Dr. Babasaheb Ambedkar Technological University, Lonere.

Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)

(underMaharashtra Act No. XXIX of 2014)

P.O. Lonere, Dist. Raigad, Pin 402 103, Maharashtra

Telephone and Fax. : 02140 -275142

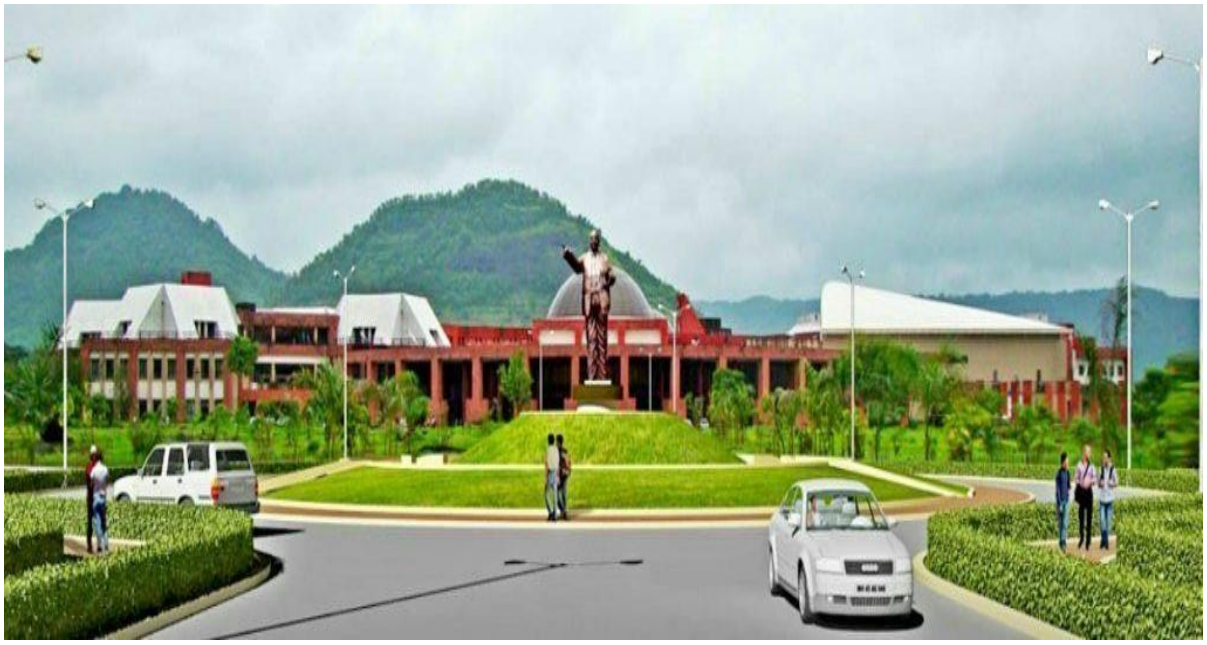
www.dbatu.ac.in

COURSE STRUCTURE AND SYLLABUS

for

Third Year B. Tech. Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering

With effect from the Academic Year2022-2023



Dr. Babasaheb Ambedkar Technological University, Lonere.

B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

Basic Sciences Courses(BSC)		
BTBS101	Engineering Mathematics - I	(3-1-0)4
BTBS102	Engineering Physics	(3-1-0)4
BTBS107 L	Engineering Physics Lab	(0-0-2)1
BTBS201	Engineering Mathematics - II	(3-1-0)4
BTBS202	Engineering Chemistry	(3-1-0)4
BTBS207 L	Engineering Chemistry Lab	(0-0-2)1
BTBS301	Engineering Mathematics-III	(3-1-0)4
BTBS404	Analog and Digital Electronics	(3-0-0)3
BTBSL40 9	Analog and Digital Electronics Lab	(0-0-2)1

Engineering Sciences Courses(BSC)		
BTES103	Engineering Graphics	(2-0-0)2
BTES105	Energy and Environment Engineering	(2-0-0)2
BTES106	Basic Civil and Mechanical Engineering	(2-0-0)
BTES108L	Engineering Graphics Lab	(0-0-4)2
BTES203	Engineering Mechanics	(2-1-0)3
BTES204	Computer Programming	(3-0-0)3
BTES205	Workshop Practice	(0-0-4)2
BTES206	Basic Electrical and Electronics Engineering	(2-0-0)
BTES208L	Engineering Mechanics Lab	(0-0-2)1
BTES305	Engineering Material Science	(3-0-0)

Humanities and Social Science Including Management Courses(HSSMC)		
BTHM104	Communication	(2-0-0)2
	Skills	
BTHM109 L	Communication Skills Lab	(0-0-2)1
BTHM304	Basic Human Rights	Audit
BTHM506	Foreign Languages (A) Japanese Language (B) German Language	Audit
BTHM706	Engineering Operations and Project Management	Audit

Professional Core Course (PCC)		
BTEEC302	Electrical Machines-I	(3-1-0)4
BTEEC303	Electrical and Electronics Measurement	(3-1-0)4
BTEEL306	Electrical Machines Lab	(0-0-2)1
BTEEL307	Electrical and Electronics Measurement Lab	(0-0-2)1
BTEEC401	Network Theory	(3-1-0)4
BTEEC402	Power System	(3-1-0)4
BTEEC403	Electrical Machines-II	(3-1-0)4
BTEEL406	Network Theory Lab	(0-0-2)1
BTEEL407	Power System Lab	(0-0-2)1
BTEEL408	Electrical Machines-II Lab	(0-0-2)1
BTEEC501	Power System Analysis	(3-1-0)4
BTEEC502	Microprocessor and Microcontroller	(3-0-0)3
BTEEC503	Power Electronics	(3-1-0)4
BTEEL507	Power System Analysis Lab	(0-0-2)1
BTEEL508	Microprocessor and Microcontroller Lab	(0-0-2)1
BTEEL509	Power Electronics Lab	(0-0-2)1
BTEEC601	Switchgear Protection	(3-0-0)3
BTEEC602	Electrical Machine Design	(3-1-0)4
BTEEC603	Control System	(3-1-0)4

	Engineering	
BTEEL606	Switchgear Protection Lab	(0-0-2)1
BTEEL607	Electrical Machine Design Lab	(0-0-2)1
BTEEL608	Control System Engineering Lab	(0-0-2)1
BTEEC701	High Voltage Engineering	(3-1-0)4
BTEEC702	Power System Operation and Control	(3-1-0)4
BTEEL707	High Voltage Engineering Lab	(0-0-2)1

Professional Elective Course (PEC)		
BTEEPE405	(A)Electromagnetic Field Theory	(3-0-0)3
	(B)Signals and System	
	©Advance Renewable Energy Sources	
	(D)Electronic Devices and Circuits	
BTEEPE504	(A)Industrial Automation	(3-0-0)3
	(B)Power Quality Issues	
	©HVDC	
BTEEPE604	(A)Application of Power Electronics in Power System	(3-0-0)3
	(B)Smart Grid Technology	
	©Modeling, Simulation and Control of Electric Drives	
BTEEPE703	(A)Energy Audit and Conservation	(3-0-0)3
	(B)Electrical System Design for Building	
	©Flexible AC Transmission System	
	(D)Electrical Utilization	

Open Elective Course (OEC)		
BTEEOE50	(A)Embedded System	(3-0-0)3
	(B)Electrical Safety	
	©Condition Monitoring of Electric Apparatus	
BTEEOE605	(A)E-waste Management	(3-0-0)3
	(B)Power Plant Engineering	
	©Sensor Technology	
	(D)Lightning Interaction with Power System	
BTEEOE704	(A)Process Control Instrumentation	(3-0-0)3
	(B)Biomedical Instrumentation	
	©Mechatronics	
BTEEOE705	(A)Testing, Maintenance and Commissioning of Electrical Equipment	(3-0-0)3
	(B)Electric and Hybrid Electric Vehicles	
	©Internet of Things (IoT)	

Seminar / Mini Project / Internship		
BTES209S	Seminar	(0-0-2)1
BTES211P	(Internship – I) Field Training / Internship/Industrial Training (minimum of 4 weeks which can be completed partially in first semester and second Semester or in at one time).	1
BTEEM308	Miniproject-I	(0-0-4)2
BTEEP410	(Internship – II)	1
BTEEM509	Miniproject-II	(0-0-2)1
BTEES609	Seminar	(0-0-4)2
BTEEP610	(Internship – III)	
BTEEM708	In house project-I / Mini project-III	(0-0-4)2

