MINOR DEGREES OFFERED UNDER SVEC-19 REGULATIONS

Offering Dept.	Title of the Minor	Students of Eligible Branches
CSE	Artificial Intelligence and Machine Learning	All branches except CSE, IT and CSSE
IT	Internet of Things	All branches except IT
CSSE	Cyber Security	All branches except CSE, IT and CSSE
ECE	VLSI and Embedded Systems	All branches except ECE
EEE	Power Systems and Drives	All branches except EEE
EIE	Instrumentation and Control Engineering	All branches except EIE
ME	Robotics	All branches except ME
CE	Sustainable Engineering	All branches except CE

Academic Regulations for Minor Degree:

The concept of Minor degree is introduced in the curriculum of all B.Tech. programs offering a Major degree. The main objective of Minor degree in a discipline is to provide additional learning opportunities for academically motivated students and it is an optional feature of the B.Tech. Program. To earn a Minor degree in a discipline, a student has to earn 18 extra credits (By studying FIVE theory & THREE laboratory courses or SIX Theory Courses) from the core courses of the minor discipline.

a. Students having a CGPA of 8.0 or above up to II B.Tech I-Semester without any backlogs shall be permitted to register for a Minor degree by paying the requisite fee.

b. In the subsequent semesters, the student has to pass all the courses registered for Major and Minor Degrees in the first attempt i.e., regular examinations without any backlog to keep the Minor Degree registration active or else it shall be cancelled.

c. If a student becomes ineligible for continuing the Minor Degree, the earned credits under Minor Degree cannot be transferred to Major

Degree; they will remain extra. These additional courses will be mentioned in the transcript. However, they are eligible to receive B.Tech. Degree after satisfying its requirements.

d. The evaluation pattern of the courses shall be similar to the evaluation of regular program courses.

e. Minimum strength required for offering Minor Degree in a discipline is 40 students.

f. A student registered for Minor degree shall pass in all subjects that constitute the requirement for the Minor degree program. No class/division (i.e., second class, first class and distinction, etc.) shall be awarded for Minor degree program.

g. The Minor degree shall be mentioned in the degree certificate as Bachelor of Technology in XXX with Minor in YYY. For example, Bachelor of Technology in Computer Science & Engineering with Minor in Title of the Minor Pursued. This shall also be mentioned in the transcripts, along with the list of courses taken for Minor degree program. However, the performance of the student in the Minor courses will not be considered for the calculation of SGPA and CGPA for the award of Major Degree.

h. Separate course/class work and time table shall be arranged for the various Minor degree programs. Attendance regulations for these Minor discipline programs shall be as per regular courses.

i. Students aspiring for Minor degree must register from III B.Tech I-Semester onwards and must opt for a Minor in a discipline other than the discipline he is registered in.

j. A Student shall register for Minor with the following combinations:

Offering Theory and Laboratory Courses: SEVEN credits in a semester starting from III B.Tech I-Semester to III B.Tech II-Semester (TWO theory & ONE laboratory courses) and FOUR credits in IV B.Tech I-Semester (ONE theory & ONE laboratory courses).

Offering Theory Courses only: SIX credits in a semester starting from III B.Tech I-Semester to IV B.Tech I-Semester (TWO theory courses).

NOTE: Interested meritorious students shall be permitted to register either for a Minor degree in a discipline (or) Honors Degree in a discipline only, but not both.

MINOR DEGREE IN
POWER SYSTEMS AND DRIVES

Offering Department: ELECTRICAL AND ELECTRONICS ENGINEERING
Students of Eligible Branches: CSE, CSSE, IT, ECE, EIE, ME and CE

COURSE STRUCTURE

Year & Semester	Course Code	Course Title	Contact Periods per week				Credits (C)	Scheme of Examination Max. Marks		
			L	T	P	Total		Int. Marks	Ext. Marks	Total Marks
III B.Tech. I-Sem (2 Theory + 1 Lab)	19BM50201	Electrical Engineering Materials	3	-	-	3	3	40	60	100
	19BM50202	Electricity Safety and Safe Practices	3	-	-	3	3	40	60	100
	19BM50203	Sustainable Energy Resources	3	-	-	3	3	40	60	100
	19BM50231	Electrical Workshop Practice	-	-	2	2	1	50	50	100
III B.Tech. II-Sem (2 Theory + 1 Lab)	19BM60201	Principles of Energy Auditing and Conservation	3	-	-	3	3	40	60	100
	19BM60202	Special Machines and their Controllers	3	-	-	3	3	40	60	100
	19BM60203	Utilization of Electrical Energy	3	-	-	3	3	40	60	100
	19BM60231	Auditing and Conservation Practice Lab	-	-	2	2	1	50	50	100
IV B.Tech. I-Sem (1 Theory + 1 Lab)	19BM70201	Power Electronic Converters	3	-	-	3	3	40	60	100
	19BM70202	Fundamentals of Electric Vehicles	3	-	-	3	3	40	60	100
	19BM70203	Protection of Electrical Systems	3	-	-	3	3	40	60	100
	19BM70231	Simulation of Electrical Systems Lab	-	-	2	2	1	50	50	100

.**Note:** If any student has chosen a course from the above list in their regular curriculum then, he/she is not eligible to opt the same course/s for the Minor degree. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course.

III B. Tech. – I Semester

(19BM50201) **ELECTRICAL ENGINEERING MATERIALS**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Basic Electrical and Electronics Engineering.

COURSE DESCRIPTION: Dielectric properties of organic and inorganic materials and their required properties; Dielectric properties of insulators in static fields and alternating fields; Breakdown of dielectric materials in presence of high voltages; polymer insulation materials and their behaviour in presence of High voltages; Applications of various dielectric materials in high voltage equipment.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. understand the dielectric properties of various organic and inorganic materials and their suitability for high voltage applications.
CO2. realize the behavior of dielectric materials in the presence of static and in alternating fields.
CO3. understand the breakdown mechanism of various dielectric materials in the presence of high voltages.
CO4. realize the various polymer type insulation system for high voltage applications and the breakdown mechanism in composite insulation system.
CO5. understand the suitability of various dielectric materials for various high voltage equipment.

DETAILED SYLLABUS:

UNIT-I: CONDUCTING AND SEMICONDUCTOR MATERIALS (07 Periods)
Ohms law and relaxation time of electrons, Electron scattering and resistivity of metals, thermal conductivity of metals, superconductivity; classification of semiconductors, Energy gap, conductivity in intrinsic semiconductors, Hall Effect and carrier density.

