DR. BABASAHEB AMBEDKAR TECHNOLOGICALUNIVERSITY, LONERE.

Dr. Babasaheb Ambedkar Technological University (Established as a University of Technology in the State of Maharashtra)
(Under Maharashtra Act No. XXIX of 2014)
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National Education Policy (NEP) 2020 for the session 2024-25

Structure and Syllabus of Minor Degree in Electrical Engineering

Semester-wise Credit distribution structure for Four Year UG Engineering Program - One Major, One Minor

Semester		I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course	BSC/ESC	06-08	08-10		--	--	--	--	--	14-18
Engineering Science Course		10-08	06-04		--	--	--	--	--	16-12
Programme Core Course (PCC)	Program Courses	--	02	08-10	08-10	10-12	08-10	04-06	04-06	44-56
Programme Elective Course (PEC)		--	--	--	--	04	08	02	06	20
Multidisciplinary Minor (MD M)	Multidisciplinary Courses		-	02	02	04	02	02	02	14
Open Elective (OE) Other than a particular program		--	--	04	02	02	--	--	--	08
Vocational and Skill Enhancement Course (VSEC)	Skill Courses	02	02	--	02	--	02	--	--	08
Ability Enhancement Course (AEC -01, AEC-02)	Humanities Social Science and Management (HSSM)	02	--	--	02	--	--	--	--	04
Entrepreneurship/Economics/ Management Courses		--		02	02	--	--	--	--	04
Indian Knowledge System (IKS)			02		--	--	--	--	--	02
Value Education Course (VEC)		--	--	02	02	--	--	--	--	04
Research Methodology	Experiential Learning Courses	--	--	--	--	--	--		04	04
Comm. Engg. Project (CEP)/Field Project (FP)		--	--	02	--	--	--	-	-	02
Project		--	--	--	--	--	--		04	04
Internship/ OJT		--	---			--	--	12	-	12
Co-curricular Courses (CC)	Liberal Learning Courses	02	02		--	--	--	--	-	04
Total Credits (Major)		**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**20-22**	**160-176**

Comparison between Major and Minor in Electrical Engineering:

Aspect	Major Degree (B.Tech)	Minor Degree
Duration	4 years	Taken alongside major degree (optional)
Total Credits	160-176 credits	14-16 credits
Courses	~30-36 courses	5-6 courses
Core Courses	Comprehensive core and advanced courses	Fewer core courses
Electives	Includes multiple electives and specializations	1-2 elective courses
Project Work	Full-year major project	Small project or research
Career Outcome	Full qualification in Electrical Engineering	Enhances knowledge in a secondary field

Structure of Minor Degree in Electrical Engineering

Category	No. of Courses	Credits per Course	Total Credits
Foundation Courses	1-2	2-4	2-4
Core Electrical Engineering Courses	2-3	2-4	4-6
Electives/Specialization Courses	1-2	2-4	2-4
Project/Research Work	1	2-4	2
Total	5-6 Courses	–	**10-14**

Minor Degree in Electrical Engineering Semester vise credit distribution

	SEM-III	SEM-IV	SEM-V	SEM-VI	SEM-VII	SEM-VIII	Total credits required to complete a Minor Degree in Electrical Engineering
Total Credit	2	3	3	3	2	2	15
Category	Foundation Courses	Core Electrical Engineering Courses	Core Electrical Engineering Courses	Core Electrical Engineering Courses	Electives/ Specialization Courses	Project/ Research Work	

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Multidisciplinary minors Subjects in Electrical Engineering Department (MDM Subject)

Semester	Category	Subject Code	Subject Name	Total Credit
SEM-III	Foundation Courses	25AF1293MD306	Electrical and Electronics Measurements	2
SEM-IV	Core Electrical Engineering Courses	25AF1293MD406	Electrical Machine	3
SEM-V	Core Electrical Engineering Courses	25AF1293MD506	Power System	3
SEM-VI	Core Electrical Engineering Courses	25AF1293MD606	Switchgear And Protection	3
SEM-VII	Electives/Specialization Courses	25AF1293MD706	High Voltage Engineering	2
SEM-VIII	Project/Research Work	25AF1293MD806	Project/Research Work	2
Total credits required to complete a Minor Degree in Electrical Engineering				15

