TULSIRAMJI GAIKWAD-PATIL College of Engineering & Technology

Mohgaon, Wardha Road, Nagpur - 441 108

An Autonomous Institute

DEPARTMENT OF ELECTRICAL ENGINEERING

B.Tech. Electrical Engineering
VI Semester

Syllabus

From

Academic Year 2023-24

Tulsiramji Gaikwad-Patil College of Engineering & Technology, Nagpur

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

SCHEME OF INSTRUCTION & SYLLABI

Programme: Electrical Engineering

Scheme of Instructions: Third Year B.Tech. in Electrical Engineering

Semester – VI

Sr. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hrs./Wk	Credits	EXAM SCHEME				
									CT1	CT2	CA	ESE	TOTAL
1	HSMC	BEE3601	Engineering Economics & Management	3	-	-	3	3	15	15	10	60	100
2	PCC	BEE3602	EHVAC & HVDC Transmission	3	-	-	3	3	15	15	10	60	100
	PCC	BEE3603	Electric Drives &Vehicle Technology	3	1	-	4	4	15	15	10	60	100
3	PCC	BEE3604	High Voltage Engineering Lab	-	-	2	2	1	-	-	25	25	50
	PCC	BEE3605	Electric Vehicle Technology Lab	-	-	2	2	1	-	-	25	25	50
4	PROJ	BEE3606	Mini Project#	-	-	2	2	2	-	-	50	50	100
5	PEC	BEE36**07-10**	Program Elective-III	4	-	-	4	4	15	15	10	60	100
6	PEC	BEE36**11-14**	Program Elective-IV	4	-	-	4	4	15	15	10	60	100
7	OEC	B$$XX**01-16**	Open Elective -II	3	-	-	3	3	15	15	10	60	100
8	MCC	BAU3606	Social Awareness	2	-	-	2	Audit	-	-	-	-	-
			Total	**22**	**01**	**6**	**29**	**25**	**90**	**90**	**160**	**460**	**800**

 # Every Student will undergo Industrial Training/Internship of Two weeks in summer vacation after B. Tech. V Sem. Examinations.

*** $$- CS, IT, EC, CE, ME, AE, BT**

L- Lecture T-Tutorial P-Practical

CT1- Class Test 1 TA/CA- Teacher Assessment/Continuous Assessment

CT2- Class Test 2 ESE- End Semester Examination (For Laboratory End Semester performance)

Course Category	HSMC (Hum., Soc. Sc, Mgmt.)	BSC (Basic Sc.)	ESC (Engg. Sc.)	PCC (Programme Core courses)	PEC (Programme Elective courses)	OEC (Open Elective courses from other discipline)	Project / Seminar / Industrial Training	MCC (Mandatory Courses)
Credits	03	--	--	09	08	03	02	Yes
Cumulative Sum	09	25	21	49	14	06	04	--

PROGRESSIVE TOTAL CREDITS :103+25 =128

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

BEE3601: Engineering Economics & Management

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To know the students about basic concept of economics.
2	To know the students about functions of various banks, types of taxes, advantages /Disadvantages of various taxes, inflation, deflation.
3	To get the knowledge of marketing & financial management.

	Course Contents	Hours
Unit I	**Theory of Demand & Utility:** Law of Demand. Types of Demand,, Elasticity of demand, methods of measurement of elasticity of demand, law of diminishing marginal utility, factors of production.	**(9)**
Unit II	**Price Determination & depreciation:** Laws of return, Average cost, Marginal cost, fixed cost, variable cost, perfect competition. Imperfect competition (monopoly, oligopoly, monopolistic competition) , Depreciation, Methods to calculate depreciation	**(9)**
Unit III	**Functions of Banks, Taxation & Economic Policy:** Banks, Functions of Central & Commercial Banks, Inflation, Deflation, Stagflation, Direct and Indirect Taxes, Globalization, Liberalization business cycles.	**(9)**
Unit IV	**Functions of Management & Share market:** Nature & Scope of management, functions of management-planning, organizing, directing, Controlling & Communicating. **Share Market:** Concept & overview of share market, Effect of Share market on Economy, share market Terminology.	**(9)**
Unit V	**Marketing & Financial Management:** Marketing Mix, channels of distribution, advertising and sales promotion, objectives of financial marketing, balance sheet, profit and loss account, budget and their importance.	**(9)**

Text Books

1	O.P. Khanna, “Industrial Engineering and Management”, Dhanpat Rai & sons,1999
2	R.Panner Selvam, “Production and Operations Management”, PHI Learning, 2002
3	Mart and Telsang, “Industrial Engineering and Production Management”, S.Chand and Co., 1998

Reference Books

1	Shailendra Kale, “Production and Operations Management”, McGraw Hill, India 2013

Useful Links
https://nptel.ac.in/courses/112107209
https://www.youtube.com/watch?v=RaXQ8wQ6TUs

