Jabalpur Engineering College, Jabalpur

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

(AICTE Model Curriculum Based Scheme)

Bachelor of Technology (B.Tech.) IV 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	EE41	PCC	Electrical Engineering Materials	70	20	10	-	-	100	3	1	-	4
2	EE42	PCC	Electrical Machine-I	70	20	10	30	20	150	3	-	2	4
3	EE43	PCC	Power System-I	70	20	10	30	20	150	3	-	2	4
4	EE44	PCC	Electrical & Electronics Instruments	70	20	10	30	20	150	3	-	2	4
5	EE45	PCC	Electromagnetic Field Theory	70	20	10	-	-	100	3	1	-	4
6	EE46	ESC	Drawing & Design of Electrical Machine Lab	-	-	-	30	20	50	-	-	4	2
Total				**350**	**100**	**50**	**120**	**80**	**700**	**15**	2	**10**	**22**
7	EE47	DLC	Self-Learning Presentation (SWAYAM/NPTEL/MOOC)	-	-	-	-	-	-	-	-	-	8
8	EE48	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 EE47 for the award of Honours (Minor Specialization).									

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

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

PCC: Professional Core Course, ESC: Engineering Science 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					
EE41	Electrical Engineering Materials	70	20	10	-	-	100	3	1	-	4

ELECTRICAL ENGINEERING MATERIALS

Module-I: Conductors
Electron theory, conductivity, factor affecting conductivity, classification & properties of conducting materials. Effect of temperature variation, Alloys and their properties, properties and application of high Conductivity (Copper, aluminum, bronze & brass) & high resistivity (constantan, nichrome, carbon & platinum) materials, Application of conducting materials with their suitability in Electrical Machines, power systems, Electrical instruments etc. super conducting materials, their properties & Applications.

Module-II: Semiconductors
General concepts, energy band, types of semiconductors, intrinsic and extrinsic semiconductor, variation of electrical. conductivity, Elements having semiconducting properties, Fermi Dirac distribution, general application, Hall effect & its applications, conduction in semiconductors,drift and mobility, current flow in semi-conductors, P-N Junction formation by alloying Zener effect.

Module-III: Magnetic Materials
Magnetism, classification of magnetic materials (diamagnetic, paramagnetic and ferromagnetic), their properties & applications, Eddy currents, Hysteresis loop for hard and soft magnetic materials, magnetic susceptibility, coercive force, curie temperature, magnetostriction, Ferro-electric materials, piezo-electric materials & their properties.

Module-IV: Dielectrics & Insulators
Electrical, mechanical & chemical properties of insulating materials, Classification of Insulating materials, Liquid insulators (transformer oil and its properties), gaseous insulators, solid electrical insulating materials, resins and varnishes, Properties of gaseous, liquid and solid dielectric, dielectric as a field medium, electric conduction in gaseous, liquid and solid dielectric, Breakdown in dielectric materials, mechanical and electrical properties of dielectric materials, effect of temperature on dielectric materials, polarization, loss angle and dielectricloss.

Module-V: Special Materials
Photo emissive materials, nanomaterials, metamaterials, special conductive materials (materials to thermoelectric transformation, fuses, solder material etc.) material for photovoltaic cell

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Text Books:

1. Dr. C.S. Indulkar and Dr. S. Thiruvengadam, "Electrical Engineering Materials", S.Chand Publication.
2. S P Seth, "A course in Electrical Engineering Materials", Dhanpat Rai Publication, Third Edition.

Reference Books:

1. B.M.Tareev, "Materials for Electrical Engineering".
2. A. J. Dekker, "Electrical Engineering Materials", PHI,India Publication, First Edition.

Course Code: **EE41**
Course category: **PCC**
Course Name: **Electrical Engineering Material**

After the completion of this course students will able to-

CO-1: Select proper conducting material suitable for electrical machine, power system and various electrical measuring instruments.
CO-2: Analyse in depth the electrical and magnetic properties of various material.
CO-3: Explain superconductivity of magnetic materials with their applications in various fields. CO-**4**: Classify various insulating materials along with their properties.
CO-**5**: Elaborate the modern usage of special materials in engineering.

