TULSIRAMJI GAIKWAD-PATIL
College of Engineering & Technology

Mohgaon, Wardha Road, Nagpur - 441 108

An Autonomous Institute

DEPARTMENTOFELECTRICALENGINEERING

B. Tech. Electrical Engineering

Teaching Scheme

Considering

National Education Policy 2020

From

Academic Year 2024-25

Vision of Institute

To emerge as a learning Center of Excellence in the National Ethos in domains of Science, Technology and Management.

Mission of Institute

1. To strive for rearing standard and stature of the students by practicing high standards of professional ethics, transparency and accountability.
2. To provide facilities and services to meet the challenges of Industry and Society.
3. To facilitate socially responsive research, innovation and entrepreneurship.
4. To ascertain holistic development of the students and staff members by inculcating knowledge and profession as work practices.

Vision of the Department

To emerge as a learning hub and center of excellence in the domain of Electrical Engineering.

Mission of the Department

1. To disseminate knowledge replete with quality education in the field of Electrical Engineering in meticulous and methodical manner.
2. To provide platform to address societal issues as well as challenges faced by industries.
3. To developer search culture and inculcate innovative and entrepreneurial skills.
4. To ensure overall development of students and staff by instilling knowledge and professional ethics as a part of lifelong learning.

Program Outcomes (PO)

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of Complex Problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and software tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of ,and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice.
9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

PSO1: Formulate the solutions to Electrical and Electronics Engineering problems using the basic concepts.

PSO2: Develop the process to interpret networks parameters in power system operation and control with their protection and driving mechanisms.

PSO3: Apply project based learning to conduct experiments with Electrical Machines, Power Electronics to develop energy efficient system

Program Education Objectives (PEO)

1. Demonstrate and analyze the fundamental knowledge with respect to the various domains of Electrical Engineering.
2. Investigate and apply modern tools to develop innovativeness in different applications of Electrical Engineering domain.
3. Integrate new emerging trends and concepts in Electrical Engineering profession for sustainable development.
4. Develop professionals having managerial and administrative Qualities for Electrical Engineering related industries.
5. Promote lifelong learning, to prepare for the next challenges in the field of Electrical Engineering.

Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

(An Autonomous Institution Affiliated to RTM Nagpur University, Nagpur)

SCHEME OF INSTRUCTION & SYLLABI

Programme: Electrical Engineering (NBA Accredited)

Scheme of Instructions: Third Year B.Tech. in Electrical Engineering (As Per NEP 2020)

Semester– VI

SN	Sem	Type	BoS/ Dept	Sub Code	Subject	T/P	Contact Hours			Credits	% Weightage			ESE Duration	Total Marks
							L	P	Hrs		CT/IA	CA	ESE		
1	VI	PCC	EE	BEE33601	Power System Analysis	T	3	-	3	3	30	10	60	3 Hrs	100
2	VI	PCC	EE	BEE33602	Switchgear &Protection	T	3	-	3	3	30	10	60	3 Hrs	100
3	VI	VSEC	EE	BEE33603	1.ETAP 2.PV SYST	P	-	4	4	2	-	25	25	2 Hrs	50
4	VI	PEC	EE	BEE33604-06	Program Elective-II	T	4	-	4	4	30	10	60	3 Hrs	100
5	VI	PEC	EE	BEE33607-09	Program Elective-III	T	4	-	4	4	30	10	60	3 Hrs	100
6	VI	PCC	EE	BEE33610	Power System Analysis Lab	P	-	2	2	1	-	25	25	2 Hrs	50
7	VI	PCC	EE	BEE336011	Switchgear & Protection Lab	P	-	2	2	1	-	25	25	2 Hrs	50
8	VI	MDM	ME	BME33612	Introduction to Industry 4.0	T	2	-	2	2	15	5	30	2 Hrs	50
Total							**16**	**8**	**24**	**20**	**135**	**120**	**345**	**20 Hrs**	**600**

Course Category	BSC/ESC(Basic Science Course/ Engineering Science Course.)	PCC (Programme Core courses)	PEC (Programme Elective courses)	Multidisciplinary courses	SEC(Skill Course)	Humanities Social Science &Management	Experiential Learning Courses	CC (Liberal Learning Courses
Credits	--	08	08	02	02	--	--	--
Cumulative Sum	16/13	39	12	18	08	14	02	04

PROGRESSIVE TOTAL CREDITS: 106+20 = 126

Chairperson	Dean Academics	Vice Principal	Principal	June, 2024	1.00	Applicable for AY 2024-25 Onwards
				Date of Release	Version	

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Third Year (Semester-VI) B. Tech. Electrical Engineering

BEE33601: Power System Analysis

Teaching Scheme	
Lectures	3 Hrs./week
Tutorial	0 Hrs./week
Total Credit	3

Examination Scheme	
CT	30Marks
CA	10Marks
ESE	60Marks
Total	100Marks
Duration of ESE:03 Hrs.00Min.	

Course Objective:

1	Identify the impact of faults (short circuits, open circuits, etc.) on the power system and design protection schemes accordingly.
2	Assess the system's ability to maintain steady operation following disturbances such as faults, sudden load changes, or generator outages.
3	Evaluate system performance under different operating conditions and ensure it meets reliability standards.