	Course Outcomes	CL
BEE3601.1	**Describe** demand & utility of product in industries.	**4**
BEE3601.2	**Discuss** the terms Price determinations and depreciation.	**4**
BEE3601.3	**Explain** the functions of banks, taxations & economic policies.	**4**
BEE3601.4	**Apply** the planning, organizing, direction, controlling & Communication strategies for proper management in industries.	**3**
BEE3601.5	**Apply** the skill of finance & marketing management in entrepreneurship.	**3**

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

BEE3602: EHVAC & HVDC Transmission

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To Understand various aspects of EHVAC and HVDC Power Transmission and corona losses.
2	To study the various kinds of DC Links and Harmonic filters.
3	To get basic knowledge of various HVDC Circuit Breakers.

Course Contents		Hours
Unit I	**Power Handling Capacity of EHV- AC** Necessity of EHV AC transmission, Power Handling capacities of EHV- AC transmission lines, Voltage gradients; Electric field of point charge line-charge, Maxwell's potential coefficients, Mangled formula.	**(9)**
Unit II	**Corona** Measurement of the electrostatic field, Corona types, critical disruptive voltages; factors affecting corona, methods for reducing corona power loss, corona current waveform charge voltage diagram audible noise, and radio interference.	**(9)**
Unit III	**Types of DC link and Earth Electrode** Comparison of EHVAC and HVDC systems, Kinds of DC link, Earth Electrode and earth-returns: Introduction & objectives, location and configuration, Multi-terminal HVDC system: Introduction, 2pole transmission, MTDC system with series and paral1el connected converters.	**(9)**
Unit IV	**Power flow control in HVDC system & Harmonic Filters**: Constant current control, Constant voltage control, constant ignition control, and excitation angle control, control characteristics. Parallel operation of AC and DC links (Synchronous and Asynchronous links). Harmonic Filters: Types of Filter, Configuration of AC filters, design of AC filters, single & double frequency tuned filters, Configuration of D.C. Harmonic filters, Grouping of AC & DC filters, Reactive power compensation: Reactive power requirements of HVDC converters, the effect of Delay angle and extinction angle on reactive power.	**(9)**
Unit V	**HVDC Circuit Breakers** Introduction, construction, principle, switching energy interruption of DC current, application of MRTB, types of HVDC C. B., HVDC substation protection against short-circuit: fault Clearing, protective zones, protection symbols, HVDC line pole protections (fault clearing and re- energizing), HVDC sub-station protection against over-voltage, difference between Insulation coordination of AC and DC systems.	**(9)**

Text Books	
1	EHVAC and HVDC TransmissionEngineering and Practice. Author: Sunil S. Rao Publication: Khanna publications, 2003.
2	Electrical Power Systems. Author: C. L. Wadhwa, Publication: 2nd Edition New Age International, 2009.
3	EHV-AC, HVDC transmission and distribution engineering, Author: S. K. Sharma, Publication: S. K. Kataria & Sons, 2013.
Reference Books	
1	HVAC Transmission, Author: Rakosh Das Begamudre, Publication: New Age International, 2006
2	HVDC Power Transmission Systems, Author: K. R. Padiyar, Publication: New Age International, 2017.
3	E. W. Kimbark, Direct Current Transmission, 2nd edition, John Wiley & Sons, New Delhi. 2006.
Useful Links	
1	https://nptel.ac.in/courses/108104013
2	https://archive.nptel.ac.in/content/syllabus_pdf/108104013.pdf

	Course Outcomes	CL
BEE3602.1	**Calculate** power handling capacity of EHVAC transmission lines.	**4**
BEE3602.2	**Understand** the Corona effect on transmission line.	**2**
BEE3602.3	**Distinguish** the Multi Terminal HVDC Systems.	**4**
BEE3602.4	**Analyze** power flow control in HVDC lines & design parameters of harmonic filters.	**4**
BEE3602.5	**Apply** appropriate circuit breakers and protective schemes for the protection of HVDC systems.	**3**

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

BEE3603: Electric Drives and Vehicle Technology

Teaching Scheme	
Lectures	3 Hrs/week
Tutorial	1 Hrs/week
Total Credit	4

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To understand the starting, speed control/braking, heating and cooling characteristics of electric motors and to learn the necessity of flywheel.
2	To learn the converter and Chopper control of DC drives.
3	To explain the basic of Electric vehicles and its major parts.