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		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE42	Electrical Machine -I	70	20	10	30	20	150	3	-	2	4

ELECTRICAL MACHINES – I

Module-I: Transformer
Review of Single phase transformers, open circuit and short circuit test, Sumpner's test, polarity test, Power and distribution transformer, All day efficiency, Autotransformer working, equivalent circuit, comparison with two winding transformers and Phasor diagram.
Three Phase Transformer, construction, various groups and connections, harmonics in emf & magnetizing current, Scott Connection, Parallel operation

Module-II: Principles of Operation of Rotating Machines
Principle of electromagnetic energy conversion, Constructional details of ac machines, description of magnetic and electric circuits in cylindrical rotor and salient pole machine, concept of Armature & field winding.

Module-III: Generator
Principal of operation, EMF equation, classification on the basis of excitations, armature windings and its types, operating, characteristics, armature reaction and commutation, losses and efficiency.

Module-IV: DC Motor
Principal of operation, Torque equation, types of DC motors, starting methods and speed control, ward Leonard Method, solid state control, Swinburn's test, Hopkinson's test, braking Applications of DC machines

Module-V: Single Phase Induction Motor
EMF Equation of single Phase Induction motor, double field revolving theory, equivalent circuit, string methods and types of single phase Induction motor

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List of Experiment:

1. To conduct open circuit and short circuit tests on a 3-phase three winding transformer and determine the equivalent circuit parameters in pu.
2. To operate two single phase transformer of different KVA rating in parallel and plot the variation of current shared by each transformer v/s load current.
3. To conduct Sumpners test identical single phase transformer and determine their efficiency at various loads.
4. To separate hysteresis and eddy current losses of a single phase transformer at rated voltage and frequency by conducting no load tests at different frequencies keeping V/f constant.
5. To perform speed control of DC shunt motor using armature and field control plot the variation of speed with added resistance.
6. To perform direct load test on a DC shunt motor and plot the variation of (a) Input current (b) speed (c) torque (d) efficiency v/s output power.
7. To obtain magnetization characteristics of a DC machine. Estimate field circuit resistance of a DC shunt generator at rated speed. Measure field winding and armature winding resistance. Plot the external characteristics of DC shunt generator.
8. To make scott connection of two single phase transformer and to verify the current relation by drawing phasor diagram for balanced and unbalanced resistive load condition.
9. To conduct Swinburn's test on a dc shunt motor. Compute and plot the efficiency at various loads.
10. To conduct direct load test on DC Compound generator with (a) Shunt field alone (b) Cumulative and differential compounding for short shunt connections.

Text Books:

1. Nagrath and Kothari, "Electrical Machines", TMH Publication, Second Edition.
2. Ashfaq Hussain, "Electrical Machines", Dhanpat Rai Publication, Second Edition.

Reference Books:

1. P.S.Bhimbra, "Electrical Machinery", Khanna Publication, First Edition.
2. LangsDorf, "AC machines", TMH Publication, Second Edition.

Course Code : EE42
Course category: PCC
Course Name : Electrical Machines-I

After the completion of this course students will able to-

CO-1: Explain the basic concept of Transformer and Rotating Machine.
CO-2: Analyze performance of Transformer and DC Machine.
CO-3: Evaluate the Parameter and performance of DC Machines & Single Phase Induction Motor and Transformer.

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		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE43	Power System-I	70	20	10	30	20	150	3	-	2	4

POWER SYSTEM -I

Module-I: Generating station
Choice of sites, advantage and disadvantage, schematic arrangement, functioning and environmental aspects of - Steam power plant, hydroelectric power plant, Nuclear power, Diesel power plant and Gas Turbine power plant, Load curves, Load duration curves, Selection of generating units, Base load and Peak load in Power station.

Module-II: Transmission and Distribution
Elements of a transmission lines, Typical AC Power supply system, advantages of high transmission voltage, Power factor improvement, various system of power transmission, comparison of conductor material in overhead system, Primary and secondary distribution system, AC distribution, method of solving AC distribution problems.