Project(MP)

BTEEP802	In house project-I / Internship & Project in Industry	(0-0-26) 13

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B.Tech (Electrical Engineering / Electrical Engineering (Electronics and Power)/ Electrical & Electronics Engg / Electrical & Power Engineering)

Plan of Study:

No.of Courses								
1	I	II	III	IV	V	VI	VII	VIII
2	BTBS101	BTBS201	BTBS301	BTEEC401	BTEEC501	BTEEC601	BTEEC701	BTEEPE801
3	BTBS102	BTBS202	BTEEC302	BTEEC402	BTEEC502	BTEEC602	BTEEC702	BTEEP802
4	BTES103	BTES203	BTEEC303	BTEEC403	BTEEC503	BTEEC603	BTEEPE703	
5	BTHM104	BTES204	BTHM304	BTBS404	BTEEPLE504	BTEEPE604	BTEEOE704	
6	BTES105	BTES205	BTES305	BTEEPE405	BTEEOE505	BTEEOE605	BTEEOE705	
7	BTES106	BTES206	BTEEL306	BTEEL406	BTHM506	BTEEL606	BTHM706	
8	BTBS107L	BTBS207L	BTEEL307	BTEEL407	BTEEL507	BTEEL607	BTEEL707	
9	BTES108L	BTES208L	BTEEP308	BTEEL408	BTEEL508	BTEEM608	BTEEM708	
10	BTHM109L	BTES209S	BTES211P	BTEEL409	BTEEPE509	BTEEP609	BTEEP609	
11		BTES211		BTEEP410	BTEEP409			

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A. Program Educational Objectives (PEOs)

Graduates will able to–

1.To equip graduates with a strong foundation in engineering sciences and Electrical Engineering fundamentals to become effective collaborators, researchers and real-time problem solver with technical competencies.

2.Perceive the limitation and impact of engineering solutions in social, legal, environmental, economical and multidisciplinary contexts.

3.Excel in Industry/technical profession, higher studies, and entrepreneurship exhibiting global competitiveness.

B. Program Outcomes (POs)

Engineering Graduate will be able to –

1. **Engineering knowledge**:Apply the knowledge of mathematics, science,engineering fundamentals, and anengineering specialization to the solution ofcomplex engineering problems.
2. **Problem analysis**:Identify, formulate, review research literature, and analyzecomplex engineering problems reaching substantiated conclusions using firstprinciples of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**:Design solutions for complex engineeringproblems and design systemcomponents or processes that meet the specifiedneeds with appropriate consideration for the public health and safety, and thecultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:**Use research-based knowledgeand 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 IT tools including prediction and modeling to complexengineering activities with an understanding of the limitations.
6. **The engineer and society:**Apply reasoning informed by the contextualknowledge to assess societal, health, safety, legal and cultural issues and theconsequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:**Understand the impact of the professionalengineering solutions in societal and environmental contexts, and demonstrate theknowledge of, and need for sustainable development.
8. **Ethics:**Apply ethical principles and commit to professional ethics and 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 oncomplex engineering activities with the engineeringcommunity and with society at large, such as, being able to comprehend and write effective reports anddesign documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering andmanagement principles and apply these to one's own work, as a member and leader in a team, to manageprojects and in multidisciplinary environments.
12. **Life-long learning:**Recognize the need for, and have the preparation and ability to engage in independentand life-long learning in the broadest context of technological change.

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Curriculum for Semester V

Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme				Credit
			L	T	P	CA	MSE	ESE	Total	
PCC4	BTEEC501	Power System Analysis	3	1	-	20	20	60	100	4
PCC5	BTEEC502	Microprocessor and Microcontroller	3	-	-	20	20	60	100	3
PCC6	BTEEC503	Power Electronics	3	1	-	20	20	60	100	4
PCC2	BTEEPLE504	Group B	3	-	-	20	20	60	100	3
OEC1	BTEEOE505	Group C	3	-	-	20	20	60	100	3
HSSMC	BTHM506	Foreign Language #	-	-	-	-	-	-	-	Audit
LC	BTEEL507	Power System Analysis Lab	-	-	2	60	-	40	100	1
LC	BTEEL508	Microprocessor and Microcontroller Lab	-	-	2	60	-	40	100	1
LC	BTEEL509	Power Electronics Lab	-	-	2	60	-	40	100	1
Project	BTEEPE510	Mini project-II	-	-	2	60	-	40	100	1
Internship	BTEEP410	Internship-II Evaluation	-	-	-	-	-	50	50	1
		Total	**15**	**2**	**10**	**340**	**100**	**510**	**950**	**22**

Semester VI

PCC7	BTEEC601	Switchgear and Protection	3	-	-	20	20	60	100	3
PCC8	BTEEC602	Electrical Machine Design	3	1	-	20	20	60	100	4
PCC9	BTEEC603	Control System Engineering	3	1	-	20	20	60	100	4
PEC3	BTEEPE604	Group D	3	-	-	20	20	60	100	3
OEC2	BTEEOE605	Group E	3	-	-	20	20	60	100	3
LC	BTEEL606	Switchgear and Protection Lab	-	-	2	60		40	100	1
LC	BTEEL607	Electrical Machine Design Lab	-	-	2	60		40	100	1
LC	BTEEL608	Control System Engineering Lab	-	-	2	60		40	100	1
Seminar	BTEEM609	Seminar	-	-	4	60		40	100	2
Internship	BTEEP610	Internship-III (minimum of 4 weeks which can be completed partially in third or fourth semester or in at one time)	-	-	-	-	-	-	-	Credits to be evaluated in VII sem.
		Total	**15**	**2**	**10**	**340**	**100**	**460**	**900**	**22**

BSC= Basic Science Course, ESC= Engineering Science Course, PCC= Professional Core Course, PEC= Professional Elective Course, OEC= Open Elective Course, LC= Laboratory Course, HSSMC= Humanities and Social Science including Management Course

 # Online NPTEL Course

Semester V

BTEEPE504 Professional Elective (Group B)	BTEEOE505 Open Elective (Group C)
(A)HVDC	(A) Embedded System
(B) Power Quality Issues	(B) Electrical Safety
(C) Industrial Automation	(C) Condition Monitoring of Electric Apparatus

BTHM506 Foreign Language
(A) Japanese Language
(B)German Language

Semester VI

BTEEPE604 Professional Elective (Group D)	BTEEOE605 Open Elective (Group E)
(A) Flexible AC Transmission System	(A) E-waste Management
(B) Smart Grid Technology	(B) Power Plant Engineering
(C) Modeling, Simulation and Control of Electric Drives	(C) Sensor Technology
	(D) Lightning Interaction with Power System

Semester V

BTEEC501 POWER SYSTEM ANALYSIS **4 Credits**

Unit 1: Modeling of Power System **7 Hours**

Complex power flow, balanced and reactance diagrams of a power system, per unit system per unit representation of transformers, synchronous machines, representation of loads. Graph theory and its applications for formation of primitive network and Z and Y matrices, incidence matrices, Y-bus and Z-bus matrices.

Unit 2: Load Flow Studies: **7 Hours**

Introduction, network model formulation, formation of Y-bus by singular transformation, load flow problem, Iterative methods of load flow such as Gauss Gauss-Seidel, Newton-Raphson method, decoupled load flow and fast decoupled load flow, Automatic Generation control.

Unit 3: Symmetrical Fault Analysis: **7 Hours**

Transients on a transmission line, short circuit of a synchronous machine on no load and on load. Short circuit current computation on no load and on load, selection of circuit breakers, Z-bus formulation, algorithm of short circuit studies.

Unit 4: Symmetrical Components: **7 Hours**

Fundamentals of symmetrical components, sequence impedance and sequence network of star connected loads, transmission lines, synchronous machines and transformer sequence network of a loaded generator.

Unit 5: Unsymmetrical Faults Analysis **7 Hours**

single line to ground (l-g), Line to line (L-L), double line to ground (L-L-G) faults analysis of above faults using bus impedance matrix, bus voltage and line current during faults. open conductor faults.