	Course Contents	Hours
Unit I	**Fundamentals of Electric drive** – Fundamental torque equation – Load torque components – Nature and classification of load torques – Steady state stability – Load equalization– Four quadrant operation of drive (hoist control) – Braking methods: Dynamic – Plugging – Regenerative methods. Selection of motor-Power capacity for continuous and intermittent periodic duties flywheel effect.	**(9)**
Unit II	**D.C. motor drives:** 1-phase half and fully controlled converter fed separately and self-excited DC motor drive. Dual converter control of D.C separately excited motor. Chopper controlled dc drives of separately excited dc motor, chopper control of series motor.	**(9)**
Unit III	**A.C. motor drives:** Induction motor drives operation of induction motor with unbalanced source voltages analysis of induction motor from non-sinusoidal voltage supply, starting and braking of induction motor, Stator voltage control, variable frequency control using voltage source invertors, and current sources invertors.	**(9)**
Unit IV	**Electric Vehicles:** 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, Overview of Tesla car.	**(9)**
Unit V	**Hybrid Electric Vehicles:** 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)**

Text Books

1	G. K. Dubey, “Fundamentals of Electric drives” Alpha Science, 2nd edition 2001
2	B. K. Bose, “Power Electronics and drives” Prentice Hall, 2nd edition, 2002.
3	H. Pratab, “Modern Electric Traction” Pritam Surat, Pearson, 1973.

4	Prof. Sunil Pawar, "Electric Vehicle Technology" Notion Press Publication, 2nd edition, 2020.
5	S. K. Pillai, "Basic course in Electrical Drives" Pritam Surat, 1973Pearson
6	R. Krishnan, Electric Motor drives – Modelling, Analysis & Control:, PHI India Ltd, 2009.

Reference Books	
1	Vedam Subrahmanyam, " Electric drives concepts and applications" McGraw-Hill, 1996.
2	James Larminie, John Lowry, "Electric Vehicle Technology", Wiley, 2003.
Useful Links	
1	https://nptel.ac.in/courses/117/106/117106034/
2	https://nptel.ac.in/courses/108108076/

	Course Outcomes	**CL**
BEE3603.1	**Understand** the concept of Electrical characteristics like starting, speed control and braking along with numerical	2
BEE3603.2	**Apply** the knowledge of various converters control methods used for DC drives.	3
BEE3603.3	**Analyze** the operation of AC motor drives.	4
BEE3603.4	**Explain** the basic of Electric vehicles and its major parts.	2
BEE3603.5	**Illustrate** the various hybrid electric vehicles.	4

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

BEE3604: Electric Drives and Vehicle Technology Lab

Teaching Scheme		Examination Scheme	
Practical	2 Hrs/week	**CA**	25 Marks
Total Credit	1	**ESE**	25 Marks
		Total	50 Marks
		Duration of ESE: 02 Hrs 00 Min.	

Course Outcomes (CO)

Students will be able to

1	**Explain** the fundamentals of electric drive and different electric braking methods.
2	**Understand** the heating and cooling process of motors.
3	**Analyze** the operation of three phase converter fed dc motors and quadrant operations of dc motors.
4	**Explain** the basic of Electric vehicles and its major parts.
5	**Illustrate** the hybrid electric power trains and their modes of operations.

Sr. No.	List of Experiment	CO
1	To obtain Speed-Torque characteristics of DC Series Motor.	**CO1**
2	To obtain Speed-Torque characteristics of DC Shunt Motor.	**CO1**
3	To study single phase half-controlled DC drive.	**CO2**
4	To study of three phase fully controlled bridge converter.	**CO2**
5	Speed control of DC motor using 3 phase fully controlled bridge converter.	**CO3**
6	To study of single-phase AC voltage regulator (using SCR).	**CO3**
7	Design of bidirectional battery circuit using Buck/Boost converter using MATLAB/Simulink.	**CO4**
8	Electric Vehicle Drive Simulation with MATLAB/Simulink.	**CO4**
9	Case study of Electric Vehicle with DC Machines.	**CO5**
10	Case study of Electric Vehicle with AC Machines.	**CO5**

Text Books

1	G. K. Dubey, “Fundamentals of Electric drives” Alpha Science, 2nd edition 2001
2	B. K. Bose, “Power Electronics and drives” Prentice Hall, 2nd edition, 2002.
3	H. Pratab, “Modern Electric Traction” Pritam Surat, Pearson, 1973.

Reference Books

1	Vedam Subrahmanyam, “ Electric drives concepts and applications” McGraw-Hill, 1996.
2	James Larminie, John Lowry, “Electric Vehicle Technology”, Wiley, 2003.
3	S. K. Pillai, “Basic course in Electrical Drives” Pritam Surat, Pearson, 1973

Useful Links

1	https://nptel.ac.in/courses/117/106/117106034/
2	https://nptel.ac.in/courses/108108076/

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

BEE3605: High Voltage Engineering Lab

Teaching Scheme		Examination Scheme	
Practical	2 Hrs/week	**CA**	25 Marks
Total Credit	1	**ESE**	25 Marks
		Total	50 Marks
		Duration of ESE: 02 Hrs 00 Min.	