Module-III: Main components of a transmission line: Conductor materials, types of line supports and Insulators, Potential distribution over suspension insulator strings, string efficiency, Method of improving string efficiency, spacing of conductors and ground, sag, sag tension calculation.

Module-IV: Electrical design of Transmission lines
Line parameters, calculation of inductance and capacitance of single circuit transmission line, three phase lines with stranded and bundle conductors, skin effect, proximity effect, generalized ABCD constants and equivalent circuits of short, medium and long lines, Performance-Regulation and efficiency of short, medium and long lines.

Module-V: Underground Cables
Construction and Insulation material for cables, classification, insulation resistance and Capacitance of single core cable, Dielectric stress in a single core cable and most economical size of conductor in a cable Grading intersheath and capacitance grading.

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List of Experiment:

1. Study of insulators.
2. To find the string efficiency of insulator string.
3. To find the insulation resistance of a cable.
4. Simulation of Ferranti effect using MATLAB.
5. Modeling & Simulation of Transmission line parameter using MATLAB. (Programmers based on sag calculation for different land terrain).

Text Books:

1. V.K. Mehta, "Principles of Power System", S. Chand & Company LTD., Second Edition.

Reference Books:

1. J.B.Gupta, "A Course In Power System", S.k. Katariya & sons, 2013th Edition.
2. Nagrath I J and Kothari DP; "Power System Engineering", Tata McGraw Hill, Third Edition.
3. Ashfaq Hussain; "Electrical Power System". Fifth Edition.

Course Code: **EE43**
Course category: PCC
Course Name: **Power system-I**

After the completion of this course students will able to Understand-

CO-1: The working of various conventional Power plants.
CO-2: Design of transmission lines and evaluations of its performance.
CO-3: Distribution systems by overhead lines and cable, its design and performance analysis.

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		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE44	Electrical & Electronic Instruments	70	20	10	30	20	150	3	-	2	4

ELECTRICAL & ELECTRONIC INSTRUMENTS

Module-I: Cathode Ray Oscilloscope (CRO)
Different parts of CRO; Block diagram, Electrostatic focusing, Electrostatic deflection, post deflection, acceleration , Screen for CRTs, Graticule, Vertical & Horizontal deflection system, Time base circuit, Oscilloscope probes, Application of CROs: Measurement‘ of phase, frequency and other application, Special purpose CROs-multi input, Dual trace, Dual beam, Sampling, Storage, Analog and digital oscilloscopes

Module-II: AC Bridges
Sources and detectors, Use of Bridges for measurement of inductance, Capacitance & Q factor Maxwell’s bridge, Maxwell’s inductance capacitance bridge, Hays bridge, Andertons bridge, Owen’s Bridge, De-sauty’s Bridge, Schering Bridge, High Voltage, Schering bridge, Measurement of relative permittivity, Heaviside Campbell bridge, Wiens bridge, Universal bridge, errors in Bridge circuit, Wagner's Earthing device, Q meter and its application.

Module-III: Transducers
Classification of transducer, Strain Gauge, Displacement Transducer (LVDT) & (RVDT), (RTD) Thermistor, Thermocouple, Piezo-Electric transducers, Optical Transducer, photo emissive, Photoconductive, photovoltaic, Photodiode, Phototransistor, Nuclear Radiation Detector, Capacitive Transducer.

Module-IV: Signal Generator
Signal Generator, Fixed & variable frequency AF oscillators, Sine wave generators, Standard signal generator, AF Sine and Square wave generator, Function generator, Square and pulse generator, Random noise generator, Sweep generator, TV Sweep generator, Marker generator, Sweep Marker generator, Wobbly scope, video pattern generator, Vectro-scope, Beat frequency Oscillator,
Wave analyzer: Harmonic Distortion Analyzer, Spectrum Analyzer, Network analyzer.