Syllabus for Multidisciplinary minors in Electrical Engineering

SEM-III

Foundation Course: Introduction to EE

<table>
<tr><th colspan="3">Electrical and Electronics Measurements</th></tr>
<tr><td colspan="2">Teaching Scheme
Lectures Theory: 02 Hr / Week
Credit:02</td><td>Examination Scheme
Internal Assessment: 20 Marks
Mid-Sem Exam: 20 Marks
End Sem Exam: 60 Marks</td></tr>
<tr><td colspan="3">Course Outcome:
1. Solve higher order linear differential equation using appropriate techniques for modelling and analyzing electrical circuits.
2. Solve problems related to Fourier transform, Laplace transform and applications to Communication systems and Signal processing.
3. Obtain Interpolating polynomials, numerically differentiate and integrate functions, numerical solutions of differential equations using single step and multi-step iterative methods used in modern scientific computing.
4. Perform vector differentiation and integration, analyze the vector fields and apply to Electromagnetic fields.
5. Analyze conformal mappings, transformations and perform contour integration of complex functions in the study of electrostatics and signal processing.</td></tr>
<tr><th>Unit</th><th>Contents</th><th>Hrs.</th></tr>
<tr><td>1</td><td>Introduction:
Definitions- Accuracy, tolerance, sensitivity, reproducibility, absolute and secondary measuring instruments, recording instruments.
Analog Ammeters and Voltmeters:
Permanent magnet Moving Coil (PMMC) & Moving Iron (MI) instruments: construction, torque equation range extension, effect of temperature, classification, errors, advantages, and disadvantages. (numerical)</td><td>5</td></tr>
<tr><td>2</td><td>Analog Wattmeter and Power Factor Meters:
Electrodynamometer type: wattmeter & power factor meter: construction, working, torque equation, advantages and disadvantages; Measurement of active and reactive power in single phase and in three phase with balanced loads. (numerical)
Analog Energy Meter: Single phase induction type energy meters, construction, working, lag adjustments, errors; Maximum demand indicators.</td><td>5</td></tr>
<tr><td>3</td><td>Electrical Bridges:
DC bridges: Wheatstone, Kelvin’s, Kelvin’s double bridge, Megger, Earth resistance measurement, loss of charge method for measurement of high resistance;
AC bridges: Maxwell’s bridges, De-Sauty, Anderson, Schering, Wien; for measurement of inductance and capacitance and their limitations. (numerical)</td><td>5</td></tr>
</table>

4	**Instrument Transformers:** Construction, working, ratio error and phase errors, testing & applications of current transformer and potential transformer. **Transducers:** Thermistor, RTD, thermocouple, LVDT, strain gauge, piezoelectric transducers, digital shaft encoders, tachometer, Hall Effect sensors.	**5**
5	**Electronic Instruments:** Digital voltmeters, Dual trace and dual beam Cathode Ray Oscilloscopes (CRO), measurement of voltage and frequency, Lissajous patterns, Digital Storage Oscilloscope – sampling of waveforms for understanding the functioning of DSO wave analyzers, harmonic distortion analyzer, LCR meter and Q-meter	**5**
	References: 1. Electrical Measurements and Measuring Instruments, E.W. Golding, F.C. Widdis, Reem Publications,2011. 2. Electronic Instrumentation and Measurements, H S Kalsi, McGraw Hill, Fourth Edition, 2019 3. Introduction to Measurements and Instrumentation, Arun K. Ghosh, Fourth Edition, Eastern Economy Edition, PHI Learning, 2012. 4. Dr. Shashikant Bakre, Electricity Metering in Easy Steps: An outline book on smart energy meters for everyone, 2015. 5. Ndinechi, M. C., O. A. Ogungbenro, and K. C. Okafor. "Digital metering system: a better alternative for electromechanical energy meter in Nigeria." International Journal of Academic Research 3.5 (2011): 189-192. 6.Sawhney A. K., Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai &Co.,2015	

SEM-IV

Core Course: Electrical Machine

Electrical Machine	
Teaching Scheme Lectures Theory: 03Hr / Week Credit:03	**Examination Scheme** Internal Assessment: 20 Marks Mid-Sem Exam: 20 Marks End Sem Exam: 60 Marks

Course Outcome:

1. Identify transformer, dc machine and three phase and single phase induction motors.
2. Evaluate and analyze the steady state parameters, operating characteristics and performance of transformers and dc machine
3. Analyze starting, speed control methods of dc and induction machines
4. Analyze and apply the energy conversion principles to rotating machines.
5. Select a suitable SRM, stepper motor, PMDC motor

Unit	Contents	Hrs.
1	**Single Phase Transformers:** Single-phase Transformer-EMF equation, equivalent circuit refer to either sides, transformer on different loads, pharos diagram, voltage regulation, losses, efficiency, maximum efficiency, energy efficiency, performance characteristics, auto transformers, variable frequency transformer, voltage & current transformers, welding transformers, pulse transformer **Numerical**	7
2	**Three Phase Transformers:** Construction, working principle, connections, factors affecting the choice of connection, voltage pharos diagram, vector groups, open delta or V-V connection, performance characteristics.	7
3	**D.C. Machine:** Construction details, working principle, back EMF, generated EMF, methods of excitation, types of DC Machines, armature reaction, effect of armature reaction, commutation, magnetizing and demagnetizing ampere turns, torque equation, speed equation, **Numerical**	7
4	**Characteristics and Testing of DC Machine:** Open circuit characteristics of DC generator, DC motor: break test, Swinburne test, Hopkinson's test, losses and efficiency, condition for maximum efficiency, types of starters, speed control and braking methods of DC Motors, **Numerical**	6
5	**A.C. Machines**: Classification of A.C. Machines, principle of operation and constructional features of synchronous and induction machines, rotating mmf waves in A.C. Machines, ac machine windings, winding factors, the emf equation, harmonics in generated emf, causes of harmonics and their suppressions	6
6	**Synchronous Machines** Synchronous Machines : Construction, types, armature reaction, circuit model of synchronous machine, determination of synchronous reactance, phasor diagram, power angle characteristics, parallel operation of synchronous generators, synchronizing to infinite bus bars, two axis theory, synchronous motor operation, characteristic curves, synchronous condenser, dynamics.	6

References:

1. Nasser Syed, "Electrical Machines and Transformers", A New York, Macmillon 1984.
2. Leinsdorf A. S., "Principles of DC Machines", 6th Edition, McGraw Hill Book Company 1959.
3. P. C. Sen., "Principles of Electric Machines and Power Electronics", 2nd edition, John Wiley and Sons Inc., 1997.
4. M. G. Say, "Alternating Current Machines", 5th edition, Low price edition, ELBS, Reprinted 1994
5. Bhag S. Guru and Huseyin R. Hiziroglu, "Electric Machinery and Transformers", 3rd Indian edition, Oxford University Press, Reprint 2014.

Text Books:

1. D. P. Kothari and I. J. Nagrath, "Electric Machines", Tata Mc Graw Hill Publication, 4th edition 2010, Reprint 2012.
2. P. S. Bimbhra: Electrical Machinery – Khanna Publishers, 7th edition, 2011.

SEM-V

Core Course: Power System

Power System	
Teaching Scheme Lectures Theory: 03 Hr / Week Credit:03	**Examination Scheme** Internal Assessment: 20 Marks Mid-Sem Exam: 20 Marks End Sem Exam: 60 Marks

Course Outcome:

1. Able to develop mathematical models for analysis.
2. Able to select proper methodologies of load flow studies for the power network.
3. Able to develop the understanding of contingency Analysis.
4. Able to develop programs for power system studies.

Unit	Contents	Hrs.
1	**Electrical Power Generation:** Evolution of Power Systems, Typical Layout of an Electrical Power System– Introduction to different sources of energy. Construction and working of thermal power plants, Hydro power station, Nuclear Power Plant with neat block diagram of major parts. Descriptive treatment of alternator exciter & excitation systems, major electrical equipment's in generating stations.	6
2	**Variable Load on Power Stations:** Structure of Electric Power System, Load Curves, Important Terms and Factors, Units Generated per Annum, Load Duration Curve, Types of Loads, Typical Demand and Diversity Factors, Load Curves and Selection of Generating Units, Important Points in the Selection of Units, Base Load and Peak Load on Power Station.	6
3	**Electrical Design of Overhead Transmission Lines :** Line conductors, inductance, and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, concept of GMD and GMR, Composite conductors-transposition, bundled conductors, and effect of earth on capacitance. Skin effect, proximity effect, Ferranti Effect. Corona: Introduction, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona, Numerical.	6
4	**Mechanical Design of Transmission Lines:** Types of conductors, Choice of conductor materials, Stranded copper & ACSR conductor, Insulation consideration, Different types of insulator, supports, distribution of voltage across the insulator string, String efficiency, Effect of wind & ice coating on transmission line, sag due to equal & unequal supports, with their derivation, Numerical.	6

