Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute under Mumbai University) Andheri (W), Mumbai – 400058

COURSE CONTENTS

Sem. VII

B.Tech. (ELECTRICAL) ENGINEERING

Academic Year: 2018-19

List of Courses

Course Code: PC-BTE701 Course:-Electric Drives (AY 2018-19)

Course Objectives:

1. Discuss DC and Induction motor characteristics
2. Explain DC drives and closed loop control of DC drives
3. Discuss Scalar control and control of slip ring Induction motors

Course Outcomes: Students will demonstrate the ability to

1. Understand the characteristics of dc motors and induction motors.
2. Understand the principles of speed-control of dc motors and induction motors.
3. Understand the power electronic converters used for dc motor and induction motor speed control.

Course Contents:

Module	Details	Hours
1	DC motor characteristics Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation	06
2	Chopper fed DC drive Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting.	06
3	Multi-quadrant DC drive Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking.	06
4	Closed-loop control of DC Drive Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design.	06
5	Induction motor characteristics Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage	06

	and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.	
6	Scalar control or constant V/f control of induction motor Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation	06
7	Control of slip ring induction motor Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery.	06

Text/ Reference Books:

1. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall..
2. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall.
3. G. K. Dubey, "Fundamentals of Electrical Drives", CRC Press.
4. W. Leonhard, "Control of Electric Drives", Springer Science & Business Media.

Sr. No.	Examination	Modules
1	**Test 1**	**1, 2**
2	**Test 2**	**3,4**
3	**End Semester**	**01-07**

Course Code: PC-BTE702 Course:-Electric Drives Laboratory (AY 2018-19)

Course Objective:

1. Perform simulations of electrical drives
2. Perform experiments on Plugging. Braking of DC and Induction motors
3. Perform experiments to understand different types of electrical drives

Course Outcomes: Students will demonstrate the ability to

1. Simulate Electrical Drives
2. Understand braking and plugging of dc and induction motors.
3. Understand DC, induction and stepper motor drive.

Course Contents:

Module	Details	Hours
1	Simulation of Electrical drives.	**2**
2	Simulation of starting of DC motor (soft start).	**2**
3	Dynamic braking of DC motor.	**2**
4	Plugging of DC motor/Plugging while lowering the load.	**2**
5	Regenerative braking of DC motor (by making V<Eb) for high inertia load.	**2**
6	DC or AC Dynamic braking of 3 phase induction motor.	**2**
7	Plugging of induction motor	**2**
8	Single phase full wave controlled DC motor drive.	**2**
9	Chopper Drive.	**2**
10	V/F control of Induction motor using PWM inverter	**2**
11	Measurement of moment of inertia by retardation test	**2**
12	Study of stepper motor drive	**2**

Course Code: PE-BTE701 Course:-Wind and Solar Energy Systems (AY 2018-19)

Course Objectives:

1. Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
2. Understand the basic physics of wind and solar power generation.
3. Understand the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems.

Course Outcomes: Students will demonstrate the ability to

1. Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
2. Understand the basic physics of wind and solar power generation.
3. Understand the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems

Course Contents:

Module	Details	Hours
1	Physics of Wind Power: History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.	**06**
2	Wind generator topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent- Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.	**12**
3	The Solar Resource: Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.	**04**
4	Solar photovoltaic: Technologies-Amorphous, mono crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.	**08**
5	Network Integration Issues: Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and	**08**

	wind systems.	
6	Solar thermal power generation: Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.	**04**

Text/ Reference Books:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems**",** John Wiley and Sons 2004.
3. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill,1984.
4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004
6. .J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

Sr. No.	Examination	Modules
1	**Test 1**	**1, Part of 2**
2	**Test 2**	**Part of 2, 3, Part of 4**
3	**End Semester**	**01-07**

Course Code: PE-BTE702 Course:-Industrial Electrical Systems (AY 2018-19)

Course Objectives:

1. Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
2. Understand various components of industrial electrical systems.
3. Analyze and select the proper size of various electrical system components.