Unit 6: Security Analysis **7 Hours**

Basic Concepts, Security analysis, Load Dispatch centre, Contingency Analysis, preventive and emergency control, Electrical Power Quality, causes, affects and mitigation methods.

Text books:

1. I.J. Nagrath& D.P. Kothari, “Modern System Analysis”, Tata McGraw- Hill

2. Stevenson W.D “Elements of Power System Analysis”, McGraw- Hill Wadhawa C.L “Elements Power System”, John Wiley & sons.

Reference Books:

1. “Power System Analysis”, T.K. Nagsarkar, M.S. Sukhiya. (OXFERD U. P.)
2. Stevenson W.D. and Grainger J.J. “Power System Analysis” McGraw- Hill
3. A.R. Bergen and Vijay Vittal, Power Systems Analysis, Pearson Education Asia, 2001.
4. Stagg W.D. & EI-AbiadA.H.,”Computer Method in Power System Analysis”, McGraw- Hill
5. H.Saadat “Power System analysis”, McGraw- Hill
6. Elgred O.I. electrical Energy System Theory”, McGraw-Hill.

7. J.D. Glover, M. Sarma and T.J. Overbye, Power System Analysis and Design, Fourth Edition, Thomson Engineering Press, 2008.

BTEEC502 MICROPROCESSOR AND MICROCONTROLLER 04 Credits

Unit 1: Microprocessor architecture 7 Hours

8085 architecture, functional block diagram, Arithmetic Logic Unit (ALU), Timing and control Unit, Registers, Data and Address bus, Interface unit, 8085 instructions, Instruction word size: one byte, two byte and three byte instructions, addressing modes of 8085, assembly language programming Timing and control signals, Fetch operations, Execution operations, Machine cycle and state, Instruction and data flow, System timing diagram– interrupts.

Unit 2: Memory interfacing 7 Hours

Types of main memories, Compatibility between memory and system BUS, Address space, Partitioning of address space, Special chips for address decoding, ROM and RAM interfacing, i/o interfacing: memory map i/o, i/o map i/o scheme. Programmable peripheral interface. Data transfer techniques and their implementation: Programmed data transfer, DMA mode of transfer, I/O port, Device polling in interrupt driven mode of data transfer, DMA controller and data transfer in DMA mode, Serial mode of data transfer

Unit 3: Applications of microprocessors 7Hours

Interfacing of A/D converters, interfacing of D/A converter, wave generator, multiplex seven segment LED display system, measurement of frequency, phase angle and power factor. Traffic light controller and stepper motor controller.

Unit 4: 8051 Microcontroller 8 Hours

Intel 8051 architecture, memory organization, flags, stack, and special function registers, I/O, ports - connecting external memory, counters and timers, serial data I/O, Interrupts. Microcontroller instructions - addressing modes, moving data, logical operations, arithmetic operations, jump and call instructions – subroutines - Interrupts and returns.

Unit 5: Microcontroller programming 8 Hours

Assembly Language Programming, timer and counter programming, connection to RS 232 and RS 485, Interrupt programming. Peripherals and interfacing - Serial and parallel I/O (8251 and 8255), Programmable DMA controller, Programmable interrupt controller, ADC/DAC interfacing.

Text/Reference Books:

1. Systems and Microprocessors, John P. Hayes, Digital McGraw-Hill I.E.
2. Microprocessor Architecture, Programming and Applications, R.S.Gaonkar, Wiley Eastern.
3. Microprocessor and Interfacing: Programming and Hardware, D.V. Hall, McGraw-Hill I.E
4. Digital Systems and Microprocessors , John P. Hayes, McGraw-Hill I.E.

BTEEC 503 POWER ELECTRONICS **04 Credits**

Unit 1: Introduction **7 Hours**

Concept of Power Electronics, Different types of power electronics devices, converter systems, areas of application, recent developments. Device characteristics, protection and operation: Terminal characteristics of major power electronics devices(SCR, BJT, MOSFET, IGBT, GTO, TRIAC,), ratings, protection, heating, cooling and mounting, series and parallel operation, firing circuits, Snubber circuits

Unit 2: Phase controlled rectifiers **7 Hours**

Analysis and design of diode rectifier circuits and controlled rectifier circuits (for R, RL, RLE load), Phase control, power factor, DC load voltage, Polyphase rectifiers, Current and voltage waveforms analysis, Applications for DC motor drives. Effect of source impedance on the performance of converters, dual converters.

Unit 3: Choppers **7 Hours**

Principle of chopper operation, Control strategies, Types of chopper circuits and steady state analysis. Commutation in chopper circuits, buck, boost and buck-boost chopper, Discontinuous current analysis, Non-ideal effects and dynamic performance, Applications for DC motor drives. PWM control and operation

Unit 4: Inverters **7 Hours**

Classification of inverters, Single-phase and three-phase Voltage source Inverters, Methods of controlling output voltage, frequency and phase, Reduction of harmonics in the inverter output voltage, Current source inverters and operations. Applications for AC motor drives, Pulse Width Modulation (PWM): Types of PWM.

Unit 5: AC Voltage Controller **10 Hours**

Types of AC voltage controllers, Single phase voltage controllers, Sequence control of ac voltage controllers, 3-phase AC voltage controller operation Application of AC-AC Phase Control, Singlephase and poly phase control circuits, Applications for AC motor drives, Cycloconverters: Principles of cycloconverter operation, Methods of controlling output voltage and frequency in cases of: Single phase to single phase, three phases to single phase, three phases to three phase operation.

Applications: Power supply applications, few applications in residential and industrial systems, Electric utility.

Reference Books:

1. Power Electronics , P C Sen, TMH
2. Power Electronics, Dubey, TMH
3. Thyristorised Power Controllers, Dubey et. al., TMH
4. Power Electronics, Rashid Mohammed, PHI

5. Power Electronics & Drives, V. Subrahmanyam, New Age

BTEEPE504A HVDC **03 Credits**

Unit 1: Introduction to HVDC transmission **7 Hours**

Development of HVDC Technology, DC versus AC Transmission, DC System components and their functions, Converter configuration, Selection of Converter Configuration, Firing angle, Current and extinction angle control, DC link power control, Reactive power control and VAR sources, MTDC system types

Unit 2: Bridge converters **7 Hours**

Rectifier and inverter operation, equivalent circuit representation, power reversal, desired features of control and actual control characteristics.

Unit 3: Basic HVDC controllers **7 Hours**

Converter faults, commutation failure, bypass action in bridges, protection issues in HVDC - DC reactors, voltage and current oscillations, DC circuit breakers and over voltage protection.

Unit 4: Harmonics in HVDC **7 Hours**

Characteristics and uncharacteristic harmonics, troubles due to harmonics, harmonic filters – active and passive filters. Introduction to Hybrid HVDC and Off-shore wind power evacuation schemes .

Unit 5: Component models for analysis of AC DC system **7 Hours**

Power flow analysis Of AC DC system, transient stability analysis, dynamic stability analysis, advances in HVDC Transmission, application in wind power generation.

Text/ Reference Books:

1. K. R. Padiyar, ―HVDC power transmission system‖, Willey eastern limited, Second edition.

2. 2. E. W. Kimbark, ―direct current transmission‖, Wiley- inter science, NewYork.

BTEEPE504B POWER QUALITY ISSUES **03 Credits**

Unit 1: Introduction **7 Hours**

Definition of Power quality, Power Quality –Voltage & Current Quality, Importance of Power Quality, Power quality Evaluation. General Classes of Power quality Problems, Transients, Long-Duration Voltage Variations, Short-Duration Voltage Variations, Voltage Imbalance, Waveform Distortion, Voltage fluctuation, Power Quality Terms, CBEMA and ITI Curves. Voltage Sags and Interruptions: Sources of Sags and Interruptions, estimating voltage Sag Performance, Fundamental Principles of Protection, Solution at the End-User Level, Motor –Starting Sags.

Unit 2: Transient over Voltages **7 Hours**

Sources of Transient Over voltages, Principles of Over voltage Protection, Devices for over voltageProtection, Utility Capacitor-Switching transients, Utility System Lightning Protection, ManagingFerro-resonance, Switching Transient Problems with Loads, Computer Tools for TransientsAnalysis.