5	**Performance of Transmission Lines:** Classification of overhead transmission lines, performance of single phase short transmission lines, three phase short transmission lines, effect of load power factor on regulation and efficiency, different types of medium transmission line, Analysis of long transmission lines, generalized constant of transmission line, determination of generalized constant of transmission lines, percentage regulation, Transmission efficiency, numerical based on above.	**6**
6	**AC & DC Distribution:** Classification of Distribution system, Requirement of distribution system, design consideration in distribution system. AC Distribution: Calculations, method of Solving AC Distribution problem, three phase unbalanced load, four wire unbalanced star connected load, ground detector, DC Distribution: types, DC distribution calculation, and three wire DC system.	**6**
	References: 01. Gupta B. R. " Power Plant Engineering".(Eurasia publications) 02. Nag P. K. " Power Plant Engineering",(Tata McGraw Hill Publications) 03. Kothari Nagrath, "Electric Power System", (Tata McGraw Hill Publications) 04. Wadhva S. L.,"Electric Power System",(Tata McGraw Hill Publications) Stevension W. B., "Power System", (English Language Book Society publications)	

SEM-VI

Core Course: Switchgear and Protection

SWITCHGEAR AND PROTECTION	
Teaching Scheme Lectures Theory: 03 Hr / Week Credit:03	**Examination Scheme** Internal Assessment: 20 Marks Mid-Sem Exam: 20 Marks End Sem Exam: 60 Marks

Course Outcome:

1. Explain the working of different types of switchgear equipment's like circuit breakers and relays.
2. Design the ratings for fuses according to the requirement
3. Elucidate various protection schemes of various power system components like alternators, transformers and bus-bars.
4. Explain various methods of over voltage protection in power systems.

Unit	Contents	Hrs.
1	**Introduction to Switchgear and Protection** Introduction, Need for power system protection, effects of faults, Requirement of Relays, Relays Terminology, basic circuit, relay connection with trip circuit and circuit breaker, types of relay, Protective Devices: Philosophy of protection, zones of protection, primary and backup protection, Methods of earthing and their effect on fault conditions. Different types of relays: attracted armature type, balanced beam type, induction type	5
2	**Static and Numerical Relays** Amplitude and phase comparator techniques, Differential relays, directional relay, impedance relay, admittance relay, MHO relay, description of numerical relays, relaying algorithms, use of numerical relays as fault locator and disturbance recorder. Microprocessor Based Relays: Advantages, over current relays, directional relays, distance relays.	5
3	**Circuit Breakers and Fuses** Introduction, arcing in circuit breakers, arc interruption, re-striking and recovery voltage, current chopping, resistance switch, Air blast circuit breakers, minimum and bulk oil circuit breakers, SF6 and Vacuum Circuit breakers, circuit breakers rating, testing of CB, point on wave switching, Definitions of terms in fuses, HRC fuses. Introduction, fuse characteristics, types of fuses, application of HRC fuses. Selection of circuit breakers, high voltage DC breakers.	5
4	**Protection of Transmission Lines** Over current protection, construction and operation of instantaneous over current relay. Directional Over current relay , distance protection, unit protection schemes, carrier aided distance protection, protection of feeders, protection of ring main and parallel feeders, protection of radial feeders by over current relays, distance relays and carrier current protection scheme. Protection of induction motor's against overload, short-circuits, thermal release, miniature circuit breaker	5

5	**Protection of Alternators & Transformers** Differential protection of alternator, protection of stator against phases to ground fault, phase to phase faults, inter turn fault, protection against unbalanced loading, protection of rotor against ground fault, field failure, reverse power, back up protection, field suppression, protection of bus bars, frame leakage protection. Differential protection of transformer for different winding configurations, difficulties encountered in differential protection and their remedies. Standards and specifications related to switch gear and protection	**5**
	References: 1. Power system protection and switchgear‖, Ravindranath and Chander, TMH 2. Fundamentals of power system protection‖, Paithankar and Bhide, PHI 3. J. L. Blackburn and T. J. Domin, Protective Relaying: Principles & Applications, CRC Press, 2006. 4. Electrical power system‖, Wadhwa, New Age. 2. ―Power system protection‖, Badri Ram, TMH	