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Module- V: Digital Measurement and Instruments

Advantages of Digital instruments over analog instruments, Digital to analog conversion (DAC) Variable resistive type R-2R Ladder Type, Binary ladder, weighted converter using op amp and transistor, Practical DAC, Analog to digital conversion (ADC), ramp Technique, Dual slope, Integrating Type, Successive Approximations, digital voltmeters and multi-meters, Resolution and sensitivity of digital meter, PLC structure, Principal of operation, response time and application, Digital panel meter, Data acquisition system, Data Transmission and Telemetry, Digital display system and indicators instruments used in computer controlled instrumentation RS 232 & IEEE 488, GPIB electric interface.

List of Experiments:

1. Measurement of inductance of a coil using Hay's bridge.
2. Measurement of inductance of a coil using Anderson Bridge.
3. Measurement of inductance and capacitance using Maxwell's inductance- capacitance bridge.
4. Measurement of capacitance of a capacitor using Schering Bridge.
5. Measurement of frequency using Wein's bridge.
6. Measurement of Displacement using LVDT.
7. Measurement of speed of a Motor using photoelectric transducer.
8. Temperature measurement & Control using thermocouple & using thermistor.
9. Measurement of frequency of signal using CRO.
10. Measurement of force using strain gauge.

Text Book:

1. A.K. Sawhney, "Instrumentation and Measurements", Dhanpat Rai and Co. Ltd, Fourth Edition.

References Books:

1. H.S. Kalsi, "Electronics Instrumentation", TMH, Third Edition.
2. Helfric and Cooper, "Modern Electronic Instrumentation and Measurement Techniques", First Edition.

Course Code: **EE44**
Course Category: **PCC**
Course Name: **Electrical & Electronic Instruments**

After the completion of this course students will able to-

CO-1: Analyze different wave forms using CRO.
CO-2: Calculate inductance and capacitance with the help of AC bridges.
CO-3: Use transducers to convert non electrical quantities into electrical.
CO-**4**: Analyze different signal generator and wave analyzer.
CO-**5**: To analyze various conversion methods for Analog to Digital and vice versa and working of various Digital Instruments.

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		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE45	Electro Magnetic Field Theory	70	20	10	-	-	100	3	1	-	4

ELECTRO MAGNETIC FIELD THEORY

Module-I: Electrostatics-I
Sources and effects of electromagnetic fields, Coordinate Systems, Vector fields, Gradient, Divergence, Curl, theorems and applications, Coulombs Law, Electric field intensity, Field due to discrete and continuous charges, Gauss's law and applications.

Module-II: Electrostatics-II
Electric potential, Electric field and equipotential plots, Uniform and Non-Uniform field, Utilization factor, Electric field in free space, conductors, dielectrics, Dielectric polarization, Dielectric strength, Electric field in multiple dielectrics, Boundary conditions, Poisson's and Laplace's equations, Capacitance, Energy density, Applications.

Module-III: Magneto statics
Lorentz force, magnetic field intensity (H), Biot–Savarts Law, Amperes Circuit Law, magnetic field intensity due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B), Magnetic flux density in free space, conductor, magnetic materials, Magnetization, Magnetic field in multiple media, Boundary conditions, scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density, Applications.

Module-IV: Electrodynamic Fields
Magnetic Circuits, Faradays law, Transformer and motional EMF, Displacement current, Maxwell's equations (differential and integral form), Relation between field theory and circuit theory, Applications.

Module-V: Electromagnetic Waves
Electromagnetic wave generation and equations, Wave parameters; velocity, intrinsic impedance, propagation constant, Waves in free space, lossy and lossless dielectrics, conductors, skin depth, Poynting vector, Plane wave reflection and refraction.

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Text Books:

1. V.V.Sarwate, "Electromagnetic fields and waves", Newage Publishers First Edition.
2. J.P.Tewari, "Engineering Electromagnetics - Theory, Problems and Applications", Khanna Publishers, Second Edition.
3. S.P.Ghosh, Lipika Datta, "Electromagnetic Field Theory", McGraw Hill Education (India) Private Limited, First Edition.
4. K A Gangadhar, "Electromagnetic Field Theory", Khanna Publishers, Eighth Edition.