Course Outcomes (CO)

Students will be able to

1	**Understand** Breakdown Mechanism in Dielectric Mediums.
2	**Demonstrate** Lighting and Switching effects of over voltages.
3	**Determine** the breakdown mechanism and switching over voltages in gaseous medium.
4	**Demonstrate** the method of generation and measurements of High Voltages and Currents in laboratory.
5	**Illustrate** the methods Non Destructive and High Voltage Testing of Electrical Apparatus.

Sr. No.	List of Experiment	CO
1	Study & Perform the Horn gap	**CO1**
2	Determine the dielectric strength of transformer oil.	**CO1**
3	Determination of break down voltage for different types of insulating materials.	**CO1**
4	Demonstrate the components, control and operation of 150kV, 225J impulse generator.	**CO2**
5	Determination of the break down characteristics of air under the influence of uniform and non-uniform AC field, wing electrode configurations.	**CO2**
6	Demonstrate Sphere gap for measurement of High DC, AC and Impulse voltages.	**CO3**
7	Perform Corona Phenomenon.	**CO4**
8	Study of Rectangular Pulse Current Generator.	**CO4**
9	Functioning of Voltage Doublers Circuit using Virtual Labs.	**CO5**
10	Functioning of Critical Flashover of a Sphere Gap Using Impulse Voltage Generator Using Virtual Labs.	**CO5**

Text Books

1	High Voltage Engineering by M.S.Naidu and V. Kamaraju, TMH Publications.
2	High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Ltd.

Reference Books

1	High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl,by Elsevier.
2	High Voltage Insulation Engineering by Ravindra Arora, Wolfgang New Age Internationals (P) Ltd.
3	High voltage Engineering, Theory and Practice , Mazen Abdel Salam, Hussein Anis, AhdanEI-Morshedy, RoshdyRadwan, Marcel Dekker

Useful Links

1	https://archive.nptel.ac.in/courses/108/104/108104048/
2	https://www.ee.iitkgp.ac.in/high_voltage

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

BEE3607: Biomass Energy and its Utilization

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

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 & gasifier.	**(9)**
Unit IV	**Hydrogen, Methane and Methanol:** Bio-hydrogen production, metabolic, 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, 2005.
2	G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, 4th Edition, 1984.
3	N.S. Rathore, N.L. Panwar "Biomass Production And Efficient Utilization For Energy Generation, CRC Press, 1st Edition, 2021

Reference Books	
1	John Twidell, " Renewable Energy Soources", Routledge, Fourth Edition,2015
2	Muhammad Rashed Al Mamun, "Utilization of Biomass for supply of renewable energy in rural area.", Springer 1st Edition,2011
3	Dan Bahadur Pal, Pardeep Singh, "Utilization of Waste Biomass in Energy, Environment and Catalysis", CRC Press, 1st Edition, 2022
Useful Links	
1	https://nptel.ac.in/103103207, https://nptel.ac.in/103103206
2	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.	4
BEE3607.2	**Explain** the conversion mechanism of biomass to biogas through thermo-chemical and gasification process.	4
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.	4
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

BEE3608: Electrical Distribution System

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To know about electrical distribution system and its necessity in the real world.
2	To determine the performance of a distribution system through its important parameters i.e. voltage drops and power losses.
3	To improve the voltage profiles and power factor of the system to better value using various voltage control and compensation techniques.

	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.	**(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 Reclosures 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	V. Kamaraju, “Electrical Power Distribution Systems”, TMH, 2009 .
2	Dr. S. Sivanagaraju, Dr. K. Shankar,” Electrical Distribution Systems”, Danapathi Rai Publications, 2014,
3	A. S. Pabla, “Electric Power Distribution”, Tata Mc Graw-Hill Publishing Company, 2019,

Reference Books	
1	Turan Gonen, “Electrical Power Distribution System Engineering” CRC Press, 2014
2	SN Singh, “Electrical Power Generation, Transmission and Distribution” PHI Publications, 2010
3	M. K. Khedkar & G. M. Dhole, “Electric Power Distribution Automation” University Science Press., 2011
Useful Links	
1	https://onlinecourses.nptel.ac.in/noc19_ee61/preview
2	https://archive.nptel.ac.in/courses/108/107/108107112/

	Course Outcomes	CL
BEE3608.1	**Understand** the general aspects of electrical distribution system.	2
BEE3608.2	**Classify** the types of Feeders based on Voltage levels and loading.	4
BEE3608.3	**Understand** the need for protection and distribution automation.	2
BEE3608.4	**Recognize** the significance of voltage drop and power loss in the distribution system.	2
BEE3608.5	**Assess** the control of voltage and reactive power in distribution system.	4

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BEE3609: - Industrial Automation

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To give a solid grounding of fundamental concept of industrial automation systems.
2	To focus on architecture components and techniques for automation in industries.
3	To develop ability to recognize articulate and solve industrial problem using automation technologies.

