysis of 1-pulse & 2-pulse converter with R and L load.
6. Analysis of three phase semi converter & full converter with R and R-L load.
7. Analysis of single phase dual converter.
8. Analysis of single phase cyclo-converter.
9. Analysis of Three phase controlled Rectifire.
10. Analysis of Three phase cyclo-converter.

Course Code : EE54
Course Category : PCC
Course Name : Power Electronics – I

After completion of this course students will be able to-

CO1: Ability to illustrate the performance and characteristics of various power Semiconductor devices.
CO2: Analysis of various power electronic circuits for single phase and three phase power supply.
CO3: Design and operation of power electronic circuits for various loads and supply.

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		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE55	Power system -II	70	20	10	-	-	100	3	1	-	4

POWER SYSTEM -II

Module -I

Voltage and Reactive Power Control: Importance of Voltage control, location of voltage control equipments, Method of voltage control, Excitation control, various types of voltage regulators, voltage control by synchronous condenser, Generation and Absorption of Reactive power, Role of Reactive power on voltage and voltage regulation, Relation between incremental Reactive power & Active power, Voltage at a node.

Module -II

Compensation in Power Systems: Introduction, Concepts of Load compensation, Loadability characteristics of overhead lines, uncompensated transmission line, Symmetrical line, Radial line with asynchronous load, Compensation of lines, Load Frequency control, Effect of voltage & frequency on load.

Module -III

Travelling Waves: Production of travelling waves, open circuited line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T- junction, Attenuation of travelling waves.

Corona: Phenomenon and theory of corona formation, Calculation of potential gradient, Critical Voltages, Radio and Television interference.

Module -IV

Per Unit Representation of Power Systems: The one line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system.

Symmetrical Faults: Fault calculations, purpose of fault analysis, short circuit capacity, star-delta and delta-star transformation, Transient is a series R-L circuit.

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Module -V

Symmetrical Components and Unsymmetrical Faults: Fortescue's Theorem, significance of positive, negative and zero sequence components. Average 3-phase power in terms of symmetrical components, sequence impedances and sequence networks.

Text Books:

1. J.B.Gupta, "A Course in Power System", S.k. Katariya & sons, 2013th Edition.
2. V.K. Mehta, "Principles of Power System", S. Chand & Company LTD., Second Edition.

Reference Books:

1. Dr. B.R. Gupta "Power System Analysis and design", S.Chand First Edition.
2. M.L. Soni, P.V.Gupta, U.S. Bhatnagar, A Chakrabarti, "Power system Engineering", Dhanpat Rai & Co.
3. P.S. R. Murty, "Electrical Power System", B H Publication, First Edition.

Course Code : **EE55**
Course Category : **PCC**
Course Name : **Power System- II**

After completion of this course students will be able to -

CO1: Evaluation and design of power system components.

CO2: Analyze and test the faults in power system.

CO3: Calculation of parameters associated with electrical power.

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