Course Outcomes: Students will demonstrate the ability to

1. Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
2. Understand various components of industrial electrical systems.
3. Analyze and select the proper size of various electrical system components.

Course Contents:

Module	Details	Hours
1	Electrical System Components LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices	**08**
2	Residential and Commercial Electrical Systems Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components	**08**
3	Illumination Systems Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.	**06**
4	Industrial Electrical Systems I HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.	**08**

5	Industrial Electrical Systems II (6 Hours) DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.	**06**
6	Industrial Electrical System Automation Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.	**06**

Text/ Reference Books:

1. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
3. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
4. Web site for IS Standards.
5. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

Sr. No.	Examination	Modules
1	**Test 1**	**1, Part of 2**
2	**Test 2**	**Part of 2, 3, Part of 4**
3	**End Semester**	**01-07**

Course Code: PE-BTE703 Course:-Design Management and Auditing of Electrical Systems (AY 2018-19)

Course Objectives:

1. Introduction to types of electrical projects and electrical systems, energy conservation law, basics of tendering and estimation.
2. Discussion of basic concepts of design of electrical systems like power distribution, switchgear protection and auxiliary system.
3. Learning of management and auditing procedure of electrical systems.
4. Understanding renewable-energy and green building concepts from design perspective.

Course Outcomes: Students will demonstrate the ability to

1. Work as a team leader or a member in multidisciplinary projects in the role of electrical engineer.
2. Identify the requirement of the project and design electrical systems accordingly as per IS standards.
3. Apply energy efficient ways in design and selection of electrical components.
4. Realize role of renewable-energy and green building concepts in electrical design.

Course Contents:

Module	Details	Hours
1	Introduction: Types of electrical projects, Types of electrical systems, Review of components of electrical system, Different plans/drawing in electrical system design, Single line diagram in detail, Introduction to Energy Conservation Act 2001	**04**
2	Design of Power Distribution System: Different types of distribution systems and selection criteria, Electrical load: Size, LF, DF, future estimates, Substation equipment options, Design consideration in: Transformer selection, sizing and specifications. IS standards applicable in above designs. (Substation 'LV' Design)	**06**
3	Design of Switchgear Protection and Auxiliary System: Selection of HT/LT switchgears, Metering, Switchboards and MCC, Protection systems, cables: selection and sizing, cable installation and management systems, Basics of selection of emergency/backup supplies. UPS, DG set, Batteries, Preliminary design of interior lighting system, IS standards applicable in above designs.	**06**
4	Tendering Process: Basics of tendering and estimation, Review of economic and financial analysis techniques: Time value of money, Simple payback, IRR.	**04**
5	Monitoring and Management of Electrical Systems: Energy monitoring and Targeting: Defining monitoring and targeting, Elements of monitoring and targeting, Energy analysis techniques for energy optimization. Electricity billing, Electrical load management and maximum demand control, Power factor improvement	**10**

	and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and transformer losses, Introduction to Energy Efficient Technologies in Electrical systems: Maximum Demand controllers, Automatic Power factor controllers, Energy Efficient motors, Soft starters, Variable speed drives, Energy Efficient Transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of each technology. Energy Management System (EMS) and Building Management System (BMS) systems.	
6	Energy Audit: Definition, Energy audit-need, types of Energy audit, Energy management (audit) approach- understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments: Audit of installations comprising following with respect to their electrical energy usage: Electric Motors, HVAC systems, Fan and blower systems, Compressed air systems pump, DG sets, Lighting installations etc. Evaluation of energy conservation opportunities, Energy conservation in buildings, Economic and non-economic aspects of energy conservation in electrical systems	**08**
7	Use of Renewable and Green Building Concept: Impact of renewable energy sources in electrical system design. Concept of Green Building and its accreditation.	**04**

Text Books/ Reference Books:

1. Handbook of Electrical Installation Practice. , By Geoffery Stokes, Wiley Blackwell
2. Designing with light: Lighting Handbook., By Anil Valia, Lighting System
3. Energy Management Handbook. By W.C. Turner, JohnWiley and Sons
4. Handbook on Energy Audits and Management. edited by Amit Kumar Tyagi, Tata Energy Research Institute (TERI).
5. Electrical Design: Estimating and Costing, by K. B. Raina and S. K. Bhattacharya, New Age International Publishers
6. Energy Auditing Made Simple, By P. Balasubramanian, Seperation Engineers (P) Limited
7. Energy Management Principles, By C.B.Smith, Pergamon Press 3. Energy Conservation Guidebook, Dale R. Patrick, Stephen Fardo, Ray E. Richardson, Fairmont Press
8. Handbook of Energy Audits., By Albert Thumann,William J. Younger, Terry Niehus, CRC Press
9. Electric Power Distribution Equipment and Systems, by T. A. Short, Taylor and Francis 6. Electrical Power Distribution, A. S. Pabla, Mc-Graw Hill
10. Websites: www.energymanagertraining.com, www.bee-india.nic.in

Sr. No.	Examination	Modules
1	Test 1	1, 2, Part of 3
2	Test 2	Part of 3, 4, Part of 5
3	End Semester	01-07

Course Code: PE-BTE704 Course:-High Voltage Engineering (AY 2018-19)

Course Objectives:

1. Discuss breakdown in gases, solid and liquid insulating material
2. Introduce generation and measurements of high voltages.
3. Discuss lightening and switching over voltages
4. Discuss high voltage testing

Course Outcomes: Students will demonstrate the ability to

1. Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
2. Knowledge of generation and measurement of D. C., A.C., & Impulse voltages.
3. Knowledge of tests on H. V. equipment and on insulating materials, as per the standards.
4. Knowledge of how over-voltages arise in a power system, and protection against these over-voltages.

Course Contents:

Module	Details	Hours
1	Breakdown in Gases Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism, Corona discharge	**08**
2	Breakdown in liquid and solid Insulating materials Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications of insulating materials.	**07**
3	Generation of High Voltages Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators	**07**
4	Measurements of High Voltages and Currents Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.	**07**
5	Lightning and Switching Over-voltages Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over voltages, Protection against over-voltages, Surge diverters, Surge modifiers.	**07**
6	High Voltage Testing of Electrical Apparatus and High Voltage Laboratories Various standards for HV Testing of electrical apparatus, IS, IEC standards, Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high	**06**

	voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety precautions in H. V. Labs.	

Text/ Reference Books:

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education, 2013.
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2007.
3. D. V. Razevig (Translated by Dr. M. P. Chourasia), "High Voltage Engineering Fundamentals", Khanna Publishers, 1993.
4. E. Kuffel, W. S. Zaengl and J. Kuffel, "High Voltage Engineering Fundamentals", Newnes Publication, 2000.
5. R. Arora and W. Mosch "High Voltage and Electrical Insulation Engineering", John Wiley & Sons, 2011.
6. Various IS standards for HV Laboratory Techniques and Testing

Sr. No.	Examination	Modules
1	**Test 1**	**1,2**
2	**Test 2**	**3,4**
3	**End Semester**	**01-07**

Course Code: PE-BTE705 Course:-Digital Control Design (AY 2018-19)

Prerequisite: Courses Control System, Control System Design

Course Objectives:

1. Obtain discrete representation of LTI systems.
2. Analyze stability of open loop and closed loop discrete-time systems.
3. Design and analyze digital controllers.
4. Design state feedback and output feedback controllers.

Course Outcomes: Students will demonstrate the ability to

1. Obtain discrete representation of LTI systems.
2. Analyze stability of open loop and closed loop discrete-time systems.
3. Design and analyze digital controllers.
4. Design state feedback and output feedback controllers.