UNIT-II: DIELECTRIC PROPERTIES OF INSULATORS IN STATIC FIELDS AND ALTERNATING FIELDS (08 Periods)
Dielectric Properties of Insulating Materials, Various Types of Polarization in Dielectrics; Static dielectric constant, Polarization and dielectric constant, Internal fields in solids and liquids, static dielectric constant of solids, spontaneous polarization; Frequency dependency of polarization, Ionic polarization, complex dielectric constant, dipolar relaxation, dielectric losses.

UNIT-III: BREAKDOWN PHENOMENA OF DIELECTRIC MATERIALS (12 Periods)
BREAKDOWN IN GASES — Townsend's theory, Streamer's theory, breakdown in electro negative gases, Paschen's law, time lags of breakdown; insulation co-ordination.
BREAKDOWN IN SOLID DIELECTRICS — Thermal breakdown and electro mechanical breakdown, treeing and tracking, Internal discharges.

BREAKDOWN IN LIQUID DIELECTRICS — Suspended particle theory and stressed oil volume theory.

UNIT-IV POLYMER AND COMPOSITE INSULATING MATERIALS (09 Periods)

Polymeric Organic Materials, Thermoplastic Polymers, Thermoset Polymers, Polymer Compounds, Polyvinylchloride (PVC), Polyethylene (PE), Epoxy resins; Composite Insulating System—Impregnated Paper as a Composite Insulation System, Insulating Board Materials, Fiber Reinforced Plastics, Breakdown in composite insulators.

UNIT-V: APPLICATIONS OF INSULATION MATERIALS (09 Periods)

Applications in Power Transformers, Applications in Rotating Machines, Applications in Circuit Breakers, Applications in Cables, Applications in Power Capacitors, Applications in Electronic Equipment.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

TEXT BOOKS:

1. Dekker, Adrianus J. *Electrical engineering materials*. Prentice-Hall, 1959.
2. Naidu MS. *High voltage engineering*. Tata McGraw-Hill Education; 2013.

REFERENCE BOOKS:

1. Arora, Ravindra, and Wolfgang Mosch. *High voltage and electrical insulation engineering*. Vol. 69. John Wiley & Sons, 2011.

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	--	--	--	--	--	1	3	--	--	--	--	--	--	2
CO2	3	1	--	--	--	--	2	--	--	--	--	--	--	--	2
CO3	3	1	--	--	--	3	2	1	--	--	--	--	1	--	2
CO4	3	--	--	--	--	3	2	2	--	--	--	--	2	--	3
CO5	3	--	--	--	--	3	2	1	--	--	--	--	2	--	3
Average	3	1	--	--	--	3	1.8	1.75	--	--	--	--	1.67	--	2.4
Course Correlation Level	3	1	--	--	--	3	2	2	--	--	--	--	2	--	3

Correlation Level:3-High 2-Medium 1-Low

III B. Tech. – I Semester
(19BM50202) ELECTRICITY SAFETY AND SAFE PRACTICES

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Basic Electrical and Electronics Engineering.

COURSE DESCRIPTION: The course deals with the various aspects of potential risk due to electrical shock; safety precautions to be followed while working in hazardous zones; safe practices while handling various electrical equipment and during maintenance; and relevant electrical safety standards and Indian rules and acts.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. understand the Indian electricity rules, regulations and various standards to be maintained for safety of life and equipment.
CO2. understand the potential effects of electrical shock and safety measures to protect against such risk.
CO3. understand the safety aspects and safe practices to be followed while installing residential, commercial and agricultural appliances.
CO4. identify various hazardous working zones and take necessary precautionary measures while working in such areas.
CO5. follow safety measures during installation, testing, commissioning and maintenance of electrical equipment/plant.

DETAILED SYLLABUS:

UNIT-I: INDIAN ELECTRICITY RULES AND ACTS (09 Periods)

OSHA standards of electrical safety, Basic electrical safety rules as per OSHA; Objectives and scope of IE acts and IE rules; Significance of equipment earthing, Earthing of equipment bodies, structures and non-current carrying metallic parts, earthing of system neutral; Rules regarding first aid and firefighting facility, Electrical safety general requirements as per IE rules.

UNIT-II: ELECTRICAL SAFETY AND SAFETY MANAGEMENT (10 Periods)

ELECTRIC SAFETY: Terms and definitions, objectives of safety and security measures, Hazards associated with electric current and voltage, Protection against electrical hazards and types, Effect of current on human body, Principles of electrical safety and approach to prevent accidents.

ELECTRIC SHOCKS AND ITS PREVENTION: Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns.

UNIT-III: ELECTRICAL SAFETY IN RESIDENTIAL, COMMERCIAL AND AGRICULTURAL INSTALLATIONS (08 Periods)

Introduction—Wiring and fitting; Domestic appliances—water tap giving shock, shock from wet wall, fan firing shock; Multi-storied building, Temporary installations, Agricultural

pump installation; Do's and Don'ts for safety in the use of domestic electrical appliances; Principles of safety management in electrical plants.

UNIT-IV: ELECTRICAL SAFETY IN HAZARDOUS AREAS (08 Periods)

Hazardous zones—class 0, 1 and 2; Sparks, flashovers and corona discharge in electrical plants; equipment for hazardous locations; Equipment/Enclosures for hazardous gases and vapours; Classification of Enclosures for hazardous locations; Explosives and provisions of Explosives Act.

UNIT-V: SAFETY DURING INSTALLATION, TESTING AND MAINTENANC

(10 Periods)

Safety during installations: Preliminary preparations, preconditions for start of installation work and safe sequence, safety aspects during installations.

Safety during testing: Purpose of commissioning checks and tests, equipment tests, high voltage energization tests, performance and acceptance tests, safety aspects during commissioning.

Safety during maintenance: Operators safety, Types of safety maintenance, Safety procedures, safety precautions during maintenance, planning of maintenance.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

TEXT BOOKS:

1. S.Rao, Prof. H.L.Saluja, *Electrical Safety, Fire Safety Engineering and Safety Management*, 2nd Edition, Khanna Publishers. New Delhi, 2018 Reprint.

REFERENCE BOOKS:

1. Cadick, John, Mary Capelli-Schellpfeffer, and Dennis K. Neitzel. *Electrical safety handbook.* McGraw-Hill Education, 2012.

ADDITIONAL LEARNING RESOURCES:

Indian Electricity acts:

1. https://cercind.gov.in/Act-with-amendment.pdf
2. https://www.indiacode.nic.in/handle/123456789/2058?view_type=browse&sam_handle=123456789/1362

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	--	--	1	3	1	3	--	--	--	1	1	--	2
CO2	3	1	--	--	1	2	2	--	--	--	--	1	2	--	2
CO3	3	1	--	--	1	2	2	--	--	--	1	1	1	--	2
CO4	3	1	--	--	2	3	2	2	--	--	--	1	2	--	3
CO5	3	1	--	--	--	3	2	2	--	--	--	1	2	--	3
Average	3	1	--	--	1.25	2.6	1.8	2.34	--	--	1	1	1.6	--	2.4
Course Correlation Level	3	1	--	--	1	3	2	3	--	--	1	1	2	--	3

Correlation Level:3-High 2-Medium 1-Low

III B. Tech. – I Semester
(19BM50203) **SUSTAINABLE ENERGY RESOURCES**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: Courses on Basic Electrical and Electronics Engineering.