Unit 3: Fundamentals of Harmonics **7 Hours**

Harmonic Distortion, Voltage versus Current Distortion, Harmonics versus Transients, HarmonicIndexes, Harmonic Sources from Commercial Loads, Harmonic Sources from Industrial Loads,Locating Harmonic Sources, Effects of Harmonic distortion, interharmonics, Harmonic distortionEvaluations, Principles for Controlling Harmonics, Harmonic Filter design: A Case Study,Standards of Harmonics.

Unit 4: Long-Duration Voltage Variations **7 Hours**

Principles of Regulating the Voltage, Devices for Voltage Regulation, Utility Voltage Regulatorapplication, Capacitors for Voltage Regulation, End-Users Capacitors Application, and RegulatingUtility Voltage with distributed Resources Flicker.

Unit 5: Power Quality Monitoring **7 Hours**

Monitoring considerations, Historical Perspective of Power quality Measuring Instruments, PowerQuality Measurement Equipment, Assessment of Power Quality Measurement Data, Application of intelligent Systems, Power Quality Monitoring Standards, Monitoring considerations.

References/Books:

1. Chattopadhyay, Surajit, Mitra, Electric Power Quality, Springer.
2. Haytt G. T., ―Electric Power Quality‖, Stars In Circle Publication.
3. NPTEL courses

BTEEP504C INDUSTRIAL AUTOMATION 03 Credits

Unit 1: Introduction to Industrial Automation 6 Hours

Architecture of Industrial Automation Systems, Elements of an Automated System, Functional hierarchy of an Industrial Automation system, Levels of Automation.

Unit 2: Programmable Logic Controllers 8 Hours

Introduction, Architecture of PLC, PLC Operation, **PLC Hardware Components-** Input-Output module (Discrete and Analog), **PLC Programming -** Ladder Logic, Functional Block Diagram (FBD), Ladder Logic Programming (NO-NC, Timer and Counter), PLC Communication, Application of PLCs.

Unit 3: Industrial Drives Control 7 Hours

Classification of Industrial Drives, DC Motor Drives, Induction Motor Drives, Variable Speed Drives, Servo Motor Drives, Step Motor Drives, BLDC Motor Drives, Control of Drives, Industrial Application of Drives.

Unit 4: SCADA 8 Hours

SCADA system Architecture, Elements of SCADA System, Human Machine Interface, Master Terminal Unit, Remote Terminal Unit. Alarm Handling and Trending, Access Control, Automation Logging, Archiving, Report Generation. Types of interfaces, SCADACommunication.SCADA Applications: Operation and control of interconnected power system, Automatic substation control, Electric Power Generation, Transmission and Distribution sector operation.

Unit 5: Distributed Control System 7 Hours

Introduction and Overview, System Architecture, System Elements, Difference between Centralized and Distributed Control System. Displays: Group Display, Overview Display, Detail Display, Data Highways, Field Buses, Multiplexers and Remote Sensing Terminal Units, I/O Hardware, Case study of any one DCS.

Text Books/ Reference Books:

1. C. D. Johnson, “Process Control Instrumentation Technology”, Prentice Hall of India.
2. B. G. Liptak, Instrument Engineer's Handbook, Process Control, Chilton Book Company.
3. W. Bolton, “Programmable Logic Controllers”, Elsevier.
4 Hughes, “Programmable Controllers”, ISA Publications.
5 Frank D. Petruzella, “Programmable Logic Controllers”, McGraw-Hill Book Company.
6 John W. Webb and Ronald A. Reis, “Programmable Logic Controllers”, PHI.
7 Stuart A. Boyer “Supervisors Control and Data Acquisition”, ISA.

https://archive.nptel.ac.in/courses/108/105/108105062/

BTEEOE505A EMBEDDED SYSTEM **03 Credits**

Unit 1: Embedded System Architectures **7 Hours**

Introduction, Components of Embedded Systems ARM processor - architectural design -memory organization -data operation-bus configurations. System on-chip, scalable bus architectures, Design example: Alarm clock, hybrid architectures.

Unit 2: Sensor and Actuator I/O 7 Hours

ADC, DAC, timers, Servos, Relays, stepper motors, H-Bridge, port.

Unit 3: Real time operating systems (RTOS) **7 Hours**

real time kernel – OS tasks – task states – task scheduling –interrupt processing – clocking communication and synchronization – control blocks – memory requirements and control – kernel services.

Unit 4: Embedded Networks **7 Hours**

Distributed Embedded Architecture – Hardware and Software Architectures, Networks for embedded systems– I2C, CAN Bus, Ethernet, Internet, Network-based design–Communication Analysis, system performance Analysis, Hardware platform design, Allocation and scheduling, Design Example: Elevator Controller.

Unit 5: System Design **7 Hours**

Specification, Requirements and Architectural design of PBX systems, Set-top box, Ink-jet printer, Laser printer, Personal digital Assistants.

Embedded Hardware : memory map, i/o map, interrupt map, processor family, external peripherals, memory- RAM , ROM, types of RAM and ROM, memory Testing, CRC, Flash memory.

Text/ References Books:

1. Sloss Andrew N, Symes Dominic, Wright Chris, ―ARM System Developer's Guide: Designing and Optimizing‖, Morgan Kaufman Publication,2004.
2. Raj Kamal,―Embedded Systems – Architecture: Programming and Design‖, Tata McGraw-Hill Education, 3rded.,2003.

https://archive.nptel.ac.in/course.html

BTEEOE505B ELECTRICAL SAFETY **03 Credits**

Unit 1: Primary and secondary hazards arc **7 Hours**

blast, shocks-causes and effects-safety equipment- flash and thermal protection, head and eyeprotection-rubber insulating equipment, hot sticks, insulated tools, barriersandsigns,safety tags,locking devices- voltage measuring instruments- proximity and contact testers-safety electricalone-line diagram- electrician ‘s safety kit.

Unit 2: General requirements for grounding and bonding **9 Hours**

definitions-grounding of electrical equipment bonding of electrically conducting materials andother equipment-connection of grounding and bonding equipment- system grounding- purpose ofsystem grounding- grounding electrode system grounding conductor connection to electrodes-useof grounded circuit conductor for grounding equipment- grounding of low voltage and highvoltage systems

The six step safety methods- pre job briefings - hot-work decision tree-safe switching of power system-lockout-tag out- flash hazard calculation and approach distances- calculating there required level of arc protection-safetyequipment, procedure for low, medium and high voltagesystems- the one-minute safety audit.

Unit 3: Electrical safety programmer structure **7 Hours**

development- company safety team- safety policy programme implementation- employee electrical safety teams-safety meetings- safety audit accident prevention- first aid- rescuetechniquesaccident investigation.

Unit 4: Safety related case for electrical maintenance **6 Hours**

reliability cantered maintenance (RCM) -eight step maintenance programme- frequency of maintenance- maintenance requirement for specific equipment and location.

Unit 5: Regulatory bodies **6 Hours**

National electrical safety code- standard for electrical safety in work place- occupational safety and health administration standards, Indian Electricity Acts related to Electrical Safety.

Text / Reference Books:

1. John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, Al Winfield, =Electrical SafetyHandbook ‘, McGraw-Hill Education, 4th Edition, 2012.
2. Maxwell Adams.J, =Electrical Safety- a guide to the causes and prevention of electrichazards ‘, The Institution of Electric Engineers, IET 1994.
3. Ray A. Jones, Jane G. Jones, =Electrical Safety in the Workplace ‘, Jones & BartlettLearning, 2000

BTEEOE505C CONDITION MONITORING OF ELECTRICAL APPARATUS 3 Credits

Course Outcomes:

By the end of the course, students will be able to

1. Understand the necessity of condition monitoring and reliability.
2. Have knowledge about the conventional and modern methodologies/techniques.
3. Develop basic functional models for condition monitoring system to different kind of power apparatus.
4. Determine life expectancy of the equipment

Unit 1: Basic Considerations and Maintenance 07 Hours

Basic definitions, terminologies, symbolic representation, Necessity from technical social, financial aspect, types of faults in electrical equipments {Electrical equipments such as transformer, CT/PT and rotating electrical machines, CBs, etc.}, maintenance strategies, breakdown maintenance, planned, preventative and condition based maintenance

Unit 2: Testing of Electrical Equipments 6 Hours

Cables, Transformers, Induction motor, Capacitor banks, conventional methods, Measurement of insulation resistance, Diagnostic Testing: Routine tests, type tests, special tests, offline tests, Causes of failure and remedies.