Course Contents:

Module	Details	Hours
1	Discrete Representation of Continuous Systems Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent	**06**
2	Discrete System Analysis Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.	**06**
3	Stability of Discrete Time System Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design	**04**
4	State Space Approach for discrete time systems State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.	**10**
5	Design of Digital Control System Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.	**08**
6	Discrete output feedback control	**08**

	Design of discrete output feedback control. Fast output sampling (FOS) and periodic outputfeedback controller design for discrete time systems.	

Text/ Reference Books:

1. K. Ogata, “Digital Control Engineering”, Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, “Digital Control Engineering”, Wiley Eastern, 1988.
3. G. F. Franklin, J. D. Powell and M. L. Workman, “Digital Control of Dynamic Systems”, Addison-Wesley, 1998.
4. B.C. Kuo, “Digital Control System”, Holt, Rinehart and Winston, 1980.

Sr. No.	Examination	Modules
1	Test 1	1, 2
2	Test 2	3, 4
3	End Semester	1-6

Course Code: PE-BTE706 Course:-Power Electronics Applications in Power System (AY 2018-19)

Prerequisite: Course Power Electronics

Course Objectives:

1. To study the operation of power system components that improves the power system performance.
2. Introduction of series & shunt compensation for transmission lines.
3. Discuss reactive power support & elimination of harmonics using Voltage Source Inverters.
4. To study the operation & control of HVDC transmission system.

Course Outcomes: Students will demonstrate the ability to

1. Understand the various methods of improving power system performance.
2. Able to analyze the existing system for performance improvement
3. Able to create the system performance improvement using advanced technology

Course Contents:

Module	Details	Hours
1	Introduction: Brief discussion on Transmission line theory, use of Voltage source inverters (VSI) for reactive power support, mid-point series and shunt compensation and HVDC, Discussion on voltage profile at the point of common coupling (PCC), need for load compensation, load balancing using passive elements, Limitations of load balancing using passive elements	**06**
2	Use of VSI as a Var generator, Indirect current controlled Synchronous link converter Var Compensator (SLCVC), Various PWM techniques, Harmonic elimination and space vector PWM techniques, theory and implementation issues, Expression for active and reactive powers in terms of d-q components, stationary to rotating frame transformation	**06**
3	Shunt Compensation Introduction, methods of Var generation, Thyristor controlled reactor (TCR), Thyristor switched capacitor (TSC), Fixed capacitor-thyristor controlled reactor (FC-TCR), STATCOM.	**06**
4	Series Compensation Introduction, comparison between series and shunt compensation, various equipments: GTO controlled series capacitor (GCSC), comparison of TCR and GCSC, Thyristor switched series capacitor (TSSC), Thyristor controlled series capacitor (TCSC), Static Synchronous Series compensator (SSSC), modes of operation, voltage regulator, and Phase angle regulator (PAR), Multi-function FACTS controller, Unified power flow controller (UPFC), control capabilities of UPFC,	**06**

5	HVDC: Introduction, various possible HVDC configurations, unipolar and bipolar links, components of HVDC systems – converter, transformer, smoothing reactor, harmonic filter, Reactive power support.	**06**
6	HVDC Operation of 6-pulse controlled rectifier in inverting mode of operation, effect of source inductance, equivalent circuit representation of 6-pulse converter considering effect of source inductance, operation of 12-pulse converter.	**06**
7	Control of HVDC system Rectifier and inverter characteristics, mode stabilization, current control, voltage dependent current order limit, combined rectifier- inverter characteristics, wave blocking and by-passing, limitation of HVDC system using line commutated converters, modern HVDC systems HVDC light	**06**

Text/ Reference Books:

1. Narain G. Hingorani, Laszlo Gyugyi, Understanding FACTS: Concepts and technology of flexible AC transmission systems, IEEE Press
2. K. R. Padiyaar , HVDC Power transmission and system
3. K R Padiyaar , Facts controllers in power transmission and distribution

Sr. No.	Examination	Modules
1	**Test 1**	**1, 2**
2	**Test 2**	**3, 4**
3	**End Semester**	**01-07**