Course Contents		Hours
Unit I	**Introduction:** Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems: mod bus & profi bus. Role of computers in measurement and control.	**(9)**
Unit II	**Automation components:** Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves Introduction of DC and AC servo drives for motion control.	**(9)**
Unit III	**Programmable logic controllers:** Introduction to PLC & its Architecture, Communication Protocols and Types of PLC Programming, HMI & SCADA Systems, Switch Mode Power Supply, VFD – Working, Elements & Applications	**(9)**
Unit IV	**Distributed Control System:** Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.	**(9)**
Unit V	**Overview of Industrial automation using robots:** Basic construction and configuration of robot, Pick and place robot, Welding robot. Internet of things for plant automation and overview of Industry 4.0	**(9)**

Text Books

1	Industrial Instrumentation and Control By. S.K. Singh The McGraw Hill Companies, 2010
2	Process Control Instrumentation Technology By. C.D. Johnson, PHI, 2005

Reference Books

1	Programmable logic controller, Dunning, Delmar, 4th Edition, 2006
2	Industrial control handbook, Parr, Newnem. 1998
Useful Links	
1	https://archive.nptel.ac.in/courses/108/105/108105088/#

	Course Outcomes	CL
BEE3609.1	**Explain** automation components and systems application	3
BEE3609.2	**Identify** suitable industrial automation hardware for given application	3
BEE3609.3	**Measure** industrial parameters like temperature, pressure, force, displacement, speed, flow, level, humidity and pH.	4
BEE3609.4	**Integrate** SCADA with PLC Systems	3
BEE3609.5	**Implement** an integrated industrial automation system incorporating robotic technology and IoT, and the application of Industry 4.0 principles.	5

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

BEE3610: - Power Quality

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To analyze Power Quality issues like, harmonics, voltage unbalances, sag and swell.
2	To analyze power quality for single phase, three phase systems with Non-Linear loads.
3	To investigate different types of the compensation techniques.

	Course Contents	Hours
Unit I	**Power Quality Issues in Distribution Systems**: Transient and Steady state variations in voltage and frequency, Unbalances, Sag, Swell, Interruptions, **Wave-form Distortions:** harmonics, noise, notching, dc-offsets and fluctuations. Flicker and its measurement.	**(9)**
Unit II	**Non Linear Loads:** The Effect of harmonic distortion of Single phase/Three phase static converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speeddrives on power system equipments.	**(9)**
Unit III	**Analysis and Conventional Mitigation Methods:** Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices.	**(9)**
Unit IV	**Dynamic Voltage Restorer and Unified Power Quality Conditioner** Voltage Sag/Swell mitigation: Dynamic Voltage Restorer-Working Principle and Control Strategies. Series Active Filtering. FACTS controllers for compensation: Working Principle, Capabilities and Control Strategies.	**(9)**
Unit V	**Power Quality Improvement:** Utility-Customer interface –Harmonic filters: passive–Custom power devices: Network re- configuring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC – control strategies: P-Q theory, Synchronous detection method – Custom power park – Status of application of custom power devices.	**(9)**

Text Books

1	R. C. Dugan, “Electrical Power Systems Quality”, McGraw Hill Education, 2012.
2	G.T. Heydt, “Electric power quality”, Mc Graw-Hill Professional, 1996

Reference Books	
1	J. Arrillaga, “Power System Quality Assessment”, John wiley, 2000
2	J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood ,”Power system Harmonic Analysis”,Wiley, 1997
Useful Links	
1	https://nptel.ac.in/courses/117/106/117106034/
2	https://nptel.ac.in/courses/108108076/

	Course Outcomes	CL
BEE3610.1	**Analyze** the various power quality events like short and long duration variations, Waveform distortion, Unbalance, Transients, Power factor etc.	4
BEE3610.2	**Apply** the knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and Non Linear loads.	3
BEE3610.3	**Apply** suitable mitigation strategies forsome of the power quality issues.	3
BEE3610.4	**Judge** the mitigation of power quality issues like waveform distortion, unbalance, and poor power factor.	5
BEE3610.5	**Select** appropriate of Power QualityImprovement Methods	5

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

BEE3611: - Geothermal Energy Utilization

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	Knowledge regarding energy sources including fossil, nuclear and renewable, and current and future energy conversion technologies.
2	Understand theoretical and practical limits of energy conversion among different forms and corresponding efficiencies.
3	To better understanding of thermodynamics, thermo chemistry and electrochemistry and their applications to energy conversion.

