DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

LIST OF COURSES OFFERED FOR MINOR PROGRAM (R20)

Course code	Course Title	Contact hours/week				Credits
		L	T	P	**Total**	
20EEM1	Electrical Circuits	4	0	0	4	4
20EEM2	Electrical Machines	4	0	0	4	4
20EEM3	Electrical, Electronic Measurements and Instrumentation	4	0	0	4	4
20EEM4	Elements of Power Engineering	4	0	0	4	4
20EEM5	Essentials of Power Electronics	4	0	0	4	4
20EEM6	Renewable Energy Technologies	4	0	0	4	4
20EEM7	Energy Auditing	4	0	0	4	4

20EEM1-ELECTRICAL CIRCUITS

L	T	P	Cr.
4	0	0	4

B.Tech. (Minor)

Pre-requisites: Applied Physics

Course Educational Objective: This course introduces the basics of circuit concepts, electrical parameters, single phase AC circuits, magnetic circuits, resonance, network topology and network theorems

Course Outcomes: At the end of the course, the student will be able to:

CO1: Apply network reduction techniques to simplify electrical circuits. **(Apply-L3)**

CO2: Analyze electrical circuits using theorems. **(Apply-L3)**

CO3: Examine the performance of single phase AC circuits. **(Apply-L3)**

CO4: Understand the locus diagrams and magnetic circuits. **(Understand-L2)**

C**O5**: Evaluate the two-port network parameters. **(Apply-L3)**

UNIT – I: INTRODUCTION TO ELECTRICAL CIRCUITS

Circuit Concept, R-L-C Parameters, Voltage and Current Sources, Independent and Dependent Sources, Source Transformation, Voltage – Current relationship for Passive Elements (for different input signals –Square, Ramp, Saw tooth and Triangular). Kirchhoff's Laws, Nodal Analysis, Mesh Analysis, Star–to-Delta or Delta-to-Star Transformations

UNIT – II: NETWORK THEOREMS

Superposition, Reciprocity, Thevinin's, Norton's, Maximum Power Transfer, Milliman's and Compensation theorems for D.C excitations.

UNIT – III: SINGLE PHASE A.C. CIRCUITS

R.M.S. and Average values and form factor for different periodic wave forms, Steady State Analysis of R, L and C (in Series, Parallel and Series Parallel Combinations) with Sinusoidal Excitation, Concept of Reactance, Impedance, Susceptance and Admittance, Phase and Phase difference, Concept of Power Factor, Real and Reactive powers

UNIT – IV: LOCUS DIAGRAMS, RESONANCE AND MAGNETIC CIRCUITS

Locus diagrams - series R-L, R-C, R-L-C and parallel combination with variation of various parameters - Resonance-series, parallel circuits, concept of band width and Q factor. Magnetic circuits-Faraday's laws of electromagnetic induction-concept of self and mutual inductance-dot convention-coefficient of coupling

UNIT – V: TWO PORT NETWORKS

Two port networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters

TEXT BOOKS:

1.Electric Circuits - A.Chakrabarhty, Dhanipat Rai & Sons.2018

2.Network analysis - N.C Jagan and C. Lakhminarayana, BS publications.,3rd Edition,July 2015

REFERENCE :

1.Engineering Circuit Analysis - William Hayt ,Jack E. Kemmerly, S M Durbin, Mc Graw Hill Companies, 9th Edition ,2020

2.Electric Circuit Analysis - K.S.Suresh Kumar, Pearson Education,1st Edition,2013.

3.Electrical Circuits - David A.Bell, Oxford University Press.2009.

4.Network Analysis and Circuits - M.Arshad, Infinity Science Press.2008.

20EEM2-ELECTRICAL MACHINES

B.Tech. (Minor)

L	T	P	Cr.
4	0	0	4

Pre-requisites: Applied Physics, Electrical circuits

Course Educational Objective: This course enables the student to learn the principle, construction and performance characteristics of DC and AC Machines. It also deals with principle and constructional features of transformers.