Course Code: OE-BTE701 Course:-Image Processing (AY 2018-19)

Prerequisite: Course Digital Signal Processing

Course Objectives:

1. To develop an overview of the field of image processing
2. To learn the fundamental concepts of Digital Image Processing
3. To understand basic image enhancement and segmentation techniques
4. To illustrate Image Transform calculations mathematically and develop fast transform algorithm
5. To learn Image Compression and Decompression Techniques

Course Outcomes: Students will demonstrate the ability to

1. Understand the concept of Digital Image processing.
2. Explain image enhancement and Segmentation technique
3. Understand Digital Image compression and decompression techniques
4. Perform Binary Image Processing

Course Contents:

Module	Details	Hours
1	Introduction: Background, Digital Image Representation, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	**04**
2	Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Sampling and Quantization, Some Basic Relationships between Pixels, Imagining Geometry. Image File Formats: BMP, TIFF and JPEG. Color Models (RGB, HSI, YUV)	**06**
3	Image Enhancement: Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background Smoothing Filters, Sharpening Filters, Low pass Filtering, High pass Filtering, Generation of Spatial Masks from Frequency Domain Specifications. Homomorphic Filtering	**08**
4	Image Segmentation and Representation: (i) Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique, (ii) Image Representation and Description, Chain Code, Polygonal, Representation, Shape Number, Moments	**06**
5	Binary Image Processing: Binary Morphological Operators, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening,	**06**

	Connected Component Labeling, Iterative Algorithm and Classical Algorithm	
6	Image Transform: (i) Introduction to the Fourier Transform, The Discrete Fourier Transform, Some Properties of the Two-Dimensional Fourier Transform Fast Fourier Transform(FFT), (ii) Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete Cosine Transform(DCT), Discrete Wavelet Transform(DWT),	**06**
7	Image Compression: Fundamentals – Coding Redundancy, Interpixel Redundancy, Psycho visual Redundancy, Fidelity Criteria. Image Compression Models – The Source Encoder and Decoder, Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG, MPEG-1.	**06**

Text/ Reference Books:

1. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition, 2009,
2. S. Jayaraman, E. Esakkirajan and T. Veerkumar, "Digital Image Processing" Tata McGraw Hill Education Private Ltd, 2009,
3. Anil K. Jain, "Fundamentals and Digital Image Processing", Prentice Hall of India Private Ltd, Third Edition

Sr. No.	Examination	Modules
1	**Test 1**	**1, 2, Part of 3**
2	**Test 2**	**Part of 3, 4, Part of 5**
3	**End Semester**	**01-07**

Course Code: OE-BTE702 Course:-Computer Network (AY 2018-19)

Course Objectives:

1. Discuss various types of networks
2. Introduce various layers of computer network protocols

Course Outcomes: Students will demonstrate the ability to

1. Explain the process of communication in computer network
2. Simulate the computer network.
3. Illustrate the protocols of TCP/IP.

Course Contents:

Module	Details	Hours
1	OSI reference model and network architecture: Types of communication (simplex, half duplex, full duplex), types of connections, network topology types Types of networks: peer to peer and client server networks, network hardware- transmission technology-broadcast links and point-to-point links and scale–PAN, LAN, MAN, WAN, Interne Network software: protocol hierarchies, protocol, peers, interface, network architecture, protocol stack, Connection oriented and connectionless services, service primitives Reference model: OSI,TCP/IP	**06**
2	Physical layer: Guided Transmission Media Unguided Transmission Media	**03**
3	Data link layer: Services provided by Data link layer to network layer, Framing Error detection – checksum, parity CRC Error correction: hamming codes Flow control- elementary data link protocols, Sliding window protocols HDLC- high level data link control protocol	**07**
4	Medium Access Sub layer: The Channel Allocation Problem, Multiple Access Protocols Multiple access Aloha system, CSMA– CSMA/CD,CSMA/CA Controlled access – reservation system, polling, token passing Channelization–FDMA,TDMA,CDMA Traditional Etheet- frame, addressing	**07**
5	Network layer: IPV4 addresses – address space, notations, classful, classless addressing Need for network layer, ipv4 datagram, fragmentation Routing table: Static, Dynamic, Routing protocol: Intra domain – Distance vector RIP, link state-OSPF, inter domain – path vector BGP.	**08**
6	Transport layer: Process to process delivery- client server paradigm, multiplexing,	**08**