COURSE DESCRIPTION: Concepts of non-conventional and hybrid energy systems; Operational modes of Co-generation and their economic benefits.

COURSEOUTCOMES: After successful completion of this course, the students will be able to:

CO1. understand the impacts of conventional energy resources on environment and realize various measures to minimize the greenhouse gas effects.
CO2. understand the generating principles and operational aspects of energy from solar.
CO3. understand the generating principles and operational aspects of wind energy conversion technologies.
CO4. understand the generating principles and operational aspects of Ocean energy, Biomass and geothermal energy conversion technologies.
CO5. asses the energy harnessing methods and develop a hybrid energy and energy storage systems.

DETAILED SYLLABUS:

UNIT-I: ENVIRONMENTAL ASPECTS OF POWER GENERATION FROM CONVENTIONAL SOURCES (07 Periods)

Impact of conventional sources on Environment; Limitation of fossil fuels – effects of hydro-electric projects - Atmospheric pollution – Green House Gases (GHG) emission from various energy sources and its effects – disposal of nuclear waste— need for renewable energy sources.

UNIT-II: ENERGY FROM SOLAR (11 Periods)

Introduction, solar radiation, measurement of solar radiation—pyranometer; solar energy collectors; flat plate collectors— liquid and air (non-porous) types; Focusing type— parabolic & point types; solar photovoltaic system— PV cell and its types, configuration of solar panel, PV system; Applications: solar pump, solar water heater.

UNIT-III: ENERGY FROM WIND (08 Periods)

Introduction, power extraction from the wind, Wind turbines— horizontal axis wind turbine—propeller type and vertical axis wind turbine— darrieus rotor type; basic components of wind energy conversion systems, Applications: energy storage, water pumping; environmental impacts.

UNIT-IV: ENERGY FROM OCEAN, BIOMASS AND GEOTHERMAL RESOURCES (11 Periods)

Energy from ocean: Introduction, ocean thermal energy conversion (OTEC): open and closed cycle power plants; tidal energy: schematic diagram of tidal power plant; advantages and disadvantages.

Energy from Biomass: Introduction, biomass conversion technologies-direct, thermochemical and biochemical conversions; biogas generation—anaerobic digestion process.

Geothermal energy: Introduction, Geothermal resources, geothermal power plants—vapor dominated and liquid dominated; environmental issues.

UNIT-V: COGENERATION AND HYBRID ENERGY SYSTEMS (08 Periods)

Cogeneration- Electricity generating systems, Economic and Environmental benefits. Operational modes of co-generation.

Hybrid energy systems: Need for hybrid systems, configuration and coordination, Block diagram approach of Stand-alone PV-wind system, PV-Diesel and Wind-diesel; energy storage systems — ultra capacitors, SMES, Battery.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

TEXT BOOKS:

1. Rai, G.D., *Non-conventional Energy Sources*, Khanna Publishers, New Delhi, 2017.
2. *S.Rao, Dr.B.B.Parulekar, Energy Technology,* third Edition, Khanna publications, 2013.

REFERENCE BOOKS:

1. J K Kaldellis, *Stand-alone and Hybrid Wind Energy Systems*, Wood head, publishing, 1st Edition 2010.
2. David Flin, Cogeneration: A User's Guide. Renewable energy series, Vol. 11. IET, 2010.
3. D P Kothari, K C Singal and Rakesh Ranjan, 'Renewable Energy Sources and Emerging Technologies' 2nd Edition, 2012.
4. S N Bhadra, D Kastha and S Banerjee, 'Wind Electric Systems', Oxford Publications, 2nd Edition, 2007
5. C S Solanki, 'Solar Photo-voltaics – Fundamentals, Technologies and Applications', PHI Pvt.,Ltd., 2nd Edition, 2011.
6. R. K. Rajput, A textbook of power system engineering, Laxmi publications (P) Ltd, 2016.

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	--	--	--	--	3	3	--	--	--	--	--	3	--	2
CO2	3	--	--	--	--	3	3	--	--	--	--	--	3	--	3
CO3	3	--	--	--	--	3	2	--	--	--	--	--	3	--	2
CO4	3	--	--	--	--	3	3	--	--	--	--	--	3	--	3
CO5	3	--	--	--	--	2	3	--	--	--	--	--	3	--	3
Average	**3**	**--**	**--**	**--**	**--**	**2.8**	**2.8**	**--**	**--**	**--**	**--**	**--**	**3**	**--**	**2.6**
Course Correlation Level	3	--	--	--	--	3	3	--	--	--	--	--	3	--	3

Correlation Level:3-High 2-Medium 1-Low

III B.Tech. – I Semester
(19BM50231) ELECTRICAL WORKSHOP PRACTICE

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	2	1

PRE-REQUISITES: A course on Basic Electrical and Electronic Engineering

COURSE DESCRIPTION: Exercises on assessing of electrical parameters and functionality of electrical apparatus; Design and estimation of electrical systems, and protection system for electrical devices and systems; Troubleshooting of electrical appliances and calibration of measuring instruments.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

- CO1 demonstrate the usage of power tools for installation applications and cable laying with relevant accessories.
- CO2 install panel boards for domestic/industrial applications, design and estimate wiring requirements following the code of conduct.
- CO3 practice the measurement of electrical quantities using modern day tools and also calibrate the precession of the measuring instruments.
- CO4 Realize the protection equipment used in domestic/industry and practice protection schemes for a particular application.
- CO5 demonstrate the practice of using various ancillary equipment for electrical appliances and also troubleshoot in the case of malfunctioning of electrical appliances.
- CO6 work independently or in teams to solve problems with effective communication.

List of Exercises/List of Experiments:

*(Minimum **Ten** experiments are to be conducted)*

1. Identification and usage of hand and power tools, PPE for electrical installation applications.
2. Practice of cable laying and termination using conduits, casings, cable joints and its necessary items.
3. Installation and testing of single/three phase distribution boards for domestic/industrial applications.
4. Design and estimation of wiring for a typical house.
5. Measurement of electrical quantities using analog and digital meters.
6. Practice energy meter for measurement of energy and tariff estimation.
7. Calibration of measuring instruments.
8. Operation and testing of Fuse, MCB and Relays.
9. Measurement of equipment to earth resistance and determine the internal leakage currents.
10. Practicing and testing of DOL starter for Induction Motors.
11. Design of Timers for operation of electrical appliances.
12. Troubleshooting of electrical appliances — Fan, Mixer/grinder, Water heater/Iron box.