Course Contents		Hours
Unit I	General concept of renewable energy technology, World energy futures for geothermal, geothermal energy sources and their availability –Commercial or conventional energy sources, new trends in renewable energy technologies.	**(9)**
Unit II	Introduction to Geothermal energy, Important aspects of Geothermal Energy, Structure of Earth's interior, Geothermal system-Hot Spring structure, Geothermal Resources (Hydrothermal, Geopressured, Petro-thermal system, Magma Resources), Advantages and disadvantages of geothermal energy over other energy forms, application of geothermal energy.	**(9)**
Unit III	Geothermal reservoirs, water-dominated (hot water field, wet steam field), vapor dominated, Underground water, Aquifer, Underground water Vs Aquifer, Categories of Geothermal sites: Hyper Thermal Regions, Semi thermal Regions, Normal Regions, Earth's Thermal Engine Classification of geothermal resources: Hot Dry Rock Systems, Geo pressured Reservoirs, Magma Energy, Hot Dry Rock Fracturing Technique, Estimation of Potential from Dry Rocks, and Estimation of potential from hot aquifers.	**(9)**
Unit IV	Introduction to Geothermal Resources, Cocept of Geothermal Power Plants (Dry Steam Units, Single-Flashing Units, Dual Flashing Units, Several Flashing Processes: A Useful Theoretical, Binary Units, Hybrid Geothermal-Fossil Power Units), Effects of Impurities in the Geothermal Fluid, Cooling Systems, Geothermal District Heating: An Example of Energy Savings and Environmental Benefit, Environmental Effects	**(9)**

Unit V	Classification of geothermal power plants, Geothermal systems for electricity generation, Dry steam power plant, Binary cycle (ORC) power plant, Single-flash power plant, Double-flash power plant.	**(9)**

Text Books	
1	Kriti Yadav, Anirbid Sircar, Apurwa Yadav "Geothermal Energy Utilization, Technology and Financing," 1st Edition, 2022
2	Carlo Roselli, Maurizio Sasso , "Geothermal Energy Utilization and Technologies", 2020
3	Mario Fanelli , Mary H. Dickson " GEOTHERMAL ENERGY UTILIZATION AND TECHNOLOGY", 1st edition 2005

Reference Books	
1	E Huenges, "Geothermal Energy Systems Exploration, Development, and Utilization," 2nd edition 19 April 2010
2	William E. Glassley, "Geothermal Energy: Renewable Energy and the Environment, Second Edition" 13 October 2014
Useful Links	
1	https://nptel.ac.in/courses/117/106/117106034/
2	https://nptel.ac.in/courses/108108076/

	Course Outcomes	**CL**
BEE3611.1	Understand the world renewable energy scenario and its availability	2
BEE3611.2	Illustrate the parameters and subsystem for geothermal technology	4
BEE3611.3	Analyze the concepts of geothermal power plants and its benefit.	4
BEE3611.4	Determine and understand the hybrid technology with respect to geothermal power plants	3
BEE3611.5	Distinguish various types of geothermal power plants	4

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

BEE3612: - Elements of Substation Design

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To give students the basic knowledge of types of substations & bus/switching configurations
2	To enable students to the process of design of substation grounding and protection
3	To Outline the communication protocols, structure of a SCADA

	Course Contents	Hours
Unit I	**High Voltage Switching Equipment:** Ambient conditions, Disconnect switches, Load Break switches, high speed grounding switches, power fuses, circuit switches, circuit breakers	**(9)**
Unit II	**Types of Substations & Bus/Switching Configurations:** Transmission substation, distribution substation, collector substation, switching substations, gas insulated substations, air insulated substations, bus configurations: single bus, double bus, double break, main and transfer bus, double bus, single breaker, ring bus, break-and-a-half, Comparison of configurations.	**(9)**
Unit III	**Design of Substation Grounding and Protection:** Reasons for substation grounding system, accidental ground circuit, Design criteria-Actual Touch and step voltage, soil resistivity, grid resistance, grid current, use of the design equations, selection of conductors, grounding fence, other design considerations. Lightning stroke protection-lightning parameters, empirical design methods. Substation fire protection-Fire hazards, fire protection measures, fire protection selection criterion.	**(9)**
Unit IV	**Substation Automation and Communications:** Introduction, components of substation automation system, automation applications, protocol fundamentals, supervisory control and data acquisition (SCADA) historical perspective, SCADA functional requirements, SCADA communication requirements, components of SCADA system, SCADA communication protocols, the structure of a SCADA communication protocol, security for substation communications, security methods, security assessment.	**(9)**
Unit V	**High Voltage Switching Equipment:** Ambient conditions, Disconnect switches, Load Break switches, high speed grounding switches, power fuses, circuit switches, circuit breakers	**(9)**