Unit 3: Analysis tools 6 Hours

Recent methods (offline), Dissolved Gas Analysis (DGA), Dissipation Factor (tan δ), Sweep Frequency Response Analysis (SFRA), Partial Discharge (PD), Time Domain Dielectric Response (TDDR), Frequency Domain Spectroscopy (FDS), Chemical analysis. Image processing techniques

Unit 4: Online condition monitoring and instrumentation 6 Hours

Recent methods (online), vibration, chemical and temperature monitoring, sensor and data acquisition system, Modern algorithms, GA, and signal processing techniques. Application to various equipments such as transformer, induction motor, synchronous generator and motor, DC motor, CT and PT, case studies.

Unit 5: Current, Flux and Power Analysis 6 Hours

Discrete time Fourier series and its convergence, discrete time Fourier Transform, its properties, frequency response. Introduction to DFT in time domain and frequency domain, Derivation of DFT from DTFT, Inverse DFT, Convolution using DFT, Computational Complexity of the DFT, Decimation-in-time FFT Algorithm, Decimation In Frequency FFT Algorithm, Wavelet transform, Lab view platform.

Unit 6: Reliability and failure rate Assessment 8 Hours

Comparison of DIT AND DIF algorithms. Introduction to FIR and IIR Filter Design. Calculation of Power Equipment Reliability for Condition-based Maintenance Decision-making, Optimum

Reliability- Centered Maintenance, Cost Related Reliability Measures for Power System Equipment, Reliability based replacement refurbishment/planning

Text Books:

1. P. Vas, “Parameter estimation, condition monitoring and diagnosis of electrical machines”, Clarendon Press Oxford, 1993.
2. P. Tavner, Li Ran, J. Penman and H. Sedding, “Condition monitoring of rotating electrical machines”, IET press, 2008.

Reference Books:

1. Xose M Lo´pez, Ferna´ndez, H Bu¨lentErtan, J Turowski, “Transformers analysis, design, and measurement”, CRC Press, 2012
2. S.V. Kulkarni and S. A. Khaparde, “Transformer Engineering: Design, Technology and Diagnostics”, Second edition, CRC Press, 2013
3. R. Billinton and R. N. Allan, *“* Reliability Evaluation of Power Systems, 2nd ed. New York”, NY, USA: Plenum, 1996.
4. Videos on Transformer condition evaluation with ABBs Mature Transformer Management Program
5. Induction motor condition monitoring with ABBs, Siemens, General Electricals (source You Tube

BTEEL507 POWER SYSTEM ANALYSIS LAB **1 Credit**

Any Eight Experiments from the following list.(Any Experiment from the following list can be performed either SCILAB/MATLAB/Any Other Software.)

1. Write a program to draw the per unit reactance diagram of a given power system.
2. Solution of building the Bus Admittance matrix for given power system network.
3. Solution of power flow problem of a given power system using Gauss-Siedel method.
4. Solution of power flow problem of a given power system using Newton Raphson Method.
5. Solution of power flow problem of a given power system using Fast Decoupled method.
6. Single Line to Ground Fault (L-G) analysis of a Three Phase Transmission Line at no load and light load conditions.
7. Line to Line Fault (L-L) analysis of Three Phase Transmission Line at No load and Light load conditions.
8. Double Line to Ground Fault (LLG) analysis of Three Phase Transmission Line at No load and Light load conditions.
9. Symmetrical L-L-L Fault analysis of Three Phase Transmission Line at No load and Light load conditions.

BTEEL508 MICROPROCESSOR AND MICROCONTROLLER LAB 01 Credit

1	Study of Architecture of 8085
2	Assembly language program for addition and subtraction of 8 bit &16 bit numbers based on 8085 microprocessor
3	Assembly language program for multiplication of two numbers based on 8085 microprocessor
4	Assembly language program for Multiplication and division of two numbers based on 8085 microprocessor
5	Assembly language program for determination of smaller and larger no based on 8085 microprocessor
6	Assembly language program for ascending and descending order based on 8085 microprocessor
7	Assembly language program for rolling/flash LED based on 8085 microprocessor
8	Interfacing of 7 segment LED to 8085 microprocessor
9	Interfacing of Stepper motor with microprocessor
10	Programs based on arithmetic instructions for 8051 microcontroller
11	Interfacing of stepper motor to 8051 microcontroller
12	Interfacing of DC motor to 8051 microcontroller
13	Interfacing of converters ADC 0808/0809 and DAC 0808
14	Generate Delay using Timer section of 8051 microcontroller.

Conduct any 4 practicals fro 1 to 7 and 4 practicals from 8 to 14.

BTEEL509 POWER ELECTRONICS LAB **01 CREDIT**

1.V-I characteristics of various power electronics devices.(At least two devices SCR/MOSFET/IGBT/TRIAC/GTO)

Group A (minimum four)

2.Experimental analysis of single phase uncontrolled converter

3.Experimental analysis of single phase Half controlled converter

4.Experimental analysis of single phase fully controlled converter

5.Experimental analysis of three phase bridge inverter.

6.Experimental analysis of BUCK /BOOST/BUCK -BOOST converter

Group B

7.Simulation of Single phase Semi controlled converter

8.Simulation of Single phase Fully controlled converter

9.Simulation of Single phase inverter

BTEEPE510 MINI PROJECT II **01 Credits**

Guidelines:

Stage	Work to be carried
I	• Selection of a project (Hardware or Software Based) on recent trends in Electrical Engineering. • Planning the outcome of the project and listing out the expected outcome of the project. • Literature Survey
II	• Development of Project Idea in the form of working model (Hardware based projects) or production of appropriate simulation results of the proposed idea (Software based projects).
III	• Verification of the results obtained of the working model or the simulation results. • Comparing if the outcomes as defined in Phase I are met and taking corrective action.
IV	• Completion of project by developing the Project Report and submitting the report to the concerned to receive the final credits.

Semester VI

BTEEC601 SWITCHGEAR AND PROTECTION 04 Credits

Unit 1: Introduction to Switchgear and Protection 7 Hours

Introduction, Need for power system protection, effects of faults, Requirement of Relays, Relays Terminology, basic circuit, relay connection with trip circuit and circuit breaker, types of relay, Protective Devices: Philosophy of protection, zones of protection, primary and backup protection, Methods of earthing and their effect on fault conditions. Different types of relays: attracted armature type, balanced beam type, induction type.

Unit 2: Static and Numerical Relays 7 Hours

Amplitude and phase comparator techniques, Differential relays, directional relay, impedance relay, admittance relay, MHO relay, description of numerical relays, relaying algorithms, use of numerical relays as fault locator and disturbance recorder. Microprocessor Based Relays: Advantages, over current relays, directional relays, distance relays.

Unit 3: Circuit Breakers and Fuses 7 Hours

Introduction, arcing in circuit breakers, arc interruption, re-striking and recovery voltage, current chopping, resistance switch, Air blast circuit breakers, minimum and bulk oil circuit breakers, SF6 and Vacuum Circuit breakers, circuit breakers rating, testing of CB, point on wave switching, Definitions of terms in fuses, HRC fuses. Introduction, fuse characteristics, types of fuses, application of HRC fuses. Selection of circuit breakers, high voltage d.c. breakers.

Unit 4: Protection of Transmission Lines 7 Hours

Over current protection, construction and operation of instantaneous over current relay. Directional Over current relay , distance protection, unit protection schemes, carrier aided distance protection, protection of feeders, protection of ring main and parallel feeders, protection of radial feeders by over current relays, distance relays and carrier current protection scheme. Protection of induction motor‘s against overload, short-circuits, thermal release, miniature circuit breaker

Unit 5: Protection of Alternators & Transformers 7 Hours

Differential protection of alternator, protection of stator against phases to ground fault, phase to phase faults, inter turn fault, protection against unbalanced loading, protection of rotor against ground fault, field failure, reverse power, back up protection, field suppression, protection of bus bars, frame leakage protection. Differential protection of transformer for different winding configurations, difficulties encountered in differential protection and their remedies. Standards and specifications related to switch gear and protection

Text/References Books:

1. Power system protection and switchgear‖, Ravindranath and Chander, TMH

2. Fundamentals of power system protection‖, Paithankar and Bhide, PHI
3. J. L. Blackburn and T. J. Domin, Protective Relaying: Principles & Applications, CRC Press, 2006.
4. Electrical power system‖, Wadhwa, New Age. 2. ―Power system protection‖, Badri Ram, TMH.