REFERENCE BOOKS/LABORATORY MANUALS:

1. http://www.srisaiuniversity.org/downloads/files/n59b79d6117211.pdf
2. https://www.gtu.ac.in/syllabus/NEW_Diploma/sem-1/Pdf%20Content%20detailing/3312401Electrical%20&%20Electronic%20Workshop.pdf

ADDITIONAL LEARNING RESOURCES:

1. https://www.youtube.com/watch?v=ax-KUL17YJ4
2. https://www.youtube.com/watch?v=TJpQ3fZIt20
3. https://www.youtube.com/watch?v=6RJnsa83xTA
4. https://www.youtube.com/watch?v=w2M4tS2OMsU
5. https://www.youtube.com/watch?v=DzVJiSQNbew

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	-	-	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	1	1	2	2	1	-	-	1	--	3	1	1
CO3	3	2	--	1	2	3	1	--	-	-	1	--	3	2	2
CO4	3	2	--	--	2	--	2	1	--	--	--	1	3	1	1
CO5	3	2	--	--	--	2	2	--	--	--	--	--	3	1	1
CO6	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
Average	3	2.4	3	1	1.75	2.25	1.75	1	3	3	1	1	2.8	1.4	1.4
Course Correlation Level	3	3	3	1	2	2	2	1	3	3	1	1	3	1	1

Correlation Level:3-High 2-Medium 1-Low

III B. Tech. – II Semester

(19BM60201) PRINCIPLES OF ENERGY AUDITING AND CONSERVATION

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Basic Electrical and Electronics Engineering.

COURSE DESCRIPTION: Principles of energy audit, management and conservation; Energy efficient motors, lighting schemes; Energy measuring instruments and significance of energy economics.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. apply the relevant rules, regulations and procedure of energy audit in industries and realize the energy management principles and protocols for effective conservation of energy.

CO2. analyze performance of energy efficient motors and illumination system by applying the relevant protocols of energy auditing.

CO3. apply appropriate energy auditing instruments for energy auditing in industries and assess their economic benefits.

CO4. apply the demand side management techniques and relevant standards for organization of energy conservation awareness programs.

DETAILED SYLLABUS:

UNIT-I: ENERGY AUDIT AND MANAGEMENT PRINCIPLES (10 Periods)

Energy audit — definitions, concept, types of audit, energy index-cost index, pie charts, Sankey diagrams, load profiles,energy saving potential, energy audit of process industry, building energy audit; IE rules and regulations for energy audit.

Energy management — Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting.

UNIT-II: ENERGY CONSERVATION PRINCIPLES (08 Periods)

Energy scenario in India and world; Rules for efficient energy conservation; Technologies for energy conservation; Principles of energy conservation, roles and responsibilities of energy managers and auditors in industries.

UNIT-III: ENERGY EFFICIENT MOTORS AND LIGHTING (09 Periods)

Energy efficient motors - factors affecting efficiency, loss distribution, constructional details, characteristics, variable speed, variable duty cycle systems.

Lighting -Good lighting system, lighting control, lighting energy audit.

UNIT-IV: ENERGY INSTRUMENTS AND ECONOMIC ANALYSIS (10 Periods)

Principles of energy instruments— Infrared thermometer, data loggers, thermo-couples, pyrometers, Lux meters, tongue testers, power quality analyzer, and PLC and pic applications (Block diagram approach).

Principles of Energy Economic Analysis— The time value of money concept. Cash flow models, payback analysis, depreciation.

UNIT-V: PRINCIPLES OF DEMAND SIDE MANAGEMENT (08 Periods)

Introduction to DSM, Principles of DSM, benefits of DSM, different techniques of DSM – time of day pricing; Management and organization of energy conservation awareness programs.

Total Periods: 45

Topics for Self-study are provided in the Lesson Plan

REFERENCE BOOKS:

1. W.R. Murphy & G. Mckay Butter worth, *Energy management*, Butter worth-Heinemann publications, 2nd Edition, 2016.
2. Albert Thumann, William J. Younger, *Handbook of energy audits*, Taylor & Francis Ltd, 7th Edition, 2008.
3. UmeshRathore, *Energy management*, S.K. Kataria& Sons, 2nd Edition, 2014.
4. W.C.Turner, Stevedoty, *Energy management hand boo*k, CRC press, 6th Edition, 2006.
5. D.P. Sen, K.R. Padiyar, IndraneSen, M.A. Pai, *Recent Advances in Control and Management of Energy Systems*, Interline Publisher, Bangalore, 1993.
6. Ashok V. Desai, Wiley Eastern, *Energy Demand - Analysis, Management and Conservation Hand book on energy auditing - TERI (Tata Energy Research Institute)*, 2005.
7. Craig B. Smith, Kelly E. Parmenter, *Energy management principles Applications*, benefits, Savings, Elsevier Inc(Pergamon Press), 1st Edition, 2016.

ADDITIONAL LEARNING RESOURCES:

1. https://beeindia.gov.in/sites/default/files/1Ch3.pdf
2. https://www.youtube.com/watch?v=M1zijCmeXJg
3. https://www.youtube.com/watch?v=FTpMWXMBSyM
4. https://www.youtube.com/watch?v= T1Au P5bnQ
5. https://www.youtube.com/watch?v=ENLzwTVjxms
6. https://www.youtube.com/watch?v=7hDyLuFJ0c8
7. https://www.youtube.com/watch?v=lkNIuFkzxBk

USEFUL WEBSITES:

1. https://beeindia.gov.in/news-events/energy-conservation-building-code-rules-2018
2. https://beeindia.gov.in/content/energy-auditors
3. https://nayaenergy.com/difference-between-energy-audit-and-energy-management/
4. https://www.sgsgroup.in/en-gb/sustainability/environment/energy-services/energy-audits-and-management/energy-audit
5. https://www.consultivo.in/environment-energy/energy-audit-and-management/
6. https://www.teriin.org/energy
7. http://jnujprdistance.com/assets/lms/LMS%20JNU/Dual%20Degree%20Courses/PGD+MBA%20-%20Energy%20Management/Sem%20III/General%20Aspects%20of%20Energy%20Management%20and%20Energy%20Audit.pdf