Course Outcomes: At the end of the course, the students will be able to

CO1: Analyze the performance of DC Machines. **(Understand-L2)**

CO2: Understand the operation of transformer. **(Understand-L2)**

CO3: Analyze the performance of induction and synchronous machines. **(Understand-L2)**

CO4: Understand the operation of special electrical machines. **(Understand-L2)**

UNIT I: DC MACHINES

Principle of operation– constructional features – armature windings lap and wave windings – E.M.F Equation- Back E.M.F - Torque equation– losses-efficiency-characteristics and application of shunt, series and compound machines

UNIT II: SINGLE PHASE TRANSFORMERS & TESTING

Single phase transformers-types - constructional details- EMF equation- operation on no-load and on load - phasor diagrams- Equivalent circuit - losses and efficiency-regulation-OC and SC tests

UNIT III: INDUCTION MOTOR

Three-phase Induction motors-construction details-Production of a rotating magnetic field - principle of operation - rotor emf and rotor frequency - rotor reactance, rotor current and power factor- equivalent circuit-torque-slip characteristics

UNIT-IV: SYNCHRONOUS GENERATORS

Synchronous generator – construction, working principle- emf equation–types of rotors-– phasor diagrams-regulation methods – EMF, MMF methods – Applications

UNIT-V: SPECIAL ELECTRICAL MACHINES

Principle of operation and construction of ac servo motors-speed-torque characteristics, BLDC motor- Principle of operation and construction-Applications, stepper motor- Principle of operation and construction-Applications

TEXT BOOKS:

1. P. S. Bimbra, "Electrical Machines", Khanna Publishers, 6th Edition., 2003
2. I.J. Nagrath& D.P. Kothari, "Electric Machines", 4th Ed., Tata McGraw Hill Publishers, 2011.

REFERENCE:

1. A. E. Fritzgerald, C. Kingsley and S. Umans, “Electric Machinary”, 6th ed., McGraw-Hill Companies, 2003.
2. S. Kamakshaiah, “Electromechanics – I (D.C. Machines)”, 2nd Ed., Hi-Tech Publishers, 2012.
3. Clayton & Hancock, “Performance and Design of D.C Machines”, 2nd Ed., BPB Publishers, 2004.
4. S.K. Bhattacharya, “Electrical Machines”, TMH, 6th Ed., 2014.

20EEM3-ELECTRICAL , ELECTRONIC MEASUREMENTS AND INSTRUMENTATION

B.Tech. (Minor)

L	T	P	Cr.
4	0	0	4

Pre-requisites: Applied Physics

Course Educational Objective: This course enables the students to understand the construction and working principle of different types of meters. It also deals with different types of digital voltmeters and transducers.

Course Outcomes: At the end of the course student will able to:

CO1: Analyze the performance of AC and DC measuring instruments. **(Understand-L2)**

CO2: Determine the circuit parameters using AC and DC bridges. **(Apply-L3)**

CO3: Understand working principle of various types of digital meters. **(Understand-L2)**

CO4: Select appropriate transducers for measurement of physical phenomenon. **(Apply-L3)**

UNIT – I: INTRODUCTION TO MEASURING INSTRUMENTS

Errors in measurement, Classification, deflecting, control and damping torques, ammeters and voltmeters – PMMC, moving iron type instruments, shunts and multipliers. Construction and principle of operation of A.C (polar and coordinate type), D.C. Potentiometer (only Crompton's type) standardization & its applications.

UNIT – II: DC & AC BRIDGES

Method of measuring low, medium and high resistance –Wheat-stone's bridge, Kelvin's double bridge, loss of charge method. Measurement of inductance- Maxwell's bridge, Measurement of capacitance and loss angle– Schering Bridge.

UNIT – III: MEASUREMENT OF POWER AND ENERGY

Wattmeter theory: Construction, working, torque equation, errors and their compensation in dynamometer type wattmeter. Energy meter: Construction, working principle, torque equation, errors, simple problems.

UNIT-IV: DIGITAL METERS

Digital voltmeters – Successive approximation- ramp- dual slope integration - continuous balance type – Micro processor based ramp type DVM, digital frequency meter.