	Course Contents	Hours
Unit I	Need for system planning and operational, components Representation Single line diagram per unit quantities p.u. impedance diagram p.u. reactance diagram Network graph, Bus incidence matrix, Primitive parameters, Bus admittance matrix from primitive parameters Representation of off nominal transformer Formation of bus admittance matrix of large power network. Voltage regulation of transmission lines, Voltage regulation using per-unit quantities, effect of load power factor on voltage regulation	(9)
Unit II	**UNIT II POWER FLOW ANALYSIS** Bus classification Formulation of Power Flow problem in polar coordinates Power flow solution using Gauss Seidel method Handling of Voltage controlled buses Power Flow Solution by Newton Raphson method.	(9)
Unit III	**UNIT III SYMMETRICAL FAULT ANALYSIS** Assumptions in short circuit analysis Symmetrical short circuit analysis using Thevenin's theorem Bus Impedance matrix building algorithm (without mutual coupling) Symmetrical fault analysis through bus impedance matrix Post fault bus voltages Fault level Current limiting reactors.	(9)
Unit IV	**UNIT IV UNSYMMETRICAL FAULT ANALYSIS** Symmetrical components Sequence impedances Sequence networks Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG unsymmetrical fault occurring at any point in a power system computation of post fault currents in symmetrical component and phasor domains.	(9)
Unit V	**UNIT V STABILITY ANALYSIS** Classification of power system stability Rotor angle stability Swing equation Swing curve Power-Angle equation Equal area criterion Critical clearing angle and time Classical step-by-step solution of the swing equation modified Euler method.	(9)

Text Books	
1	"Power System Stability and Control" ,Prabha Kundur McGraw Hill Education1st Edition, 1994
2	"Modern Power System Analysis", D. P. Kothari, I. J. Nagrath, R. K. Saket, McGraw Hill Education, 5th Edition, 2022
3	"Power System Analysis", J.B. Gupta, S.K. Kataria and Sons, Reprint 2013 Edition
Reference Books	
1	"Power System Analysis and Design", J. Duncan Glover, Thomas Overbye, Mulukutla S. Sarma, Cengage Learning, 6th Edition, 2017
2	"Power System Operation and Control", A. Chakrabarti, S. Halder , PHI Learning3rd Edition, 2010

BEE33601	Course Outcomes	CL
BEE33601.1	**Formulate** bus admittance matrices, including off-nominal transformer representation, for large power networks.	4
BEE33601.2	**Apply** Gauss-Seidel and Newton-Raphson methods for solving power flow equations, including handling voltage-controlled buses.	3
BEE33601.3	**Compute** post-fault bus voltages, fault currents, and fault levels, considering current limiting reactors.	3
BEE33601.4	**Classify** power system stability and evaluate rotor angle stability using the swing equation, power-angle equation, and swing curve.	3
BEE33601.5	**Compute** post-fault currents for LG, LL, and LLG faults at generator terminals and any system location using symmetrical components and phasor domain methods	4

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Third Year (Semester-VI) B. Tech. Electrical Engineering

BEE33602: Switchgear & protection

Teaching Scheme	
Lectures	3 Hrs./week
Tutorial	0 Hrs./week
Total Credit	3

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs.00Min.	

Course Objective:

1	To introduce students with necessity and basic terminology of protective relaying, causes, types of faults & components used in power system protection.
2	To make the students to understand different types of relays and protective schemes used in power system protection.
3	To aware students about Switchgear, arc interruption theory and working of different types of circuit brakers.

Course Contents		Hours
Unit I	**General Philosophy of protection:** Necessity of Protection, Types, effects and causes of faults, fundamental requirements of a good protection scheme, Primary and Back up protection, Protective zones Rewirable & HRC fuse, MCB, ELCB and their comparison. Classification of relays. Comparison of Electro-mechanical, Static and Numerical relays.	(9)
Unit II	**Over-Current Protection:** Introduction to Over current Protection, over current relay co-ordination. Over current protection schemes for medium voltage lines, Time-Current characteristics, Current setting, Time setting, directional-over current relay, protection of parallel feeders and ring mains. Safety standards (IEC/IEEE/IS codes)	(9)
Unit III	**Distance Protection.:** Distance Protection of High Voltage lines, working principle and characteristic of Impedance relay, Mho relay, Reactance Relay, three step distance protection scheme with contact diagrams, effect of power swing, arc resistance, line length and source impedance on the operation of distance relays, Carries aided distance protection schemes with contact diagram, carrier current protection,	(9)
Unit IV	**Equipment Protection Schemes:** Bus bar Protection, Bus Bar arrangement schemes, Protection of Generator & Transformer by differential relaying and other relays, ,Causes and remedies for mal operation of differential protection, protection of Induction motor against overloading and short circuits, Buchholz relay.	(9)
Unit V	**Switchgear :** Classification of Switchgear, Arcing Phenomena, principles of arc interruption, recovery and restriking voltages, RRRV, Breaking of inductive and capacitive currents. Different types of circuit breakers (Air Blast, SF6 and vacuum circuit breaker) their constructional features, Selection of circuit breakers	(9)

Text Books

1	Sunil S. Rao, "Switchgear and Protection", Khanna Publication, 1992, New Delhi.
2	B. Ravindranath, M. Chander, "Power System Protection and Switchgear", New age International.
3	B. Ram, "Power System Protection and Switchgear", Tata McGraw Hill
4	Y.G. Paithankar, S.R. Bhide, "Fundamentals of Power System Protection", Prentice Hall, India Second Edition,2010
Reference Books	
1	C. Russell Mason, "The art & Science of Protective Relaying", Willey,1956.
2	Warrington, "Protective Relaying Vol. I & II", Springer
3	R. T., Lythall, "Switchgear Handbook", J & P Newness Butterworth, London
4	A.T John & S.K. Salman, "Digital Protection for power Systm",2004.
Useful Links	
https://onlinecourses.nptel.ac.in/noc24_ee64/preview	
https://onlinecourses.nptel.ac.in/noc23_ee59/preview	