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	--	--	2	2	1	1	--	--	--	--	--	1	2
CO2	3	3	2	--	1	2	1	1	--	--	--	--	2	3	1
CO3	3	2	2	--	2	2	2	1	--	--	2	--	2	1	3
CO4	3	3	--	--	2	1	3	1	--	--	--	--	2	1	2
Average	3	2.25	2	--	1.75	1.75	1.75	1	--	--	2	--	2	1.5	2
Course Correlation Level	3	2	2	--	2	2	2	1	--	--	2	--	2	2	2
Correlation Level:3-High 2-Medium 1-Low															

III B. Tech. – II Semester
(19BM60202) SPECIAL MACHINES AND THEIR CONTROLLERS

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: --

COURSE DESCRIPTION: Construction, Working, Types, control operation, characteristics and applications of Stepper Motors, Switched Reluctance Motors, Synchronous Reluctance Motors, Permanent Magnet Brushless DC Motors and Linear Induction Motors.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. analyze the open and closed loop operational characteristics of stepper motor and assess its performance under various scenarios.
CO2. analyse the operational aspects of switched reluctance motor to assess the performance and design the constructional features for sustainability.
CO3. analyse the operational aspects of synchronous reluctance motor to assess its performance, sustainability and applications.
CO4. analyse the sensorless and sensor based operation and control aspects of permanent magnet brushless DC motor and assess the performance under diverse scenarios.
CO5. analyze the operational and control aspects of linear induction motor and assess their performance for special applications.

DETAILED SYLLABUS:

UNIT-I: STEPPER MOTORS (9 Periods)
Constructional features, types, working principle, torque equation, characteristics, open loop and closed loop control of stepper motor, applications.

UNIT-II: SWITCHED RELUCTANCE MOTORS (9 Periods)
Construction details, principle of operation, design of stator and rotor pole arcs, torque equation, characteristics, power converters, torque equations, control of switched reluctance motor and applications.

UNIT-III: SYNCHRONOUS RELUCTANCE MOTORS (9 Periods)
Constructional features, Types – Axial and Radial flux motors. Principle of operation, characteristics, phasor diagram, control of SyRM, advantages and applications.

UNIT-IV: PERMANENT MAGNET BRUSHLESS DC MOTOR (9 Periods)
Constructional details, principle of operation, types of BLDC motor, sensorless and sensor based control of BLDC motors, torque/speed characteristics and applications.

UNIT-V: LINEAR INDUCTION MOTOR (9 Periods)
Construction, principle of operation– single sided and double-sided LIM, thrust equations, performance equations based on current sheet concept, equivalent circuit, goodness factor, characteristics and applications.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

TEXT BOOKS:

1. K. VenkataRatnam, *Special Electrical Machines*, University press, New Delhi, 2009.
2. E.G. Janardhanan, *Special Electrical Machines*, PHI learning private limited, 2014.

REFERENCE BOOKS:

1. Takashi Kenjo, *Stepping Motors and their Microprocessor controls*, clarenden press, Oxford, 1984.
2. T.J.E. Miller, *Brushless Permanent Magnet and Reluctance Motor Drives*, clarenden press, Oxford 1989.
3. R. Krishnan, *Switched Reluctance Motor Drives – Modeling, Simulation, analysis, Design and Applications*, CRC press, Special Indian Edition, 2015.

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	--	3	2	1	3	--	--	--	--	--	--	3	3
CO2	3	3	3	2	1	2	3	--	--	--	--	--	1	3	3
CO3	3	2	--	1	1	2	2	--	--	--	--	--	--	3	3
CO4	3	3	--	2	3	2	1	--	--	--	--	--	--	3	3
CO5	3	3	--	1	1	2	3	--	--	--	--	--	--	2	3
Average	3	2.8	3	1.8	1.6	1.8	2.4	--	--	--	--	--	1	2.8	3
Course Correlation Level	3	3	3	2	2	2	3	--	--	--	--	--	1	3	3

Correlation Level:3-High 2-Medium 1-Low

III B. Tech. –II Semester
(19BM60203) UTILIZATION OF ELECTRICAL ENERGY

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Basic Electrical and Electronics Engineering.

COURSE DESCRIPTION: Types and characteristics of electric drives; types of electric heating and welding; Fundamentals and various methods of Illumination; electric traction; electrolysis, Extraction and refining of metals.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. understand the operational aspects of various drives and apply an appropriate electric drives for various industrial applications.
CO2. understand the different types of heating and welding techniques.
CO3. design illumination system for proper lighting system under given circumstances.
CO4. understand the basic principle of traction systems and different braking techniques used in electric traction.
CO5. understand the basic principle and applications of electrolytic process.

DETAILED SYLLABUS:

UNIT–I: ELECTRIC DRIVES (8 Periods)

Type of electric drives – rating and choice of motor - starting and running characteristics - particular applications of electric drives - types of industrial loads - Continuous - intermittent and variable loads.

UNIT–II: ELECTRIC HEATING & WELDING (10 Periods)

Introduction - Advantages and methods of electric heating - resistance heating - induction heating and dielectric heating.

Electric welding: Classification- resistance and arc welding - electric welding equipment - comparison between AC and DC Welding.

UNIT–III: ILLUMINATION (10 Periods)

Introduction - terms used in illumination - laws of illumination - sources of light. Discharge lamps – mercury vapor and sodium vapor lamps – comparison between tungsten filament lamps and fluorescent tubes – compact fluorescent lamp – LED -Basic principles of light control - Types and design of good lighting system and practice - flood lighting.

UNIT–IV: ELECTRIC TRACTION (10 Periods)

Traction systems: System of electric traction and track electrification - Review of existing electric traction systems in India - Special features of traction motor - Speed-time curves for different services - methods of electric braking - plugging - rheostatic braking, regenerative braking.

UNIT–V: ELECTROLYTIC PROCESS (7 Periods)

Introduction - Basic principles - Faradays laws of electrolysis - Energy efficiency - Electrodeposition-Factors governing deposition Processes - Deposition of Alloys - Extraction and refining of metals.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

TEXT BOOKS:

1. C.L Wadhwa, *Generation Distribution and Utilization of Electrical Energy*, New age International Publishers, 2005 reprint.
2. J. B. Gupta, *Utilization of Electrical Power and Electric Traction*, S. K. Kataria and ons, 2002.

REFERENCE BOOKS:

1. N. V. Suryanarayana, *Utilization of Electrical Power including Electric drives and Electric traction*, New Age International (P) Limited, Publishers, 1996.
2. Alan.V. Oppenheim, Ronald.W. Schafer, John R Buck, *Discrete Time Signal Processing*, Prentice Hall, 2nd Edition, 2006. E.Openshaw Taylor, Utilization of Electric Energy, Orient Longman, 1971.