SEM-VII

Core Course: High Voltage Engineering

High Voltage Engineering		
Teaching Scheme Lectures Theory: 02 Hr / Week Credit:02	**Examination Scheme** Internal Assessment: 20 Marks Mid-Sem Exam: 20 Marks End Sem Exam: 60 Marks	
Course Outcome: 1. Recall importance of high voltage technology. 2. Discuss breakdown phenomena in different dielectrics 3. Demonstrate generation and measurement of high voltages. 4. Examine testing methods used for different HV apparatus. 5. Evaluate insulation coordination among different HV apparatus		
Unit	**Contents**	**Hrs.**
1	**Introduction to High Voltage Engineering** Electric Field Stresses, Poisson's equation, Estimation and Control of Electric Stress, Surge Voltages, their distribution and control	**2**
2	**Conduction & breakdown in gases** Gases as insulation media, ionization processes, Townsend's current growth equation, current growth in presence of secondary processes, Townsend's criterion for breakdown in electronegative gases, time lags for breakdown, Streamers theory, Paschen's law, breakdown in non-uniform fields and corona discharge, corona under positive & negative polarities, glow & arc discharge, considerations in using gases for insulation purpose.	**5**
3	**Breakdown in Dielectric Materials** Conduction & breakdown in liquid dielectrics: Pure and commercial liquids, breakdown in pure and commercial liquids, theories of breakdown in liquids. Breakdown in solid dielectrics: Intrinsic, electromechanical& thermal breakdown, chemical, electrochemical deterioration, treeing, tracking, internal discharges, breakdown in composite insulation, properties of solid insulators & other materials used in practice. Insulating materials: In power transformers, rotating machines, circuit breakers, cables, power capacitors & other equipment	**5**
4	**Over voltage due to lightening phenomenon:** Natural causes for over voltages – Lightning phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions, propagation of lightning voltage & current waves on transmission lines, reflection & transmission of traveling wave at junction, system control of over voltage due to switching protection of transmission lines against over voltage. Insulation co-ordination, surge diverters, equipment insulation level & co-ordination of substations	**5**
5	**Generation& Measurement of high voltages & currents:** Generation of a) high d. c voltage b) power frequency high alternating voltage c) high frequency a. c. d) impulse voltages Standard impulse waves shapes and it's equation, multistage impulse generator, marx circuit, generation of switching surges, tripping & control of impulse generators, generation of	**5**

	impulse currents. Measurement of High Direct Current voltages, Abraham Voltmeter Measurement of High Voltages alternating and impulse, Measurement of High Currents-direct, alternating and Impulse, Oscilloscope for impulse voltage and current measurements	
	Reference Books: 1. High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition 2. High Voltage Insulation Engineering by Ravindra Arora, Wolfgang Mosch, New Age International (P) Limited, 1995. 3. High Voltage Engineering, Theory and Practice by Mazen Abdel Salam, Hussein Anis, Ahdan El-Morshedy, RoshdyRadwan, Marcel Dekker **Text Books:** 1. Kamaraju V. & Naidu M. S., 'High Voltage Engineering', Tata-McGraw Hill 2. C. L. Wadhwa, "High Voltage Engineering", New Age International Pvt. Ltd	

SEM-VII

Project/Research Work:

Syllabus for Electrical Mini Project (2 Credits) in Electrical Engineering

Course Title: Electrical Mini Project

Credits: 2
Duration: 1 Semester
Pre-requisite: Basic knowledge of electrical circuits, power systems, and electrical machines.

Course Overview:

This course is designed to provide students with hands-on experience in designing, developing, and executing a small-scale electrical engineering project. The mini project will allow students to apply theoretical knowledge from their coursework to practical applications. Students will work individually or in teams to develop a project proposal, conduct research, implement the project, and present their findings.

Course Objectives:

1. To develop project planning and execution skills in an electrical engineering context.
2. To apply theoretical knowledge of electrical engineering in solving practical problems.
3. To foster creativity, innovation, and teamwork in project-based learning.
4. To enhance research, technical documentation, and presentation skills.