BEE33602	**Course Outcomes**	**CL**
BEE33602.1	**Understand** basic terminology of Protective relaying, different types of faults & components used in power system protection.	**2**
BEE33602.2	**Apply** over current protection schemes for medium voltage lines.	**3**
BEE33602.3	**Apply** distance protection schemes for high voltage lines.	**3**
BEE33602.4	**Analyze** protection schemes used for protection of Generators, Transformers& Motors.	**4**
BEE33602.5	**Comprehend** switching phenomenon and working of circuit breakers.	**4**

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Third Year (Semester-VI) B. Tech. Electrical Engineering

BEE33603:1. ETAP2. PV SYST

Teaching Scheme	
Lectures	0 Hrs /week
Practical	4 Hrs /week
Total Credit	2

Examination Scheme	
IA	-
CA	25
ESE	25
Total	50
Duration of ESE	2 Hrs.

BEE33603	Course Outcomes	CL
BEE33603.1	**Understand** the basic interface, toolbars, and features of ETAP for power system analysis.	2
BEE33603.2	**Develop** and execute ETAP programs for cable sizing based on load requirements	3
BEE33603.3	**Analyze** and optimize relay settings using ETAP for coordination studies.	4
BEE33603.4	**Evaluate** PV system performance under different tilt angles and ambient temperatures using PVsyst.	5
BEE33603.5	**Evaluate** the impact of battery State of Charge (SOC) on standalone PV system performance.	5

Sr. No.	Course Contents	
1	Introduction to ETAP: Overview of ETAP interface, toolbars, and features.	CO1
2	To study various ETAP commands: To understand and execute various ETAP commands for power system analysis,	CO1
3	Simulation, and automation using the ETAP interface and scripting.	CO1
4	Write a ETAP Program calculate cable sizing based on load requirements.	CO2
5	To perform arc flash analysis using ETAP software in order to calculate incident energy levels	CO2
6	Write a ETAP Program to adjust relay settings and run coordination studies.	CO3
7	Write a ETAP Program to obtain Automating fault simulations for different fault types.	CO3
8	Introduction to PVsyst.	CO4
9	Introduction to PVsyst: Learn basic interface and tools in PVsyst, different sections Project Design, Database, Tools.	CO4
10	Learn basic interface and tools in PVsyst, different section Project Design, Database, Tools.	CO4
11	Simulate energy yield for different tilt angles (0° to 45°)for PV System	CO4
12	Simulate system performance and check battery state of charge (SOC).	CO5
13	Simulate soiling losses by adjusting dirt accumulation factors.	CO5
14	Run the simulations for different ambient temperatures on PV System Performance.	CO5
15	To design and analyze a hybrid photovoltaic (PV) system with battery storage using PVsyst, by evaluating energy generation, battery charging–discharging behavior	CO5

Text Books

1	"Power Systems Analysis Illustrated with MATLAB® and ETAP" by Hem chandra Madhu sudan

2	"Photovoltaic Systems" by James P. Dunlop – Covers PV system design, including grid-connected configurations.
3	"Solar Photovoltaic Basics" by Sean White – Discusses fundamentals of solar PV system modeling and software

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Third Year (Semester-VI) B. Tech. Electrical Engineering

Program Elective-II BEE33604: Wind Energy Utilization

Teaching Scheme	
Lectures	4 Hrs./week
Tutorial	0 Hrs./week
Total Credit	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE 03 Hrs.00Min.	

Course Objective:

1	Understanding the principles of wind energy conversion, including the history and characteristics of wind.
2	Study of different wind turbine technologies, including fixed and variable speed turbines.
3	Exploring the challenges and opportunities in the wind energy industry, such as cost reduction and grid integration.

Course Contents		Hours
Unit I	**Wind Energy Fundamentals** - Introduction, Application and Historical background, Merits and Limitations, Nature and Origin of Wind, Wind Energy Quantum, Variables in Wind Energy Conversion Systems, Wind Power Density, Power in a Wind Stream, Wind Turbine Efficiency, Power of a Wind Turbine, Forces on the Blade of a Propeller, Wind Velocities and Height from Ground, Mean Wind Velocity, Energy Pattern Factor.	(9)
Unit II	**Wind Turbine**- Generator Units: Introduction, Types of Wind Turbine Generator (WTG) Units, Planning of a Wind Farm, Horizontal Axis Propeller type Wind Turbine Generator, Horizontal Axis Wind Turbine (HAWT), Practical PV Characteristics, Power Coefficients Versus Tip Speed Ratio, Operation and Control of a HAWT.	(9)
Unit III	**Wind Energy Farm and Energy Conversion System**: Wind to Electric Energy Conversion System, Power versus Velocity of WTG, Power Duration Curves Types of Wind Energy System, Wind to Electrical Energy Conversion Alternatives, Grid Connection, Energy Storage Requirements with Wind Energy System, Hybrid wind energy systems.	(9)
Unit IV	**Cost Estimation of WES** -Economics of wind Energy, fundamental of economics, Initial cost of wind energy project-cost of turbine installation-transportation-grid connection-legal and other cost, Operating cost running cost-maintenance cost, Comparison with other energy sources, Cost per unit-case study.	(9)
Unit V	**Offshore Wind Energy power**- Introduction, offshore wind energy technology, future technological development, scenario for the future offshore development of wind power, new offshore concepts, National Offshore Wind Energy Policy of India-development in India, essential components for development of offshore wind energy.	(9)