ADDITIONAL LEARNING RESOURCES:

1. https://www.NPTEL video lectures.
2. https://www.opto-e.com/basics/led-pulsing-and-strobing

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	--	--	--	2	--	--	--	--	--	--	1	2	2
CO2	2	--	--	--	--	--	--	--	--	--	--	--	1	2	--
CO3	3	3	2	--	--	2	1	--	--	--	--	--	2	2	2
CO4	2	2	--	--	--	--	--	--	--	--	--	--	1	1	--
CO5	2	2	--	--	--	1	--	--	--	--	--	--	1	1	1
Average	2.4	2.25	2	--	--	1.67	1	--	--	--	--	--	1.2	1.6	1.67
Course Correlation Level	3	2	2	--	--	2	1	--	--	--	--	--	1	2	2
Correlation Level:3-High 2-Medium 1-Low															

III B. Tech. – II Semester
(19BM60231) **AUDITING AND CONSERVATION PRACTICE LAB**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	2	1

PRE-REQUISITES:--

COURSE DESCRIPTION: Experimental investigations on behavior of insulators, performance of synchronous and asynchronous machines, relay testing and fault analysis.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. demonstrate skill in identifying an appropriate auditing tool for measuring appropriate electrical and non-electrical preliminary quantities for auditing.
CO2. demonstrate skills to apply the auditing principles for illumination, house hold utilities and suggest a suitable conservation methods for economic benefits.
CO3. demonstrate skills to audit various industrial drives and suggest suitable methods for energy conservation adhering the protocols of auditing.
CO4. perform auditing by following the auditing protocols in various commercial, agricultural and domestic class of customers and suggest an appropriate energy conservation practices for economical benefits.
CO5. work independently or in teams to solve problems with effective communication.

Practical Exercises/List of Experiments:

(Minimum Ten experiments are to be conducted.)

1. Demonstration of auditing instruments for measuring electrical and non-electrical quantities for auditing purpose.
2. Measurement of active, reactive power and energy for auditing purpose.
3. Assess power quality problems using power quality analyzer and suggest a suitable conservative measures to mitigate.
4. Testing of Electric motor drive for energy conservation.
5. Analyze star labeled electrical apparatus and compare the data sheet of various star ratings.
6. Determine energy consumption by fluorescent/incandescent lamp and evaluate net energy savings and payback period by replacing with energy efficient lamp.
7. Evaluate energy conservation in a ceiling fan with and without an electronic regulator.
8. Conserve the energy consumption in a three phase induction motor by applying an appropriate energy conservation method.
9. Determine the energy conservation in an induction motor operating in star and delta mode of operation.
10. Estimate energy and economic savings by improving power factor for a given class of consumer.
11. Estimate the economic benefits of improving load factor for a domestic consumer.
12. Audit the energy of a commercial consumer and suggest an appropriate energy conservation practice to reduce energy bill.

ADDITIONAL LEARNING RESOURCES:

1. https://sites.google.com/a/venusict.org/energy-conservation-and-management/ntpl-video-links
2. https://nptel.ac.in/courses/108/105/108105058/
3. https://www.youtube.com/watch?v=Nd_EL_B3JBQ
4. https://www.youtube.com/watch?v=lkNIuFkzxBk
5. https://www.youtube.com/watch?v=730netBSZKY
6. https://www.youtube.com/watch?v=R_FdTPbgzTs

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	--	--	2	2	--	2	--	--	--	--	--	3	2
CO2	3	3	--	--	2	2	2	2	--	--	1	--	--	3	3
CO3	3	3	--	2	2	2	2	2	--	--	--	--	2	3	2
CO4	3	3	--	2	2	3	2	2	--	--	1	--	2	3	2
CO5	--	--	--	--	--	--	--	--	3	3	--	--	--	--	--
Average	**3**	**3**	**--**	**2**	**2**	**2.25**	**2**	**2**	**3**	**3**	**1**	**--**	**2**	**3**	**2.25**
Course Correlation Level	3	3	--	2	2	2	2	2	3	3	1	--	2	3	2

Correlation Level:3-High 2-Medium 1-Low

IV B. Tech. – I Semester

(19BM70201) **POWER ELECTRONIC CONVERTERS**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	--	--	3

PRE-REQUISITES: --

COURSE DESCRIPTION:
Switched mode power supplies; Silicon Controlled Rectifier — with and without isolation, single and multiple outputs; Single phase and three phase topologies; DC-DC converter; AC-AC converter and AC-DC converter; DC-AC converter.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. demonstrate the knowledge on energy conversion of Switched mode power supplies, Matrix converter and soft switch converters.
CO2. analyze closed loop control and regulation of Switched mode dc power supplies based converter.
CO3. analyze AC-DC, AC-AC and DC-AC circuit operation and evaluate their output parameters by using different firing pulses.
CO4. analyze the Soft switching techniques of AC-DC, DC-DC and DC-AC converter circuits by using ZVS, ZCS and quasi resonance operation.

DETAILED SYLLABUS:

UNIT-I: SWITCHED MODE POWER SUPPLIES (11 Periods)
DC Power supplies and Classification; Switched mode dc power supplies - with and without isolation, single and multiple outputs; Closed loop control and regulation; Design examples on converter and closed loop performance.

UNIT-II: AC-DC CONVERTERS (11 Periods)
Switched mode AC-DC converters. Synchronous rectification - single and three phase topologies - switching techniques - high input power factor . Reduced input current harmonic distortion. improved efficiency with and without input-output isolation; Performance indices design examples.

UNIT-III: DC-AC CONVERTERS (07 Periods)
Multi-level Inversion - concept, classification of multilevel inverters, Principle of operation, main features and analysis of Diode clamped, Flying capacitor and cascaded multilevel inverters; Modulation schemes.

UNIT-IV: AC-AC CONVERTERS WITH AND WITHOUT DC LINK (07 Periods)
Matrix converters. Basic topology of matrix converter; Commutation – current path; Modulation techniques - scalar modulation, indirect modulation; Matrix converter as only AC-DC converter; AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter; Performance comparison with matrix converter with DC link converters.

UNIT-V: SOFT-SWITCHING POWER CONVERTERS (09 Periods)

Elementary principles of Soft switching techniques: ZVS and ZCS; Performance comparison hard switched and soft switched converters— AC-DC converter, DC-DC converter, DC-AC converter; Resonant DC power supplies.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

TEXT BOOKS:

1. M.H.Rashid, *Power Electronics Handbook*, Academic press, New York, 2000.
2. Fang Lin Luo and Fang Lin Luo, *Advanced DC/DC Converters, CRC Press*, New York, 2004.
3. Marian P.Kazmierkowski, R.Krishnan and Frede Blaabjerg, *Control in Power Electronics- Selected Problem*, Academic Press (Elsevier Science), 2002.