BTEEC602 ELECTRICAL MACHINE DESIGN 04 Credits

Unit I: Principles of Electrical Machine Design: 6 Hours

Principles of design, design factors, limitations, Ratings, Specifications, Standards, Performance and other criteria to be considered, Brief study of magnetic, electric, dielectric and other materials, Introduction and advantages of various approaches of Computer Aided Designing.

Unit II: Design of Simple Electrical Apparatus& AC and DC Windings: 6 Hours

Detailed design of heating coils, starters, chokes and lifting magnets, Numerical examples.

AC & DC Windings: Constructional features, types of ac windings, Choice and design of simple/ duplex lap and wave winding, Concept of multiplex windings and reasons for choosing them, Single and double layer three phase AC winding (mush) with integral slots

Unit III: Design of Induction Motor (Stator): 10 Hours

Calculation of Ampere-Turns for flux distribution in rotating machines, Calculation of Ampere-Turns for flux distribution in rotating machines, output equation of three phase IM, specific electrical and magnetic loadings, ranges of specific loadings, turns per phase, number of stator slots, calculations for main dimensions, stator design parameters, Numerical examples.

Unit IV: Design of Induction Motor (Rotor): 6 Hours

Selection of length of air gap, factors affecting length of air gap, design of rotor, Unbalanced magnetic pull and its estimation, harmonic field effect on the performance of3-phase induction motor, Design of squirrel cage and wound rotor

Unit V: Heating and Ventilation of Electrical Machines: 6 Hours

Study of different modes of heat generation, Temperature rise and heat dissipation, Heating and Cooling cycles, heating and cooling time constants, their estimation, dependence and applications, Methods of cooling / ventilation of electrical apparatus, Thermal resistance, radiated heat quantity of cooling medium (Coolant) Numerical examples.

Unit VI: Design of Transformer: 10 Hours

Design of Transformer: Design of distribution and power transformers, Types, Classification and specifications, Design and main dimensions of core, yoke, winding, tank (with and without cooling tubes), Estimation of leakage reactance, resistance of winding, No load current, Losses, Mechanical force developed during short circuits, their estimation and measures to reduce them, Numerical examples.

Textbooks:

1. Sawhaney. A. K– A Course in Electrical Machine Design (DhanpatRai).

Reference Books:

1. .Deshpande. M. V- A Course in Electrical Machine Design (Prentice Hall Of India).

2. Siskind – Electrical Machine Design (Mcgraw Hill).

BTEEC603 CONTROL SYSTEM ENGINEERING 04 Credits

Unit 1: Introduction 10 Hours

Concept of open & closed loop control system, Transfer Function: Concept of system: Physical system, Physical model, Linear and Nonlinear systems, Time variant and Time invariant system. Equations of physical systems (Mass-Spring-Dashpot system, R-L-C series & parallel circuit) Transfer Function, Procedure of obtaining transfer function.

Block diagrams and Signal flow graphs: a) Block diagram, Block Diagram reduction, and Numerical examples. b) Signal flow graph; Masons gain formula for deriving overall transfer function of systems. Feedback characteristics of control system: Concept of Negative and Positive feedback, Sensitivity of the system to parameter variation and with negative and positive feedback.

Unit 2: Time Domain Analysis 7 Hours

Typical test signals, Time domain specifications, Steady state response, Types of system, Steady State Error constants and Steady State Error, Transient Response, Concept of stability, Determination of stability by Routh - Hurwitz criterion.

Unit 3: Frequency Domain Analysis 10 Hours

Introduction to Frequency Domain Analysis, Polar plots,Bode plots, Nyquist criterion, Relative stability from Nyquistcriterion. Root Locus, Construction of Root Locus, and Stability from Root Locus plots, Effect of addition of poles & zeros on Root Locus plots, Compensation network: Lag, Lead & Lag-Lead.

Unit 4: PID Controllers 4 Hours

Introduction to Proportional (P), Integral (I) & Derivative (D) controller, individual effect on overall system performance, P-PI & PID control and effect on overall system performance.

Unit 5: State Variable Technique 8 Hours

Concept of State, State Variable & State Vector, State Variable Analysis: Different forms of state variable representations (Phase, Physical & Canonical form), Concept of Diagonalization, Obtaining StateEquations from Transfer Function representation and vice versa, Solution of State Equations, StateTransition Matrix (STM), Methods of finding STM, Power Series Method, Laplace Transform Method, Calay Hamilton Method, Controllability & Observability of linear system, Kalman‘s test.

Text Books/ReferenceBooks:

1. Ogata K., “Modem Control Engineering”, Prentice Hall of India.
2. Kuo B. C., “Automatic Control System”, Prentice Hall of India.
3. Nagarath I. J. and Gopal M., “Control System Engineering”, Willey Eastern.
4. Norman S. Nice, “Control System Engineering”, Wiley.

5. Smarajit Ghosh, “Control Systems Theory & Applications”, Pearson.
6. Gopal M., “Control System”, Prentice Hall of India.

BTEEPE604A FLEXIBLE AC TRANSMISSION SYSTEM 3 Credits

Unit 1: Transmission Interconnection 7 Hours

Flow of power in the AC system, factors affecting loading capability, power flow and dynamicstability consideration of a Transmission interconnection, Description and application of HVDCtransmission, DC System components and their functions, Converter configuration, Principles ofDC Link control and Converter control characteristics, Firing angle, Current and extinction anglecontrol, DC link power control

Unit 2: Flexible AC Transmission 7 Hours

Benefits of FACTS, Basic Realities & Roles, Types of FACTS Controller, Principles of Series and Shunt Compensation. Introduction to Voltage source and Current source converter. Shunt compensation (SVC): Objectives of shunt compensation, Midpoint voltage regulation for long transmission line, voltage instability prevention, improvement of transient stability

Unit 3: Reactive power control and VAR sources 7 Hours

Reactive power control and VAR sources Methods of controllable VAR generation, Description ofStatic VAR Compensators (SVC), Variable impedance type VAR generators. Thyristor controlledreactor (TCR), Thyristor Switched Capacitor (TSC), TSC-TCR, Fixed capacitor TCR (FC-TCR).Shunt compensation

Unit 4: Variable impedance type series compensator 7 Hours

Thyristor Switches Series Capacitor (TSSC), Thyristor Controlled Series Compensators (TCSC). Switching Converter type Series Compensator. Introduction to interline power flow controller, Special purpose FACTS controllers, Thyristor controlled voltage limiter and voltage regulator, Thyristor controlled braking resistor and current limiter.

Unit 5: (STATCOM) 7 Hours

Switching type VAR generator, Static Synchronous Compensator (STATCOM), Basic operatingprinciple, Configuration. Basic control approach, Comparison between SVC and STATCOM.Series Compensator: Objectives of series compensation, improvement of transient stabilitySynchronous Series Compensator: (SSSC) and Controller for SSSC, Basic configuration andworking of Unified Power Flow Controller (UPFC). Unified Power Flow Controller, CircuitArrangement, Basic Principle of P and Q Control, independent real and reactive power flow control, Applications GCSC, TSSC, TCSC & SSSC

Text Books/Reference Books:

1. N.G Hingorani, L. Gyugyi, ―Understanding FACTS: Concepts and Technology of FlexibleAC Transmission Systems‖, IEEEPress Book, Standard Publishers and Distributors, Delhi,2001.
2. Padiyar K.R., ―HVDC Power Transmission System‖, Wiely Eastern PVT Limited.

3. Thyristor Based FACTS Controllers for Electrical Transmission System, R.M. Mathur, and R. K.Verma
4. FACTS: Controller in Power Transmission & Distribution, K. R. Padiyar, New AgeInternational.
5. HVDC and F ACTS controllers, Application of Static converter in Power System, V.K. Sood
6. E.W. Kimbark ―Direct Current transmission‖, Vol.1, John Wielly, New York
7. T,J.E Miller, ―Reactive Power Control in Electric Systems‖, John Wiley & Sons.