Text Books	
1	John D. McDonald, Electrical Power Substation Engineering, CRC Press, 3rd Edition, 2017.
2	Rao Sumathi , Electrical Substation Engineering & Practice, Khanna Publishers
Reference Books	
1	R. S. Dahiya, Vinay Attri,"Sub-Station Engineering Design & Computer Applications" S K Kataria and sons Publications, 1st Edition, 2013.
2	P. S. Satnam, P. V. Gupta, "Substation Design and Equipment" Dhanapat Rai Publications, 1st Edition, 2013.
3	Turan Gonen, "Electric Power Distribution Engineering" CRC press, third edition, 2014
Useful Links	
1	https://www.transgrid.com.au/what-we-do/our-network/connections
2	https://new.abb.com/substations

	Course Outcomes	CL
BEE3612.1	**Describe** the main consideration in the process of substation design.	4
BEE3612.2	**Outline** the working principles of substation switching equipment.	4
BEE3612.3	**Explain** the different types of bus configurations.	4
BEE3612.4	**Design** criteria of substation grounding and protection.	6
BEE3612.5	**Illustrate** the substation communication (SCADA).	4

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

BEE3613: - Artificial Intelligence & its application

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To provide insight into fundamentals of Artificial Intelligence Techniques to the students.
2	To convey application of Artificial Intelligence techniques in power system.

	Course Contents	Hours
Unit I	**Artificial Intelligence:** History and Applications Introduction, Intelligence, Communication, Learning, Artificial Intelligence, History, Early Works, Importance, Definitions, Programming Methods, Techniques, Progress of Artificial Intelligence, Growth of AI, AI and Industry, AI and the world, Current Trends in Applied AI, Modeling, Simulation and AI, Intelligent Systems, Role of IS, Comparisons with conventional programs, Fundamentals of various IS	**(9)**
Unit II	**Artificial Neural Network:** difference between human machine and intelligence, biological neural network, artificial neuron model, Concept of Perceptron, ADALINE, Feedback in Neural Network, Neural Network Architectures: Neural Learning, Application of Neural Network in Power System	**(9)**
Unit III	**Fuzzy Logic:** Introduction, Foundation of Fuzzy Systems, Representing Fuzzy Elements, Basic Terms and Operations, Properties of Fuzzy Sets, Fuzzification, Arithmetic Operations of Fuzzy Numbers, The alpha cut method, The extension method , Linguistic Descriptions and their Analytical Forms, Fuzzy Linguistic Descriptions, Fuzzy Relation Inferences, Fuzzy Implication and Algorithms, Defuzzification Methods, Centre of Area Defuzzification, Centre of Sums Defuzzification.	**(9)**
Unit IV	**Genetic Algorithms and Evolutionary Programming:** Introduction, Genetic Algorithms, Procedure of Genetic Algorithms, Genetic Representations, Initialization and Selection, Genetic Operators, Mutation, The Working of Genetic Algorithms, Evolutionary Programming, The Working of Evolutionary Programming	**(9)**
Unit V	**Application of AI in Power Systems:** Application of Neural Network and Expert Systems in Voltage Control, Application of ANN for security assessment, Schedule Maintenance of Electrical Power Transmission Networks using Genetic Algorithm, Intelligent Systems for Demand Forecasting	**(9)**

Text Books	
1	N. P. Padhy, Artificial Intelligence and Intelligent Systems, OXFORD University Press, New Delhi, 2005.
2	Stamations V. Kartalopoulos, Understanding Neural Networks and Fuzzy Logic: Basic concepts and Applications, Prentice Hall India Private Limited, New Delhi, 2002.
Reference Books	
1	Kevin Warwick, Arthur Ekwue and Raj Aggarwal, Artificial Intelligence Techniques in Power Systems, IEE Power Engineering Series, UK, 1997.
2	Intelligent Systems and Signal Processing in Power Engineering, Springer Berlin Heidelberg, New York-Abhisek Ukil, 2010.
Useful Links	
1	https://nptel.ac.in/courses/106/105/106105077/
2	https://nptel.ac.in/courses/106/105/106102220/

	Course Outcomes	CL
BEE3613.1	Understand the fundamentals of Artificial Intelligence.	2
BEE3613.2	Apply the artificial neural network concepts in power system.	3
BEE3613.3	Implement the fuzzy logic & its concept in electric circuits.	4
BEE3613.4	Design artificial intelligence program by using genetic algorithms and evolutionary programming.	6
BEE3613.5	Apply the concepts of Artificial Intelligence in power system applications.	6

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

BEE3614: - Advanced Electrical Drives

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

Examination Scheme	
CT-1	15 Marks
CT-2	15 Marks
CA	10 Marks
ESE	60 Marks
Total	100 Marks
Duration of ESE: 03 Hrs 00 Min.	

Course Objective:

1	To understand the basic concept of working and control of modern electrical drives.
2	To impart knowledge about operational strategies of dc and ac motor drives as per different quadrant operations.