Reference Books:

1. Mathew N. O. Sadiku, "Principles of Electromagnetics", Oxford University Press Inc. Asian edition, Sixth Edition.
2. William H. Hayt and John A. Buck, "Engineering Electromagnetics", McGraw Hill Special Indian, Sixth Edition,
3. Kraus and Fleish, "Electromagnetics with Applications", McGraw Hill International Editions, Fifth Edition,
4. Joseph. A.Edminister, "Schaum's Outline of Electromagnetics", (Schaum's Outline Series), McGraw Hill, Third Edition.

Course Code: **EE45**
Course category: **PCC**
Course Name: **Electromagnetic Field Theory**

After the completion of this course students will able to-

CO-1: Illustrate concept of vectors and theorems of electrostatic fields.
CO-2: Analyze the behavior of electric field in depth the electrical and magnetic properties of various material.
CO-3: Determine the parameters of magnetic field using various laws of magnetism.
CO-**4**: Apply Faradays law and Maxwell's equations in electromagnetic fields.
CO-**5**: Examine electromagnetic waves in free space and materials medium.

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		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE46	Drawing & Design Of Electrical Machine Lab	-	-	-	30	20	50	-	-	4	2

DRAWING AND DESIGN OF ELECTRICAL MACHINE LAB

Module-I: General Electrical Engineering Drawing
Drawing of general graphical symbols and notations used in Electrical engineering, Draw lighting and power wiring diagram for a given installation, Staircase wiring, Go-down wiring, Layout of substation.

Module-II: Drawing Of Cross Sectional View and Winding of Electrical Machines
Draw the cross sectional view of various electrical machines, D.C. machine parts and cross sectional view, A.C. machine parts and cross sectional view, Winding diagrams of AC Machine ,Winding diagrams of DC machines.

Module-III: DC Machines Design
Major considerations in Electrical Machine Design, Electrical Engineering Materials, Space factor, Choice of Specific Electrical and Magnetic loadings, Thermal consideration, Heat flow, Temperature rise and Insulating Materials, Rating of machines, Standard specifications, Output Equations, Main Dimensions, Choice of Specific Electric and Magnetic Loading, Magnetic Circuits Calculations, Carter's Coefficient, Net length of Iron, Real & Apparent flux densities, Selection of number of poles, Design of Armature, Design of commutator and brushes, performance prediction using design values.

Module-IV: Transformers Design
Output Equations, Main Dimensions, KVA output for single and three phase transformers, Window space factor, Design of core and winding, Overall dimensions, Operating characteristics, No load current, Temperature rise in Transformers, Design of Tank, Methods of cooling of Transformers.

Module-V: Design of Rotating AC Machine
INDUCTION MACHINES DESIGNS
Output equation of Induction motor, Main dimensions, Choice of Average flux density, 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, Operating characteristics, Losses and Efficiency.

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SYNCHRONOUS MACHINES DESIGN

Output equations, choice of Electrical and Magnetic Loading, 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, Design of turbo alternators, Rotor design. The design problems based on the syllabus should be assigned to the students. After carrying out the detailed design, drawing sketches should be prepared by the students. Minimum five drawing sheets must be prepared and evaluated at the end of the session.

Text Books:

1. A.K. Sawhney, "A course in Electrical Machine Design", First Edition.
2. M.G. Say, "Performance and design of AC Machines", Fourth Edition.
3. M.G. Say, "Performance and design of DC Machines", Third Edition.

References Books:

1. Pal and Lal, "Electrical Engineering Drawing".
2. S. K. Bhattacharya, "Electrical Engineering Drawing", Second Edition.
3. C.R. Dargan, "Electrical Engineering Drawing", Second Edition.

Course Code: **EE46**
Course Category: ESC
Course Name: **Drawing and Design of Electrical Machines Lab**

After the completion of this course students will able to-

CO1: Draw and develop understanding of all electrical symbols, layout of sub-station /substation equipment.
CO2: Comprehend and draw AC and DC machine winding and cross-sectional view of different parts of AC and DC machine.
CO3: Illustrate and design core type power and distribution transformer. Orthographic drawing of transformer including winding, tank and tubes.
CO4: Develop a detail design of three phase induction machine.
CO5: Develop a detail design of three synchronous machines.

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