UNIT-V: TRANSDUCERS

Classification of transducers, advantages of electrical transducers, Characteristics and choice of transducers; Principle operation of LVDT and capacitor transducers; Strain gauge and its principle of operation, gauge factor, Thermistors, Piezo electric transducers.

TEXT BOOKS:

1. A course in Electrical and Electronic Measurements & Instrumentation- A.K.Sawhaney , Dhanipat Rai & Sons.4th edition,2021
2. Albert D.Helfrick and William D.Cooper – Modern Electronic Instrumentation and Measurement Techniques, Pearson / Prentice Hall of India, 2007.

REFERENCE :

1. Doeblin., “Measurements Systems : Applications and Design” McGraw-Hill,1990
2. A. S Morris, “Principles of Measurement and Instrumentation” Pearson/ Prentice Hall of India,2001
3. D. V. S Murthy, “Transducers and Instrumentation” ,Prentice Hall of India,2nd Edition,2008

20EEM4-ELEMENTS OF POWER ENGINEERING

B.Tech. (Minor)

L	T	P	Cr.
4	0	0	4

Prerequisite: Applied Physics, Basic Electric and Electronics Engineering

Course Educational Objective: This course deals with generation, transmission, and utilization of electric power and allied accessories like generators, motors and transformers.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand the basic concepts of electrical power engineering. **(Understand-L2)**

CO2: Develop a comprehensive working knowledge of the synchronous machines and transformer. **(Understand-L2)**

CO3: Identify various technologies available for electric power transmission and distribution. **(Understand-L2)**

CO4: Identify various utilization methods of electrical energy. **(Understand-L2)**

UNIT-1: INTRODUCTION

A brief history of electric power systems, the structure of the power system, concepts of power in alternating current systems-single line diagram of power Systems, Electromagnetism and Electromechanical Energy Conversion, sources of energy, comparison of energies, growth of power systems in India

UNIT -II: SYNCHRONOUS MACHINE & ELECTRIC POWER GENERATION

The Synchronous Machine: Preliminaries-synchronous machine fields-a simple equivalent circuit-steady-state characteristics-problems. Qualitative treatment of various power generation schemes-thermal, solar.

UNIT -III: ELECTRIC POWER TRANSMISSION

Transformer: introduction-operation-transformer connections. Electric transmission line parameters-line inductance-line capacitance-transmission line models-T&pi model, simple problems.

UNIT-IV: DISTRIBUTION OF ELECTRIC POWER

Introduction- Classification of distribution systems, characteristics of distribution systems, Elementary concepts of AC and DC power Distribution systems, voltage regulation and substation location.

UNIT -V: UTILIZATION OF ELECTRICAL ENERGY

Introduction to Illumination- Basic Terms- Laws of illumination-sources of light-illumination methods- discharge lamps- Mercury Vapour lamps. Electric Heating: Methods of Electrical Heating-Resistance heating- Dielectric heating- Advantages of electrical heating. Electric Welding Types –Electrical resistance welding- Arc Welding.

TEXT BOOKS

1. J.B.Gupta, “A course in Power Systems” ,S.Chand Publications,11th Edition.2013.
2. V.K.Mehta, “Principles of Power Systems” ,S.Chand Publications,10th Rev.Edn,2006
3. Wadhwa, C L, “Generation Distribution and Utilization of Electrical Energy” (multi colour edition), 4th Edition, 2017.

REFERENCES

1. Mohamed E. El-Hawary, “Introduction to Electrical Power Systems”,John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.
2. D.P.Kothari & I.J.Nagrath, “Power System Engineering”, Third Edition, Mc Graw-Hill ,3rd Education, 2019

20EEM5-ESSENTIALS OF POWER ELECTRONICS

L	T	P	Cr.
4	0	0	4

B.Tech. (Minor)

Prerequisite: Applied Physics, Basic Electric and Electronics Engineering

Course Educational Objective: This course deals with the basic theory of power semiconductor devices and their characteristics. It also deals with operating principles of rectifiers, AC voltage controllers, DC to DC converters and inverters.