BTEEPE604B SMART GRID TECHNOLOGY 03 Credits

Unit 1: Introduction to Smart Grid 9 Hours

Introduction, working definitions of Smart Grid, Need of Smart Grid, Present development & International policies in Smart Grid. Introduction to Smart Meters, Real Time Pricing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Vehicle to Grid, Smart Sensors, Home & Building Automation Smart Substations, Substation Automation, Feeder Automation. Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage**,**Indian Smart Grid –Key Challenges for Smart Grid. Application and standards, Impacts of Smart Grid on reliability, Impacts of Smart Grid on air pollutant emissions reduction.

Unit 2: Smart Grid Architecture 6 Hours

Components and Architecture of Smart Grid Design –Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs –Transmission Automation – Distribution Automation –Renewable Integration Tools and Techniques for Smart Grid: Computational Techniques –Static and Dynamic Optimization Techniques –Computational Intelligence Techniques –Evolutionary Algorithms – Artificial Intelligence techniques

Unit 3: Distribution Generation Technologies 6 Hours

Introduction to Renewable Energy Technologies –Micro grids –Electric Vehicles and plug–in hybrids –Environmental impact and Climate Change –Economic Issues

Unit 4: Communication Technologies and Smart Grid 7 Hours

Introduction to Communication Technology – Advanced Metering Infrastructure (AMI), Home Area Network (HAN), Neighborhood Area Network (NAN), Wide Area Network (WAN). Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Synchro Phasor Measurement Units (PMUs) –Wide Area Measurement Systems (WAMS). Two-way Digital Communications Paradigm, Network Architectures, IP- based Systems Power Line Communications.

Unit 5: Control of Smart Power Grid System 7 Hours

Load Frequency Control (LFC) in Micro Grid System –Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids. Security and Privacy: Cyber Security Challenges in Smart Grid, Load Altering Attacks, False Data Injection Attacks, Defense Mechanisms, Privacy Challenges.

Reference Books:

1. James Momoh, ―Smart Grid Fundamentals of Design and Analysis, Wiley, 2012

2. Keyhani, ―Smart Power Grid Renewable Energy Systems, Wiley 2011
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, ―Smart Grid: Technology and Applications, Wiley 2012.
4. Jean Claude Sabonnadiere, NouredineHadjsaid, ―Smart Grids‖, Wiley ISTE 2012.

BTEEPE604C MODELING, SIMULATION AND CONTROL OF ELCTRICAL DRIVES

3 Credits

Unit 1: Introduction **7 Hours**

Introduction to Electric drives: Advantages of Electrical Drives, Parts of Electrical drive. Choice of Electric drives. Dynamics of Electrical drives: fundamental torque equations, multiquadrant operation Classes of motor duty & criteria for selection of motor.Load equalization, stability of electrical drives, sensors in drive systems.

Unit 2: DC motor drives: **6 Hours**

Review of basic characteristics of DC motors, Single phase andThree phase rectifier controlled drives.DC-DC converter drives:Principle of Rheostatic and regenerative braking control, combined control, two and four quadrant DC-DC converter fed drives.

Unit 3: AC Drives: **8 Hours**

Speed control of three phase induction motors, Stator voltage control, Rotor voltage control, frequency control, Voltage and frequency control.Principle of Scalar andVector control of Induction motor, Static rotor resistance control method, static slip power recovery control.Direct torque control of Induction motor, direct torque control of PM synchronous motor drives

Unit 4: Sensor less control of IM drives **7 Hours**

Sensor less control of PMSM drives, Predictive torque control of induction motor drive, Multiphase machine drives, Fractional-slot concentrated winding machines and drives.

Unit 5:Machine Modeling **7 Hours**

DC, induction motor and synchronous machines; simulation of transients; simulation tools: SABER, PSPICE, and MATLAB-SIMULINK; Simulations of converters, inverters and cyclo-converters etc.

Text/References Books:

1. Dubey G. K., “Fundamentals of Electrical Drives”, Narosa Publishing house
2. De N. K., Sen P. K., “Electric Drives”, Prentice Hall of India
3. VedamSubramanyam, “Electrical Drives and Control”, TMH Publications
4. Mohammed Fazlur Rahman, ―Modeling, Simulation And Control Of Electrical Drives‖, Institution of Engineering And Technology Publication

BTEEOE605A E-WASTE MANAGEMENT **03 Credits**

Unit 1: Sources **7 Hours**

Composition and characteristic of hazardous waste, Hazardous Waste (Management and Handling) Rules, 1989 and amendments, Federal Hazardous Waste Regulations under RCRA, Superfund, CERCLA and SARA. Toxicology, public health impact, Protocols, issues and challenges in transportation of hazardous waste.

Unit 2: E-waste **7 Hours**

Introduction, toxicity due to hazardous substances in e-waste and their impacts, domestic e-waste disposal, e-waste management, technologies for recovery of resource from electronic waste.

Unit 3: Guidelines for environmentally sound management of e-waste **7 Hours**

Occupational perspectives of recycling e-waste in India, Environmental health perspectives of recycling e-waste.

Unit 4: Hazardous substances waste Electrical and Electronic Equipment **7 Hours**

Characteristics of pollutants, batteries, electrical and electronic components, plastic and flame retardants, circuit boards, pollutants in waste electrical and electronic equipment.

Unit 5: E-Waste Recycling **7 Hours**

Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials.

Text/References Books:

1. New Delhi. Johri R., ―E-waste: implications, regulations, and management in India and current global best practices‖, TERI Press, New Delhi.

2. E-Waste Managing the Digital Dump Yard, Edited by Vishakha Munshi, ICFAI University Press

3. E-Waste Managing the Digital Dump Yard, Edited by Vishakha Munshi, ICFAI University Press

4. Tchobanoglous G., Theisen H., Viquel S.A., ―Integrated Solid Waste Management: Engineering, Principles and Management issues‖, Tata McGraw Hill Publishing Company Ltd

BTEEOE605B POWER PLANT ENGINEERING 3 Credits

Unit 1: Power Generation from conventional sources 7 Hours

Introduction to conventional energy sources, Thermal, hydro, nuclear and gas power plants - their functions and control; types of prime movers, generators and excitation systems;

Alternate sources of power generation - solar, wind, geo-thermal, ocean-thermal, tidal, wave and MHD. Economic considerations in power systems-Load and Energy survey, load duration curve, plant factor and plant economics,

Unit 2: Thermal and Hydro Power Plants 7 Hours

Thermal Steam and Hydro Power Plants: Selection of site, elements and operational circuits of the power plant, turbo-alternators, plant layout, steam turbines, controls and auxiliaries.

Hydro-electric Power Plants – selection of site, elements of power plant, classification, water turbines, governor action, hydro-electric generator, plant layout, pumped storage plants.

Unit 3: Nuclear Power Plants 7 Hours

selection of site, nuclear reaction – fission process and chain reaction, constituents of power plant and layout, nuclear reactor – working, classification, control, shielding and waste disposal.

Diesel and Gas Power Plants: Advantage and limitations, types of diesel plants, general layout, and applications. Components of gas power plant, gas turbine, fuels, materials, working and applications.

Unit 4: Renewable power plants 7 Hours

Solar power generation – Photo-voltaic and solar thermal generation – solar concentrators,

Wind power generation – types of wind mills, wind generators, tidal, biomass, geothermal and magneto hydro dynamic power generation, micro-hydel power plants, fuel cells

5: Combined operation of power plants 7 Hours

Plant selection, choice of size and number of generator units, Concept of parallel operation of various generating sources and load sharing, interconnected systems, concept of

Grid, real and reactive power exchange among interconnected systems. Major electrical equipment in power plants, DC systems in power plants, station control - switch yard and control room. Economic considerations – types of costs, tariff and consumers.

Text/Reference Books:

1. Wadhwa, C.L.,"Generation Distribution and Utilisation of Electrical Energy", New Age International Publishers, 3rd Edition, 2010.
2. J.B.Gupta, "A Course in Power Systems", S.K.Kataria and Sons, Reprint 2010-2011.
3. M. M. El-Wakil, "Power Plant Technology", Mcgraw Hill, Digitized on Dec 2000
4. B. G. A. Skrotzki& W. A. Vopat, "Power Station Engineering & Economy", McGraw Hill, Digitized on Dec 2007.