REFERENCE BOOKS:

1. Issa Batarseh, *Power Electronic Circuits*, John Wiley and Sons, Inc. 2004.
2. Frede Blaabjerg and Zhe Chen,*Power Electronics for Modern Wind Turbines*, Morgan & Claypool Publishers series, United States of America, 2006.
3. Krein Philip T, *Elements of Power Electronics*, Oxford University press, 2008.
4. Agarwal, *Power Electronics: Converters, Applications, and Design*, 3rd Edition, Jai P, Prentice Hall, 2000.
5. L. Umanand, *Power Electronics: Essentials & Applications*, John Wiley and Sons, 2009.

ADDITIONAL LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108/102/108102145/
2. https://nptel.ac.in/courses/108/101/108101126/
3. https://nptel.ac.in/courses/108/101/108101038/
4. https://nptel.ac.in/courses/108/107/108107128/

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	--	--	--	--	--	--	--	--	--	--	--	1	1
CO2	3	3	--	--	--	--	--	--	--	--	--	--	--	1	1
CO3	3	3	--	3	3	--	--	--	--	--	--	--	--	3	3
CO4	3	3	--	1	1	--	--	--	--	--	--	--	--	2	1
Average	3	3	--	2	2	--	--	--	--	--	--	--	--	1.75	1.5
Course Correlation Level	3	3	--	2	2	--	--	--	--	--	--	--	--	2	2
Correlation Level:3-High 2-Medium 1-Low															

IV B. Tech. – I Semester

(19BM70202) FUNDAMENTALS OF ELECTRIC VEHICLES

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	--	--	3

PRE-REQUISITES: A course on Basic Electrical and Electronics Engineering.

COURSE DESCRIPTION: Transportation vehicles and their impact in society; Concept, configurations, principle, types and operation of Electric Vehicles (EV); Power Electronic converters in EVs; Different motor drives & energy storage and management technologies in EVs.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. understand the principle of operation of electric, hybrid-electric vehicles and various emerging technological challenges while confronting the issues during transportation.

CO2. analyze the performance characteristics of various power converters operating in different modes to assess a suitable convertor and its control strategies for sustainability of electric vehicle.

CO3. analyze various propulsion motor drives operating in different modes for sustainability and to determine their performance/operational parameters of electric vehicle.

CO4. analyze various battery energy storage & management systems and assess their adaptability for sustainable performance of electric vehicle.

DETAILED SYLLABUS:

UNIT-I: INTRODUCTION TO EVS AND HEVS (10 Periods)

Environmental impact and history of modern transportation, Electric Vehicles (EVs) — configurations, traction motor characteristics; Hybrid Electric Vehicles (HEVs) — concept and architectures; series and parallel HEVs — configuration, operation, advantages and disadvantages; HEVs — interdisciplinary nature, challenges and key technologies; Plug-in EV — concept and architectures.

UNIT-II: POWER ELECTRONICS IN EVs AND HEVs (08 Periods)

Power electronics — semiconductor devices and circuits used for control and distribution of electric power, AC-DC, DC-DC, DC-AC conversion, four quadrant operation of converters, Thermal Management of HEV power electronics.

UNIT-III: ELECTRIC PROPULSION SYSTEM (09 Periods)

Introduction, configuration and control — DC motor drives, Induction Motor drives, Permanent Magnet Motor drives and Switched Reluctance Motor drives and drive efficiency.

UNIT-IV: ENERGY STORAGE SYSTEMS (09 Periods)

Electrochemical Batteries — terminology, specific energy, specific power, energy efficiency in lead-acid batteries, nickel based batteries, lithium based batteries; Ultra-capacitors —

features, principle of operation and performance; High speed fly-wheels — operating principle, power capacity, fly-wheel technologies and hybrid energy storage systems; Fuel cell — principle of operation and performance.

UNIT-V: ENERGY MANAGEMENT SYSTEM (09 Periods)

Energy Management Strategies, Concept of State of Charge (SoC) and State of Health (SoH), EV charging standards, concept of V2G, V2V, V2H — principle of operation (Block diagram approach only). Wireless Power Transfer — principle of operation (Block diagram approach only).

Total Periods: 45

Topics for self-study are provided in the lesson plan.

TEXT BOOKS:

1. K. T. Chau, *Electric Vehicle Machines and Drives, Design, Analysis and Application*, Wiley, 2015.
2. John G. Hayes, *Electric Powertrain*, Wiley, 2018.

REFERENCE BOOKS:

1. Iqbal Husain, *Electric and Hybrid Vehicles Design Fundamentals*, 2nd Edition, CRC Press, 2011.
2. Jack Erjavec, *Hybrid, Electric & Fuel-Cell Vehicles*, 2nd Edition, Delmar Cengage learning, 2013.
3. Mehrdad Ehsani, Yimin Gao and Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles*, 2nd Edition, CRC Press, 2015.
4. Chris Mi, M. Abul Masrur, David Wenzhong Gao, *Hybrid Electric Vehicles Principles and Applications with Practical Perspectives*, Wiley, 2011.

ADDITIONAL LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108/102/108102121/
2. https://swayam.gov.in/nd1_noc20_ee18/preview
3. https://www.coursera.org/learn/electric-vehicles-mobility?#syllabus

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	--	--	1	1	--	--	--	--	--	--	--	1	1
CO2	3	3	--	--	2	2	1	--	--	--	--	--	1	3	2
CO3	3	3	--	--	2	2	1	--	--	--	--	--	1	3	2
CO4	3	3	--	--	2	2	1	1	--	--	--	--	1	3	2
Average	3	2.75	--	--	1.75	1.75	1	1	--	--	--	--	1	2.5	1.75
Course Correlation Level	**3**	**3**	--	--	**2**	**2**	**1**	**1**	--	--	--	--	**1**	**3**	**2**
Correlation Level:3-High 2-Medium 1-Low															

IV B. Tech. – I Semester
(19BM70203) **PROTECTION OF ELECTRICAL SYSTEMS**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
40	60	100	3	-	-	3

PRE-REQUISITES: A course on Basic Electrical and Electronics Engineering.

COURSE DESCRIPTION: Overview of protective schemes; fuses; circuit breakers; electromagnetic relays; protective schemes applied for various components under various operating conditions; different grounding schemes.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. apply the conceptual knowledge of various fuses for secured operation of domestic and industrial appliances.
CO2. apply the conceptual knowledge of various circuit breakers for secured operation of power system network.
CO3. apply the conceptual knowledge of various relays for secured operation of power system network.
CO4. analyze various protection schemes for the protection of alternators, transformers and motors.
CO5. apply various neutral grounding methods and determine the system parameters for protection in power system.