Course Outcomes: At the end of the course, the student will be able to:

CO1: Understand the operation of various power semiconductor devices. **(Understand-L2)**

CO2: Analyze the performance of rectifiers with and without filters. **(Apply-L3)**

CO3: Understand the operation of ac voltage controller with different loads. **(Understand-L2)**

CO4: Analyze the performance of various dc-dc converter topologies **(Apply-L3)**

CO5: Analyze the performance of inverters with different modulation techniques. **(Apply-L3)**

UNIT – I: POWER SEMI-CONDUCTOR DEVICES

Basic symbol, operation and characteristics of different power semiconductor devices - BJT, MOSFET, IGBT, SCR, GTO, DIAC and TRIAC.

UNIT – II: RECTIFIERS AND FILTERS

Half wave rectifier, Full wave rectifier, Bridge rectifier , Ripple factor Harmonic components in a rectifier circuit, Inductor filter, Capacitor filter, L- section filter, π- section filter, Multiple L-section and Multiple π section filter, and comparison of various filter circuits in terms of ripple factors, basics of regulators. single-phase Controlled rectifier with R and RL loads.

UNIT – III: AC VOLTAGE CONTROLLERS

AC voltage controllers–single phase ac voltage controller with R and RL loads for both half wave and full wave– continuous and discontinuous modes

UNIT – IV: DC TO DC CONVERTERS

Principle of operation-Control Strategies, Step-up and step-down chopper–Chopper classification- class A, B, C, D, E

UNIT – V: INVERTERS

Single phase inverter–Voltage Source Inverter (VSI)-Current source inverters (CSI) - Comparison between VSI and CSI- Single Pulse Width Modulation, Multiple Pulse Width Modulation, Sinusoidal Pulse Width Modulation.

TEXT BOOKS:

1. Md.H.Rashid "Power Electronics:Circuits, Devices and Applications", Pearson Education fourth Edition, first Indian Reprint- 2014.
2. Dr.P.S. Bhimbra, "Power Electronics", Khanna Publishers, 5th Edition, 2012.

REFERENCE:

1. Ned Mohan, T.M. Undeland and William P.Robbins, "Power Electronic Converters-Applications", John Wiley & Sons, 3rd Edition, , 2009
2. M D Singh, K B Khanchandani "Power Electronics", Tata MC Graw Hill publishers,2nd edition 2008.

20EEM6-RENEWABLE ENERGY TECHNOLOGIES

B.Tech. (Minor)

L	T	P	Cr.
4	0	0	4

Pre-requisites: Applied Physics, Applied Chemistry

Course Educational Objective: This course enables the student to understand and analyze various renewable energy technologies.

Course Outcomes: At the end of the course student will able to:

CO1: Understand the principles of renewable energy. .**(Understand-L2)**

CO2: Analyze the basic physics of solar and wind power generation. .**(Understand-L2)**

CO3:. Appreciate the ecological context of bio-energy. .**(Understand-L2)**

CO4: Evaluate the performance of fuel cells under different operating conditions for a given application. **(Understand-L2)**

UNIT–I: PRINCIPLES OF RENEWABLE ENERGY

Introduction, energy and sustainable development, fundamentals, scientific principles of renewable energy, Technical implications.

UNIT–II: THE SOLAR RESOURCE

Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability. Solar Photovoltaic Technologies-Amorphous, mono-crystalline, polycrystalline; Solar Thermal Power Generation: Technologies-elementary analysis.

UNIT–III: PHYSICS OF WIND POWER

History of wind power, Wind physics, Betz limit ratio, stall and pitch control, Wind Generator Topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbine, Induction Generators, Doubly-Fed Induction Generators and their characteristics.