Text Books

1	Joshua Earnest, Sthuthi Rachel, Wind Energy Technology, PHI Publications, 2019
2	G. D. Rai, Non-Conventional Energy Resources, Khanna Publications, 2006
3	Siraj Ahmed, Wind Energy -Theory and Practice, PHI Publications, 2016

Reference Books

1	Siegfried Heier, Grid integration of wind energy conversion systems, John Willy and Sons Ltd., 2006.

2	Wind Energy: Fundamentals, Resource analysis and Economics, Mathew Sathyajith, Springer, 2006
3	Thomas Ackermann, Wind power in Power Systems, John Willy and Sons Ltd., 2005.

Useful Links

https://nptel.ac.in/courses/101104546

https://nptel.ac.in/courses/112106622

https://www.youtube.com/watch?v=QmQ12gSz5CY

BEE32401	Course Outcomes	CL
BEE32401.1	**Acquire** knowledge on the basic concepts of Wind energy conversion system.	3
BEE32401.2	**Compare** different types of Wind Generator Systems and their characteristics.	4
BEE32401.3	**Analyze** different types of wind energy conversion systems.	4
BEE32401.4	**Estimate** the cost of wind farms and compare it with other renewable sources.	4
BEE32401.5	**Examine** the offshore wind technology and its essential components.	4

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Third Year (Semester-VI) B. Tech. Electrical Engineering

Program Elective –II BEE33605: Power Plant Engineering

Teaching Scheme	
Lectures	4 Hrs./week
Tutorial	0 Hrs./week
Total Credit	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs. 00 Min.	

Course Objective:

1	To familiarize students with the fundamental concepts of electrical power generation, including various type of power plants (e.g., thermal, hydro, nuclear, renewable).
2	To understand the principles of converting mechanical energy into electrical energy through generators and turbines.
3	To introduce students to the integration of renewable energy sources (solar, wind, etc.) into the electrical grid and power plants.

Course Contents		Hours
Unit I	**Sources of Electrical Energy:** Coal, oil and natural gas, water power, nuclear fission and fusion, their scope and potentialities for energy conversion. Electrical Load & Curves: Different factors connected with a generating station, connected load, maximum demand, demand factor, load factor, diversity factor, plant capacity and utilization factor, load curve, load duration curve, load survey, base load and peak load station, advantages of interconnection.	(9)
Unit II	**Thermal Station:** General layout, major equipment, essential and non- essential auxiliaries, electric supply to auxiliaries, cost of generation, effect of different factor on costs. Water Treatment process, Advantages and disadvantages.	(9)
Unit III	**Hydro station:** Hydrology, stream flow, flow duration curve, power duration curve, mass curve and reservoir capacity, type of hydro plants and their field of use, pumped storages plants and their utility, surge tanks, governing characteristics of turbine and hydro generators. Advantages and disadvantage.	(9)
Unit IV	Nuclear station: Principle of Nuclear energy, materials, types of nuclear reactors, breeder reactors, location, material for moderator and control rods, cost economics. Voltage control of A.C. generators: Methods of stabilizing exciter voltage, Automatic Voltage regulator action. Captive & Cogeneration.	(9)
Unit V	Renewable Energy Sources: Introduction to solar energy, Solar energy collectors, solar energy storage, electrical power generation and other Miscellaneous applications of solar energy. Introduction to wind energy Basic principles of wind energy conversion, site selection. basic component of wind energy conversion system, wind turbines and their analysis, wind Electrical generation, stand-alone and grid connected wind electrical power systems, Basic principle of Tidal power ,site selection, storage and plant layout for Tidal power plant.	(9)

Text Books

1	Dr. B.R. Gupta, "Generation of Electrical Energy", S. Chand publisher, 2017.
2	P. K. Nag, "Power Plant Engineering", TMH publisher,4thEdition, 2017.
3	G.D. Rai, "An Introduction to Power Plant Technology", Khanna Publishers,1987.
4	P.C. Sharma, "Power Plant Engineering", Kataria, S.K. & Sons publisher,2004.

Reference Books

1	M.V. Deshpande, Elements of Power Station Design:, edition: Reprint, publisher: PHI Learning Pvt. Ltd., 2009
2	Chakraborty, Sony, Power System Engineering, Dhanpatrai & Sons publications 15 th edition 2002.
3	Elanchezhian,"Power plant Engineering" ,I.K. International Publications, 2010

Useful Links

https://onlinecourses.nptel.ac.in/noc22_me73/preview

https://archive.nptel.ac.in/courses/112/107/112107291/

https://www.youtube.com/playlist?list=PLMtBdv6WGV5-zDap4AWZE7IdIFNb70KzC

BEE33605	Course Outcomes	CL
BEE33605.1	Illustrate the electrical energy sources as well as factors involved with power plant operation.	3
BEE33605.2	Analyze the working and layout of Thermal power plants and different System comprising the plant.	4
BEE33605.3	Illustrate the working principle and basic components of the Hydro Station .	3
BEE33605.4	Describe the working principle and basic components of the nuclear power plant, voltage control, captive & Cogeneration.	2
BEE33605.5	Investigate the role of renewable Energy sources.	4

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Third Year (Semester-VI) B. Tech. Electrical Engineering

Program Elective –II BEE33606: Flexible AC Transmission System

Teaching Scheme	
Lectures	4 Hrs./week
Tutorial	0 Hrs./week
Total Credit	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs. 00 Min.	