5. Chakrabarti A., Soni M.L., Gupta P.V., and Bhatnagar U.S., "A Text Book on Power Systems Engg", DhanpatRai and Sons, New Delhi, 2nd Revised Edition, 2010.
6. Nag P. K., "Power Plant Engineering", Tata McGraw Hill Publications
7. R. K. Rajput, "Power Plant Engineering", Shree Laxmi Publications

BTEEOE605C SENSOR TECHNOLOGY 03 Credits

Unit 1: Measurement and Characteristics **7 Hours**

Elements of a Measurement System; Classification of Instruments; Static Performance Parameters; Loading and Impedance Matching; Errors and Uncertainties in Measurement; Process and Standards of Calibration; Dynamic Characteristics Transfer Function Representation of a Measurement System, Impulse and Step Responses of First and Second Order Systems, Frequency Response of First and Second Order Systems.

Unit 2: Mechanical Transducers **7 Hours**

Temperature- Bimetallic Element and Fluid Expansion type Thermometers; Pressure- Manometers and Bourdon Gauges; Force- Balances, Helical Spiral Springs, Load Cells and Elastic Force Devices; Torque- Torsion Bars and Flat Spiral Springs; Liquid Level- Float Systems and Level to Pressure Converters; Flow- Pitot Static Tubes and Turbine type Flow Meters. Hot Wire Anemometer. Proximity Sensors- Reed Sensors, Inductive proximity sensor, capacitive proximity sensor, Optical sensor with through beam, Ultrasonic sensors.

Unit 3: Electrical Transducers **7 Hours**

Resistance Thermometers; Interfacing Resistive Transducers to Electronic Circuits; Thermistors-Measurement of Temperature and Thermal Conductivity, Temperature Control; Resistance Strain Gauges- Gauge Factor, Bonded and Unbonded Strain Gauges; Self Generating and Non Self Generating Inductive Transducers; Linear Variable Differential Transformers; Capacitive Transducers – Potentiometric Transducers; Thermoelectric Transducers and Sources of Errors in Thermocouples; Piezoelectric Transducers

Unit 4: Basic Signal Conditioning Elements **7 Hours**

Amplifiers- Non Electrical and Electrical types; Op Amps Inverting, Non Inverting, Summing, Differential, and Charge Amplifiers; Differentiating and Integrating Elements; Filters;

Data Transmission Elements- Electrical, Pneumatic, Position and Radio Frequency Transmission types; Compensation Elements for First and Second Order Systems – Basic Indicating, Recording, and Display Elements .

Unit 5: Feedback in Instruments **7 Hours**

Principles of Feedback and Advantages & Disadvantages of Feedback; Digital Voltmeters-Ramp and Dual Slope types; Servo type Potentiometric and Magnetic Tape Recorders; Digital Recorders of Memory type; Data Displays-Analog and Digital types.

Text/References Books:

1. Electronic Measurements and Instrumentation, K. Lal Kishore, Pearson Education Publications
2. Electronic Instrumentation, H. S. Kalsi-TMH Publications

3. Albert D Helfrick and William D Cooper; Modern Electronic Instrumentation and Measurement Techniques; 2004, PHI
4. BC Nakra, and Chaudhry; Instrumentation, Measurement and Analysis; 2004, Tata McGrawHill.
5. DVS Murthy; Transducers and Instrumentation; 2003, PHI.
6. CS Rangan, GR Sarma, and VSV Mani; Instrumentation Devices and Systems; Tata McGraw-Hill
7. Doeblin and Ernest; Measurement Systems Application and Design; 2004, Tata McGraw-Hill.
8. Tilak Thakur ― Mechatronics ‖ Oxford University Press 2016

BTEEOE605D Lightning Interaction with Power System 03 Credits

Unit 1: Lightning and Climate Change 7 Hours

Lightning Phenomenon and Parameters for Engineering Applications, Lightning Return stroke models for electromagnetic field calculations, Lightning Interaction with Power Substations, Lightning Interaction with Power Transmission Lines

Unit 2: Lightning Interaction with Medium 7 Hours

Voltage Overhead Power Distribution Systems, Flash collection rate, Effects of various parameters on lightning overvoltage, Lightning protection of MV systems, Lightning performance of overhead distribution lines, Lightning Interaction with Low-Voltage Overhead Power Distribution Networks, Typical configurations of LV networks, Lightning surges on LV power systems, Lightning protection of LV networks,

Unit 3: Lightning Protection of Structures and system inside of buildings 7 Hours

Lightning currents, Lightning protection of buildings, Volume protected against direct lightning strike, Air-termination and down-conductor system, Earth-termination system, Lightning equipotential bonding, Separation distance, Currents and voltages on lines, Grid-like spatial shield, Smart Grid functions and technologies, Lightning and digital recording technology, Lightning protection of Smart Grid sensors..

Unit 4: Impact on Renewable Energy Systems 7 Hours

Wind turbine components and overview of the lightning protection system, Lightning phenomenology and wind turbines, Lightning damage to wind turbines due to direct impacts, Lightning protection of wind turbine components, Overvoltages in wind farms, Solar energy: solar radiation, parameters, hourly and daily parameters, PV systems: off-grid and grid-connected, considerations of the grid connection, Internal and overvoltage lightning protection, External lightning protection

Unit 5: Measurement of Lightning Currents and Voltages 7 Hours

Lightning current measurements, Measurement method of lightning voltage, Application of various lightning overvoltage sensors in power systems, Application of the FDTD Method to Lightning Studies, Fundamentals, Representations of lightning source, Applications, Software Tools for the Lightning Performance Assessment, FLASH program, Lightning-induced overvoltages–electromagnetic transients program.

Text/References Books:

1. Alexandre Piantini, ―Lightning Interaction with Power Systems- volume 1, Institution of Engineering and Technology

2. Alexandre Piantini, ―Lightning Interaction with Power Systems- volume 2, Institution of Engineering and Technology

3. Vernan Cooray. ” Lightning Protection”.Power and Energy services, IET.

BTEEL606 SWITCHGEAR AND PROTECTION LAB 01 CREDITS

Conduct any 8practicals from given list

1. To verify characteristics of Static Overcurrent Relay.
2. To verify the characteristics Static over Voltage Relay.
3. To verify the characteristics of IDMT Relay.
4. To verify the characteristics of Reverse Power Overcurrent Relay/ Negative Sequence Relay.
5. To demonstrate working of Distance Protection Scheme for long transmission line.
6. To demonstrate working of Differential Protection of Transformer and sketch the schematic diagram for protection scheme.
7. To demonstrate working of Differential Protection of Alternator and sketch the schematic diagram for protection scheme.
8. Identify the components of different types of circuit breakers with their specifications (through visits/ videos/models)
9. To verify the characteristics of MCB, ELCB and HRC fuses.

BTEEL 607 ELECTRICAL MACHINE DESIGN LAB 01 Credit

Conduct any eight practical from given list

1 Symbols used in Electrical Engineering

2 Design and assembly of Choke with design report.

3 Design and assembly of Starter with design report.

4 Design and layout of simplex lap winding (Detailed Drawing Sheet)

5 Design and layout of wave winding (Detailed Drawing Sheet)

6 Design and layout of ac lap winding (Detailed Drawing Sheet)

7 Design and assembly of transformer with design report. (Detailed Sheet for General Assembly of transformer)

8 Design and assembly of three phase induction Motor with design report.(Detailed Sheet for General Assembly of Induction Motor)

9 Complete any two drawings sheets with the help of Computer Aided Design Software like AUTOCAD)

BTEEL608 CONTROL SYSTEM ENGINEERING LAB 01 Credit

Any Eight Experiments from the following list.

1. Write a program to obtain: i) pole, zero and gain values from a given transfer functionii)Transfer function model from pole, zero, gain values.
2. Write a program to determine of step & impulse response for a first order unity feedback system
3. Write a program to generate various standard test signals.
4. Write a program to plot the root locus for a given transfer function of the system using MATLAB.
5. Write a program to plot the Bode Plot for a given system using MATLAB.
6. Write a program to plot the Nyquist Plot for a given system using MATLAB.
7. Write a program to design Proportional, Proportional + Integral, Proportional+ Derivative and P-I-D Controller for second order system.
8. Write a program to determine of step & impulse response for a second order unity feedback system
9. Write a program to determine state space model from transfer function model & vice versa.
10. Write a program to determine state space model from transfer function model & vice versa

BTEEM609 SEMINAR **02 credit**

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