UNIT-IV: INTRODUCTION TO BIOMASS

Photosynthesis: a key process for life on Earth - Trophic level photosynthesis - Relation of photosynthesis to other plant processes - Photosynthesis at the cellular and molecular level, Biomass production for energy - Wood resource - Crop yield and improvement -Plant physiology and biomass - Bioengineered photosynthesis - Artificial photosynthesis. Social and environmental aspects: Bio-energy in relation to agriculture and forestry

UNIT-V: INTRODUCTION TO FUEL CELLS

History, Working principle of fuel cells, Fuel cell thermodynamics, fuel cell electrochemistry - Nernst equation, Electrochemical kinetics, Butler-Voltmeter equation, performance evaluation of fuel cells, Types of Fuel Cells: AFC, PAFC, SOFC, MCFC, DMFC, relative merits and demerits. Future trends in fuel cells.

TEXT BOOKS:

1. G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.

2. John Twidell, Tony Weir “Renewable Energy Resources”, Routledge publishers, third edition 2015.

REFERENCE :

1. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 2008.

2. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.
3. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Resources: Basic Principles and Applications”, Alpha Science International, Limited, 2004
4. J. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 4th edition,2013.
5. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd.,2nd edition, 2012.
6. Xianguo Li, “Principles of Fuel Cells” , CRC Press, first edition,2006
7. James Larminie , Andrew Dicks, “Fuel cell Systems Explained” John Wiley & Sons, Inc, 2nd edition, 2003.

20EEM7-ENERGY AUDITING

B.Tech. (Minor)

L	T	P	Cr.
4	0	0	4

Pre-requisite course: Applied Physics, Basics of Electrical & Electronics Engineering.

COURSE OBJECTIVES: This course enables the student to learn principles of energy audit and Energy conservation act. It also covers energy efficient lighting design, power factor improvement techniques, energy efficiency in HVAC systems. In addition, economic aspects such as payback period calculations, life cycle costing analysis is covered in this course.

COURSE OUTCOMES: At the end of the course, the student will be able to:

CO1: Understand the different parameters for energy auditing. .**(Understand-L2)**

CO2: Interpret the controlling of energy management. **(Understand-L2)**

CO3: Analyze the Reactive power management strategies. **(Apply-L3)**

CO4: Understand the energy conservation measures in HVAC systems. **(Understand-L2)**

CO5: Analyze economic aspects for energy conservation. **(Apply-L3)**

UNIT-I: **BASIC PRINCIPLES OF ENERGY AUDIT**

Energy audit- definitions, types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit in process industry viz., thermal power station, energy audit in buildings, Smart Metering and its implementation.

UNIT-II: **ENERGY MANAGEMENT**

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting- Energy manger, Qualities and functions.

UNIT-III: POWER FACTOR IMPROVEMENT, LIGHTING AND ENERGY INSTRUMENTS Power factor –Pf with non linear loads, effect of harmonics on power factor, power factor motor controllers - Good lighting system design and practice, lighting control ,lighting energy audit – List of Instruments for energy audit- wattmeter, data loggers, thermocouples, pyrometers, lux meters, tongue testers

UNIT–IV: SPACE HEATING AND VENTILATION

Water Heating: Introduction – Heating of buildings – Transfer of Heat–Space heating methods – Ventilation and air–conditioning (HVAC) –Energy conservation methods.

UNIT-V: ECONOMIC ASPECTS AND ANALYSIS

Economics Analysis-Depreciation Methods, time value of money, rate of return, present worth method- CASE STUDY- Energy efficient motors, replacement analysis, life cycle costing analysis- calculation of simple payback method, CASE STUDY, Power factor correction, lighting - Applications of life cycle costing analysis, return on investment .

TEXT BOOKS:

1. Industrial Energy Management: Principles and Applications by Giovanni Petrecea, Kluwer international series in engineering and computer science. Power electronics & power systems.1993.
2. Energy Management, by W.R. Murphy & G. Mckay Butter worth, Elsevier publications. 2012

REFERENCE:

1. Energy Efficient Electric Motors by John. C. Andres, Marcel Dekker Inc. Ltd – 3rd Edition, 2005.
2. Energy management by Paulo' Callaghan, Mc-Graw Hill Book company – 1st edition, 1998.
3. Energy management hand book by W.C. Turner, John wiley and son, 8th 2012.
4. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill Publishing Company Ltd, New Delhi,1991.