Course Objective:

1	Understand the concepts of flexible AC transmission systems (FACTS) and their role in modern power system operation.
2	Understand and model advanced FACTS devices such as UPFC and IPFC for power flow and phase angle regulation
3	Apply knowledge of FACTS controllers to improve transmission line performance, stability, and controllability in real-world power systems.

Course Contents		Hours
Unit I	**FACTS Concept and General System Consideration:** Transmission Interconnection, Flow of Power in an AC System, factors affecting the Loading Capability, Power Flow and Dynamic Stability Consideration of Transmission interconnection, relative importance of controllable, Types of FACTS Controllers, Benefits from FACTS Technology.	(9)
Unit II	**Voltage-Sourced and Current. Sourced Converters:** Concept of Voltage-Sourced Converters, Single-Phase Full-Wave Bridge Converter Operation, Three-Phase Full-Wave Bridge Converter, and Transformer Connections for 12-Pulse Operation, 24- Pulse and 48-Pulse operation. Three level voltage source converter, Generalized Technique of Harmonic Elimination and Voltage Control, Basic pulse width modulation converter, Concept of Current Source Converters, and comparison of current source converters with Source converters. .	(9)
Unit III	**Static Shunts Compensators**: SVC AND STATCOM : Objectives of Shunt Compensation, Midpoint Voltage Regulation for Line Segmentation, End of Line Voltage Support to Prevent Voltage Instability, Improvement of Transient Stability, comparison between STATCOM and SVC.	(9)
Unit IV	Static Series Compensators: GCSC, TSSC, TCSC and SSSC: Objectives of Series Compensation, Voltage Stability, Improvement of Transient Stability, Power Oscillation Damping, Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (only SSSC), External (System) Control for Series Reactive Compensator Applications of SSSC in load flow and transient stability studies.	(9)
Unit V	Static Voltage and Phase Angle Regulators; TCVR, TCPAR' UPFC and IPFC: Objectives of Voltage and Phase Angle regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVR and TCPARs), Introduction and operating principle of Unified Power Flow Controller (UPFC) and Interline Power Flow Controller (IPFC).	(9)

Text Books

1	Narain G. Hingorani and Laszlo Gyigyi, "Understanding FACTS Concepts and Technology of Flexible AC Transmission system A John W & Sons Inc Publicati 2000
2	K. R. Padiyar, "FACTS : Controllers in Power Transmission & Distribution", New age International, 1st Edition, 2007.
3	Yang Hua Song and Johns, "Flexible AC Transmission System (FACTS)",IEEE Publisher,2006.

Reference Books	
1	V.K.Sood, "HVDC and FACTS controllers - Applications of Static Converters in Power System", New Age international (P) Limited,Publisher ,New Delhi
2	R. Mohan Mathur, Rajiv K Verma , "Thyristor Based FACTS Controllers for Electrical ,Transmission system,"wiley , 2002
Useful Links	
https://nptel.ac.in/courses	
https://onlinecourses.nptel.ac.in/noc23_ee58/preview	

BEE33606	Course Outcomes	CL
BEE33606.1	Understand the problem and constraints related with Stability and large interconnected system.	2
BEE33606.2	Describe voltage-Sourced, current. Sourced converters and harmonic elimination techniques.	2
BEE33606.3	Illustrate the use of Static shunts compensators for improvement in Power Quality	3
BEE33606.4	Discriminate the use of Static Series Compensators for voltage stability	2
BEE33606.5	Explain the operating principal Voltage as well as phase Angle regulators and power flow controller	2

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Third Year (Semester-VI) B.Tech. Electrical Engineering

Program Electives-III BEE33607: Biomass Energy and its Utilization

Teaching Scheme	
Lectures	4 Hrs./week
Tutorial	0 Hrs./week
Total Credit	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:03 Hrs.00Min.	

Course Objective:

1	To give students the basic knowledge of biomass energy utilization
2	To enable students to the process of design of biomass systems
3	To facilitate the regulatory framework of bio-energy in India

	Course Contents	Hours
Unit I	**Biomass types and Characterization:** Biomass basics, dedicated crops, oil crops and microalgae, broad classification and compositional analysis, characteristics and properties of biomass, properties and structural components of biomass.	(9)
Unit II	**Biomass Conversion Mechanisms:** Utilization of biomass through biochemical and thermo chemical routes, conversion mechanism of biomass to biogas and its properties, classification of biogas plants. Thermo-chemical conversion of biomass to solid, liquid and gaseous fuels, gasification numerical.	(9)
Unit III	**Biomass Waste to Energy:** Energy production from biomass wastes through incineration, energy production through gasification of wastes, briquetting of biomass, Success stories through case studies of community biogas plants	(9)
Unit IV	**Hydrogen, Methane and Methanol:** Bio-hydrogen production, meta bolics, microorganisms, biogas technology, fermenter design, biogas purification, methanol production and utilization.	(9)
Unit V	**Bio - Energy Development in India** – Financial Analysis of Biomass Energy projects, Government initiatives, project financing for Biomass and Energy projects, case study on biomass energy implementation.	(9)