Course Contents		Hours
Unit I	**Vector control of Induction Motor (IM)**: Introduction, Direct or feedback vector control, Flux vector estimation – Voltage model and current model, Indirect or feed forward vector control, Slip gain tuning, Stator flux oriented vector control.	**(9)**
Unit II	**Sensor less vector control of IM**: Slip calculation, Direct synthesis from state equations, Model Referencing Adaptive System (MRAS), Speed adaptive flux observer, Extended Kalman filter.	**(9)**
Unit III	**Adaptive control of IM**: Self tuning control, MRAC, Sliding mode control, Fuzzy control, Neural control.	**(9)**
Unit IV	**Direct Torque and Flux Control of IM**: Conventional Direct torque and flux control (direct torque control (DTC)) of IM using switching table of inverter voltage vectors. – Voltage fed inverter control: Open loop V/f control; Closed loop V/f control with slip regulation; Closed loop V/f control with torque and flux control.	**(9)**
Unit V	**Synchronous Motor Drives**: Sinusoidal SPM Machine Drives: V/Hz control, self-control, Vector control.	**(9)**

Text Books

1	Mohan, N., Electric Drives: An Integrative Approach, MNPERE, 2001.
2	Krishnan, R., Electric Motor & Drives: Modeling, Analysis & Control, PHI Pvt. Ltd. , 2001.
3	Bose B.K., Modern Power Electronics & AC Drives, PHI Pvt. Ltd., 2001

Reference Books

1	G. K. Dubey, “Fundamentals of Electrical Drives”, Narosa Publishing House, New Delhi, 2nd edition,2001.
2	P. C. Krause, Oreg Wasynczuk, Scott D. Sudhoff, P.C.Krause, “Analysis of Electric Machinery and drive systems”, IEEE Press, 2002
3	Analysis of Electric Machinery‖, P.C. Krause, McGraw Hill, New York

Useful Links	
1	Video course on “Fundamentals of Electrical Drives” by Prof. Shyama Prasad Das IITK, available on nptel at https://nptel.ac.in/courses/108/104/108104140/#
2	Video course on “Advanced Electric Drives” by Dr. S P Das, IITM, available on nptel at https://nptel.ac.in/courses/108/104/108104011/

	Course Outcomes	CL
BEE3614.1	**Illustrate** vector control and indirect vector control of Induction Motor.	4
BEE3614.2	**Explain** how to achieve sensor-less vector control of Induction Motor.	2
BEE3614.3	**Discuss** adaptive control schemes used in Induction Motor drives.	3
BEE3614.4	**Analyze** direct torque control (DTC) used in induction motor drives.	4
BEE3614.5	**Describe** the speed control schemes used in PMSM drives.	4

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BAU3606: - Social Awareness

Teaching Scheme			Examination Scheme	
Lectures	2 Hrs/week		**CIE**	-
Tutorial	0 Hrs/week		**ESE**	-
Total Credit	Audit		**Total**	-

Course Activity:

1	Social awareness (Artisans-relates to engg., visit to hospitals, orphanages, police station, courts, trauma centers, consumer forums)
2	Social Service (teach in neighborhood, adopt an underprivileged school, village stay / visit (NSS), cleanliness drive, and skill transfer)

Course Contents	Hours
Human beings live in relationship with their family members and with others in the society. As a society, mankind strives to achieve ordered and organized life through which an environment of cooperation and coexistence is expected. A healthy society creating an environment of fearlessness is a key for the mankind to achieve higher goals because it is society which makes us most human, most complete as people. Although as a society, our expectation is fearlessness, but due to lack of understanding of our role in a society, we fail to fulfill the expectation. The social awareness activity shall promote an understanding and sharing of issues of societal problem through exposure to variety of artisans and different kind of organizations. It is expected that this exposure will enable the learners to appreciate social issues, problems and challenges. Each institution will offer a range of introductory activity based courses focusing on local artisans related to engineering so that students are sensitized to appreciate their problems and can take up some of the problems to solve while they do their regular studies. This course shall also include visits to visit to hospitals, orphanages, police station, courts, trauma centers, consumer forums so that they get exposed to different facets of societal problems. Care should be taken to give adequate representation to local and regional organizations and artisans. For example, Banaras has local traditions in Banarasi Saari, Toy making, etc and has almost all types of organizations. An institution in Banaras area can offer courses on these artisans. This will, in turn, also ensure wider community involvement/interaction with the institution. At the end of the course/semester, a student should be able to identify a social issue, prepare project report and give presentation on the selected issues. Contact hours per week should be 3-4 hours. Towards the end of the course, the institution can organize an exhibition in which all the students publicly demonstrate findings of their reports and their future plan of actions.	**(08)**

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