DETAILED SYLLABUS:

UNIT-I: FUSES (6 Periods)

Necessity of power system protection; Types of fuses — low voltage fuse and high voltage fuse; Advantages and disadvantages; Important terms — Current rating of fuse element, fusing current, fusing factor, cut-off current, pre-arcing time, arcing time, breaking capacity; Application of fuse in residential and commercial loads.

UNIT-II: ELECTRICAL SWITCHGEAR (9 Periods)

Essential features of switchgear, switchgear components; Phenomenon of arc, arc voltage, recovery voltage, restriking voltage; Types of circuit breakers; Construction and principle of operation — minimum oil circuit breaker, air blast circuit breaker, vacuum circuit breaker and SF_6 circuit breaker, and their comparisons, advantages and disadvantages; Applications of circuit breakers, importance of rating of circuit breakers.

UNIT-III: PROTECTIVE RELAYS (8 Periods)

Fundamental requirements of protective relaying, classification of relays — electromagnetic attraction and induction type relays; Construction and working principle of induction type over current relays, differential relays and biased differential relays; Universal torque equation; Characteristics of overcurrent, differential relays; Importance of primary and backup protection, elementary principles of static relays and microprocessor based relays.

UNIT-IV: PROTECTION OF ALTERNATORS, TRANSFORMERS AND MOTORS

(11 Periods)

Protection of alternators: Various faults in alternators — failure of prime-mover, failure of field, overcurrent, overvoltage, unbalanced loading, stator winding faults, rotor winding faults; Rotor protection; Stator protection — restricted earth fault protection and internal fault protection.

Transformer protection: Internal and external faults; Percentage differential protection, Protection against internal faults – Buchholtz relay.

Motor protection: Various faults & abnormal operating conditions, protection in motors, thermal relays and protection of small and large induction motors.

UNIT-V: SUBSTATION PROTECTION **(11 Periods)**

Protection of feeders: Protection of radial and ring main feeders using over current relays.

Protection against over-voltages: Causes of over voltages in power systems, protection against lightning over voltages — surge diverters and absorbers; Working and applications of sphere gap, horn gap and valve type of lighting arrestors.

Neutral grounding: Necessity of neutral grounding, effects of ungrounded neutral on system performance; Methods of neutral grounding — solid, resistance and reactance grounding—merits and demerits.

Total Periods: 45

Topics for self-study are provided in the lesson plan.

TEXT BOOKS:

1. Sunil S. Rao, *Switchgear Protection and Power Systems (Theory, practice and Solved Problems)*, 13th Edition, Khanna Publishers, New Delhi, 2013.
2. Rohit Mehta and V.K. Mehta *Principles of Power System,* 24th Edition, S. Chand Publishiing, 2010.

REFERENCE BOOKS:

1. Badri Ram, D. N. Viswakarma, *Power system Protection and Switchgear*, 2nd Edition, McGraw Hill education (India) Private Limited, New Delhi, 2011.
2. C. L. Wadhwa, *Electrical Power systems*, 7th Edition, New Age International (P) Limited, Publishers, New Delhi, 2017.

ADDITIONAL LEARNING RESOURCES:

1. https://nptel.ac.in/courses/108/101/108101039/
2. https://lsin.panasonic.com/blog/understand-importance-switchgear-protection-devices/
3. https://www.eit.edu.au/courses/professional-certificate-of-competency-electrical-power-system-fundamentals/
4. https://electrical-engineering-portal.com/download-center/books-and-guides/relays/protection-fundamentals
5. https://www.youtube.com/watch?v=LAiBuu_nICI

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	--	--	1	3	--	--	--	--	--	--	3	2	3
CO2	3	2	--	1	1	3	--	--	--	--	--	--	3	2	3
CO3	3	2	3	1	2	3	--	--	--	--	--	--	2	2	3
CO4	3	2	--	1	--	3	--	--	--	--	--	--	2	2	3
CO5	3	2	--	2	--	3	--	--	--	--	--	--	3	--	3
Average	**3**	**2**	**3**	**1.25**	**1.34**	**3**	**--**	**--**	**--**	**--**	**--**	**--**	**2.6**	**2**	**3**
Course Correlation Level	3	2	3	1	1	3	--	--	--	--	--	--	3	2	3
Correlation Level:3-High 2-Medium 1-Low															

IV B. Tech. – I Semester

(19BM70231) **SIMULATION OF ELECTRICAL SYSTEMS LAB**

Int. Marks	Ext. Marks	Total Marks	L	T	P	C
50	50	100	-	-	2	1

PRE-REQUISITES: A course on Basic Electric and Electronics Engineering.

COURSE DESCRIPTION: Investigation of behavior/operational aspects of various electrical systems using simulation tools.

COURSE OUTCOMES: After successful completion of this course, the students will be able to:

CO1. demonstrate generation of signals and perform basic operations on the signals
CO2. analyze various electric circuits operating under different scenarios.
CO3. investigate the time domain specifications of a electrical system and develop a controller to control the dynamics.
CO4. determine the operational aspects of various electrical machines
CO5. analyze the operation of power electronic circuits for different operating conditions
CO6. estimate the tariff for domestic load and also forecast the load from the time series data.
CO7. work independently or in teams to solve problems with effective communication.

Practical Exercises/List of Experiments:

(Minimum Ten experiments are to be conducted.)

1. Generation of continuous and discrete time signals.
2. Basic operations on continuous and discrete time signals — Time scaling and amplitude scaling.
3. Simulate Locus diagram for RL and RC circuits.
4. Determine maximum power transfer using Maximum power transfer theorem.
5. Determine time domain specifications of a transfer function.
6. PID controller for controlling time domain response.
7. Load characteristics of asynchronous machine.
8. Determination of transformer efficiency.
9. Simulation of Single-phase half and full controlled bridge converter with R and RL loads.
10. Simulation of step-down and step-up choppers.
11. Load forecasting using statistical methods.
12. Estimating load consumption and tariff for the domestic load profile.

CO-PO and PSO Mapping:

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	--	--	3	--	--	--	--	--	--	--	1	2	1
CO2	3	3	--	--	3	--	--	--	--	--	--	--	1	3	2
CO3	3	3	2	2	3	2	--	--	--	--	--	--	1	3	2
CO4	2	3	--	1	3	2	--	--	--	--	--	--	1	3	2
CO5	3	3	--	2	3	--	--	--	--	--	--	--	1	3	1
CO6	3	3	--	--	3	2	--	--	--	--	--	--	1	3	1
CO7	--	--	--	--	--	--	--	--	3	3	--	--	1	--	--
Average	2.84	3	2	1.67	3	2	--	--	3	3	--	--	1	2.84	1.5
Course Correlation Level	3	3	2	2	3	2	--	--	3	3	--	--	1	3	2

Correlation Level:3-High 2-Medium 1-Low