Text Books

1	S. Rao, Dr. B.B. Parulekar "Energy Technology", Khanna Publishers, 5th Edition
2	G.D. Rai, " Non-Conventional Energy Sources", Khanna Publishers, 4th Edition
3	N.S. Rathore, N.L. Panwar "Biomass Production And Efficient Utilization For Energy Generation, CRC Press, 1st Edition

Reference Books

1	John Twidell, " Renewable Energy Sources", Routledge, Fourth Edition
2	Muhammad Rashed Al Mamun, "Utilization of Biomass for supply of renewable energy in rural area.", Springer 1st Edition
3	Dan Bahadur Pal, Pardeep Singh, "Utilization of Waste Biomass in Energy, Environment and Catalysis", CRC Press, 1st Edition

Useful Links		
https://nptel.ac.in/103103207, https://nptel.ac.in/103103206		
Sardar Swaran Singh National Institute Of Bio-Energy (nibe.res.in)		
	Course Outcomes	**CL**
BEE3607.1	**Classify** the types of Biomass based on the properties and energy content in the biomass.	**3**
BEE3607.2	**Explain** the conversion mechanism of biomass to biogas through thermo-chemical and gasification process.	**2**
BEE3607.3	**Assess** the energy production from biomass through incineration and gasification methods.	**3**
BEE3607.4	**Facilitate** the fermenter, biogas purification, bio hydrogen production and its utilization.	**3**
BEE3607.5	**Demonstrate** the role of Government of India in the development of bio-energy in India.	**4**

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Third Year (Semester-VI) B.Tech. Electrical Engineering

Program Electives-III BEE33608: Electrical Distribution System

Teaching Scheme	
Lectures	4 Hrs./week
Tutorial	0 Hrs./week
Total Credit	4

Examination Scheme	
CT	30 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE:03 Hrs.00Min.	

Course Objective:

1	Understanding the necessity of an electrical distribution system in the real world
2	Theoretical understanding of how to assess a distribution system's performance using its key performance indicators, such as power losses and voltage dips.
3	How to use different voltage management and compensation strategies to enhance the system's power factor and voltage profiles for greater value

Course Contents		Hours
Unit I	**Introduction to Distribution Systems:** Introduction, load modeling and characteristics, Coincidence factor, contribution factor loss factor - Relationship between the load factor and loss factor. Classification of loads: Residential, commercial, Agricultural and Industrial loads and their characteristics.	(9)
Unit II	**Distribution Feeders & Substations:** Design Considerations of Distribution Feeders: Radial and loop types of primary feeders, voltage levels, feeder loading; basic design practice of the secondary distribution system. SUBSTATIONS: Rating of distribution substation, service area within primary feeders. Benefits derived through optimal location of substations. Layout of the Substation.	(9)
Unit III	**Distribution System Analysis:** Voltage drop and power-loss calculations: Derivation for voltage drop and power and its numerical	(9)
Unit IV	**Protective Devices & Automation:** Objectives of distribution system protection, types of common faults and procedure for fault calculations. Protective Devices: Principle of operation of Fuses, Circuit Re-closures and line sectionalizes, and circuit breakers. Automation:-Introduction to Distribution Automation, Data acquisition system and decentralized control, data acquisition and protection considerations of control panel.	(9)
Unit V	**Voltage Control & Power Factor Improvement:** Equipment for voltage control, effect of series capacitors, line drop Compensation, effect of AVB/AVR, Power factor control using different types of power capacitors, shunt and series Capacitors, effect of shunt capacitors (Fixed and Switched), capacitor allocation-Economic Justification Procedure to determine the best capacitor location.	(9)

Text Books

1	Electrical Power Distribution System- Kamaraju, Tata McGraw Hill Publications.
2	Electric Power Distribution, Dr.S.Sivanagaraju, Dr.K.Shankar. Danapathi Rai Publications.
3	Electric Power Distribution A. S. Pabla Tata Mc Graw-Hill Publishing Company.

Reference Books	
1	Electrical Power Distribution System Engineering, TuranGonen, CRC Press.
2	Electrical Power Generation, Transmission and Distribution, SN Singh, PHI Publications.
3	Electric Power Distribution Automation M. K. Khedkar & G. M. Dhole University Science Press.

Useful Links
https://archive.nptel.ac.in/courses/108/107/108107112/
https://www.digimat.in/nptel/courses/video/108107112/L01.html
https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-ee15/

BEE33608	Course Outcomes	CL
BEE33608.1	**Understand** the general aspects of electrical distribution system.	2
BEE33608.2	**Design** and analysis of distribution feeders and substations.	4
BEE33608.3	**Analyze** the need for protection and distribution automation. .	3
BEE33608.4	**Recognize** the significance of voltage drop and power loss in the distribution system.	2
BEE33608.5	**Implement** the need for controlling the PF, Voltage and Power and the equipment used for mitigating them.	4

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Third Year (Semester-VI) B.Tech. Electrical Engineering

Program Electives-III BEE33609: Electric Vehicles

Teaching Scheme	
Lectures	4 Hrs./week
Tutorial	0 Hrs./week
Total Credit	4

Examination Scheme	
CT	30Marks
CA	10Marks
ESE	60Marks
Total	100Marks
Duration of ESE:03 Hrs.00Min.	

Course Objective:

1	To provide good foundation for learning Hybrid and Electric Vehicle
2	To understand the concepts of power converters and motors used in Electric Vehicles.
3	To familiarize the energy storage system and charging infrastructure.

	Course Contents	Hours
Unit I	**Electric Vehicle Fundamentals**: History, Basics of Electric Vehicles, Components of Electric Vehicle, General Layout of EV, EV classification: Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs) Comparison with Internal Combustion Engine: Technology, Advantages & Disadvantages of EV, National Policy for adoption of EVs.	(9)
Unit II	**Storage System** - Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its modeling, SOC, Different Types of Batteries, Super Capacitor based energy storage and its analysis, Hybridization of different energy storage devices.	(9)
Unit III	**Electrical Drives and its Control**: Introduction to electric components used in electric vehicles, Control of Induction Motor Drive, Permanent Magnet (PM) motor Drive & Switched Reluctance Motor (SRM) Drive, four quadrant operation of drives, Converter based AC and DC drives and its analysis, dual converter.	(9)
Unit IV	**Hybrid Electric Vehicle** -Series HEVs, Parallel HEVs, Series–Parallel HEVs, Complex HEVs, Operating Modes, Degree of Hybridization, Comparison of HEVs, Plug-in Hybrid Electric Vehicles (PHEVs) Real Life examples of HEVs, compare and contrast the performance of ICE vehicles, HEVs and EVs.	(9)
Unit V	**Energy Management System and Charging Infrastructure** - Introduction to energy management strategies used in electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies, Types of EV charging Infrastructure & Standardized Communication protocols for EV charging.	(9)

Text Books

1	Prof. Sunil Pawar, "Electric Vehicle Technology" Notion Press Publication, 2nd edition, 2020
2	R. Krishnan, Electric Motor drives – Modelling, Analysis & Control:, PHI India Ltd, 2009
3	Iqbal Hussain, Electric and Hybrid Vehicles Design Fundamentals, 2/e, CRC Press, 2003.

Reference Books

1	Vedam Subrahmanyam, " Electric drives concepts and applications" McGraw-Hill, 1996
2	James Larminie, John Lowry, "Electric Vehicle Technology", Wiley, 2003.
3	C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001

Useful Links
https://nptel.ac.in/courses/108106170
https://onlinecourses.nptel.ac.in/noc22_ee53
https://onlinecourses.nptel.ac.in/noc21_ee112

BEE33609	Course Outcomes	CL
BEE33609.1	**Acquire** knowledge on the basic concepts of Electric Vehicle system.	3
BEE33609.2	**Compare** different types of batteries and their characteristics.	4
BEE33609.3	**Analyze** different types of converter based AC and DC drives.	4
BEE33609.4	**Examine** the types of Hybrid Electric Vehicles and their parameters.	4
BEE33609.5	**Illustrate** the energy management system and explore the communication protocols of charging system.	3

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Third Year(Semester-VI) B. Tech. Electrical Engineering

BEE33610: Power System Analysis Lab

Teaching Scheme	
Practical	2 Hrs./week
Total Credit	1

Examination Scheme	
CA	25 Marks
ESE	25 Marks
Total	50 Marks
DurationofESE:3Hrs.00Mins	

Course Outcomes

BEE33610.1	Simulate load transfer and monitor feeder parameters during operational conditions	4
BEE33610.2	Formulate bus admittance (Y-BUS) and impedance (Z-BUS) matrices using direct inspection methods.	3
BEE33610.3	Model and analyze transmission lines, including computation of ABCD parameters and simulation of Ferranti effect using MATLAB	4
BEE33610.4	Design and simulate multi-area load frequency control using SIMULINK.	4
BEE33610.5	Perform fault analysis (LL, LG, LLG, LLLG) on 3-phase synchronous machines to study fault behavior and system response	3

Sr. No.	List of Experiment	CO
1	To obtain the original unbalanced phase voltages from symmetrical components using MATLAB	CO1
2	Simulation of monitoring the feeder parameter from workstation	CO1
3	Formation of Admittance (Y) BUS using direct inspection method.	CO2
4	To find load flow analysis using Gauss-Seidal method in MATLAB	CO2
5	Formation of Impedance (Z) BUS using direct inspection method.	CO2
6	Design the MATLAB program to model transmission lines	CO3
7	Determination of Sequence Impedance of Cylindrical Rotor Synchronous Machine	CO3
8	Design the MATLAB program to simulate Ferranti effect	CO3
9	Determine ABCD constants and Regulation of a 3-Φ transmission line model.	CO4
10	To obtain symmetrical components of set of unbalanced currents	CO4
11	Design the SIMULINK model for two area load frequency control.	CO4
12	LLG and LLLG fault analysis of 3-Φ synchronous machine.	CO5
13	To perform power flow solution of a 3-Bus system using MATLAB-PSAT	CO5
14	LG and LL fault analysis of 3-Φ synchronous machine.	CO5
15	To become familiar with various aspects of the transient stability analysis of Single-Machine-Infinite Bus (SMIB) system using MATLAB	CO5

Text Books

1	I. J. Nagrath, D. P. Kothari, Modern Power System Analysis, 3rd Edition, Tata McGraw Hill Publishing Co. Ltd., 2003
2	Electric Power Generation: Transmission and Distribution, S. N. Singh, PHI Learning,2012
3	A Chakrabarti, M. L Soni, P. V. Gupta, U. S. Bhatnagar, "A Text book of Power System Engineering" , Dhanpat Rai Publication, 2016

Reference Books

1	"Electrical Power Systems", C.L. Wadhwa,,New Age International Publication,6th Edition,2010
2	"Computer Techniques in Power System Analysis", M.A. Pai, Tata McGraw-Hill, 2nd Edition, 2006.
3	"Power System Analysis", John J. Grainger & William D. Stevenson, McGraw Hill, 1st Edition, 1994.

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Third Year(Semester-VI) B. Tech. Electrical Engineering

BEE336011: Switchgear & Protection Lab

Teaching Scheme	
Lectures	2Hrs./week
Total Credit	1

Examination Scheme	
CA	25 Marks
ESE	25 Marks
Total	50 Marks
Duration of ESE:02 Hrs.00Min.	

Course Outcomes (CO):

1	**Determine** time-current characteristics of thermal overload relay, over current relay & earth fault Relay.
2	**Demonstrate** the characteristics of MCB, HRC fuse, Circuit Breaker & IDMT over current relay.
3	**Determine** characteristics of transmission line for ABCD parameter of PIE & T network.
4	**Demonstrate** the working performance of reverse power relay & Buchholz relay.
5	**Analyze** performance of transmission line for various faults using MATLAB.

Sr. No.	List of Experiment	CO
1	Determine time-current characteristics of thermal overload relay.	CO1
2	Determine time-current characteristics of over current & earth fault Relay.	CO1
3	Simulate Overcurrent protection using a simple logic block.	CO1
4	Determine time-current characteristics of IDMT over current relay	CO2
5	Testing of MCB & HRC fuse.	CO2
6	Demonstrate the characteristics of MCB & HRC fuse	CO2
7	Simulation of Circuit Breaker Opening & Closing Operation in MATLAB/Simulink	CO2
8	Determine characteristics of transmission line for ABCD parameter of PIE network.	CO3
9	Determine characteristics of transmission line for ABCD parameter of T network.	CO3
10	Demonstrate the working performance of reverse power relay.	CO4
11	Simulation of Transformer Differential Protection using MATLAB/Simulink	CO4
12	Demonstrate the working principle of Buchholz relay.	CO4
13	Analysis of transmission line for symmetrical faults using MATLAB.	CO5
14	Analysis of transmission line for asymmetrical faults using MATLAB.	CO5
15	Demonstrate/Simulate Transmission line protection by using the impedance /Over current relay for various faults.	CO5

Text Books

1	Sunil S. Rao, "Switchgear and Protection", Khanna Publication, 1992, New Delhi.
2	B. Ravindranath, M. Chander, "Power System Protection and Switchgear", New age International.
3	B. Ram, "Power System Protection and Switchgear", Tata McGraw Hill

Reference Books

1	C. Russell Mason, "The art & Science of Protective Relaying", Willey,1956.

2	Warrington, "Protective Relaying Vol. I & II", Springer
3	R. T., Lythall, "Switchgear Handbook", J & P Newness Butterworth, London
4	A.T John & S.K. Salman, "Digital Protection for power Systm",2004.
Useful Links	
https://onlinecourses.nptel.ac.in/noc24_ee64/preview	
https://onlinecourses.nptel.ac.in/noc23_ee59/preview	

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Third Year (Semester-VI) B. Tech. Electrical Engineering

BME33612: Introduction to Industry 4.0

Teaching Scheme	
Lectures	2 Hrs./week
Tutorial	0 Hrs./week
Total Credit	2

Examination Scheme	
CT	15 Marks
CA	05 Marks
ESE	30 Marks
Total	50 Marks
Duration of ESE:02 Hrs.00Min.	

Course Objective: On successful completion of the course, the students will be able to:

1	Know about Industry 4.0 and its scope.
2	Explain Design thinking principles and its usage for problem solution
3	Apply learned skills to approach problems that exist in real life

	Course Contents	Hours
Unit I	**Introduction 4.0 Industry:** Introduction to Sensing & Actuation, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected business perspective. Industry4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Artificial Intelligence, Big Data and Advanced Analysis. Introduction to FDM machine, 3D printing demonstration	(8)
Unit II	**Design Thinking as a Problem-Solving Process:** Describe the principles of Design Thinking. - Describe the Design Thinking process for problem solution. Basics of Industrial Internet of Things(IIOT):Introduction, Industrial Internet system, Industrial process, Key enablers of IIOT, Cyber Security	(8)
Unit III	**Case Studies:** Real time use cases from different Industries like OIL, Chemical and Pharma and Uses of UAV in industries	(8)

Text Books

1	The Concept Industry 4.0:An Empirical Analysis of Technologies and Applications in Production Logistics By Christoph Jan Bartodziej
2	Industry 4.0: Entrepreneurship and Structural Change in the New Digital Land scape, By Springer

Reference Books

1	Virtual and Rapid Manufacturing: Advanced Research in Virtual and Rapid Prototyping, By Bartolo, P J, Taylor and Francis
2	Rapid Manufacturing: An Industrial Revolution for a Digital Age By Hopkinson, N, Haque, R. ,and Dickens, P., Wiley
3	Make:3DPrintingByAnnaKaziunasFrance

Useful Links

https://npteLac.in/courses/107101086/

https://npteLac.in/courses/106105195/

https://npteLac.in/courses/112104265

BME33612	Course Outcomes	CL
BME33612.1	Know about Industry 4.0 and its scope.	2
BME33612.2	Explain Design thinking principles and its usage for problem solution	2
BME33612.3	Apply learned skills to approach problems that existing real life	2

Chairman

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