	demultiplexing, connection less vs connection oriented service. UDP: user datagram, UDP operation: connectionless services, flow and error control, encapsulation and decapsulation, queuing. TCP: TCP services: process to process communication, stream delivery service, sending and receiving buffers, segments, full duplex communication. TCP features: sequence numbers and acknowledgement number,TCP segment, TCP connection, flow control, error control, congestion control.	
7	Application layer: Remote logging: TELNET, FTP	**03**

Text/Reference Books:

1. B. F. Ferouzan, "Data and Computer Communication", 4 th Edition, Tata McGraw Hill, 2010.
2. S. Tanenbaum, "Computer Networks", 4th Edition, Prentice Hall, 2012.
3. William Stallings, "Data and Computer Communication", 10thEdition, 2014.

Sr. No.	Examination	Modules
1	**Test 1**	**1, 2, Part of 3**
2	**Test 2**	**Part of 3, 5, Part of 5**
3	**End Semester**	**01-07**

Course Code: OE-BTE703 Course:-Electrical Engineering Materials (AY 2018-19)

Course Objectives:

1. Introduce electrical and magnetic properties of material
2. Discuss properties of dielectric material and semiconductors.

Course Outcomes: Students will demonstrate the ability to

1. Understand properties of magnetic, dielectric and semiconductor material
2. Understand usage of different electrical engineering materials

Course Contents:

Module	Details	Hours
1	Electrical Conduction I : Electronic and Ionic Conduction , Conductivity in Metals , Ohm‟s Law , Relaxation Time , Collision Time , Mean Free Path of an Electron , Electron Scattering	**06**
2	Electrical Conduction II: Resistivity of Metals , Effect of Temperature and Impurity on Conductivity , Joule‟s Law , High Conductivity And Resistivity Materials , Superconductivity and Applications	**06**
3	Polarization of Dielectrics : Polar and Non-Polar Dielectrics , Basic Concept of Polarization , Types of Polarization, Dielectric Constant ,Internal Field in Dielectrics , Ferroelectric ,Spontaneous Polarization, Curie-Weiss Law, Piezoelectric and Pyroelectric , Dielectric Loss , Breakdown in Dielectrics,	**06**
4	Dielectric in Alternating Field : Dielectric Properties of Insulators in Alternating Fields, Complex Dielectric Constant , Electronic Polarization , Ionic Polarization , Frequency Dependence of Electronic Polarization, Dielectric Constant of Non-Polar Solids , Dipolar Relaxation , Loss Tangent	**06**
5	Magnetic Properties of Materials: Atomic Interpretation of Diamagnetic, Paramagnetic, Anti-Ferromagnetic and Ferromagnetic Materials. Ferromagnetic Domain.	**06**
6	Alloy for Core Materials for Rotating Machines , Transformers , Permanent Magnets and Non Magnetic Steels , Nonmetallic Magnetic Materials , Thin Film Magnets , Magnetic Materials for Ferromagnetic Tape And Memory Devices	**06**
7	Semiconductor Material Technology: Method for Material Preparation, Purification and Doping, Introduction to Processes of Manufacturing Semiconductor Devices, Transistors, Integrated Circuits .Monolithic Diodes, Integrated Resistors and Integrated Capacitor.	**06**

Text Books:

1. Dekkar, A.J., “Electrical Engineering Materials, Reprint Edition”, 2009, Prentice Hall Publications Co.
2. Kasap S.O., “Principle of Electronic Materials and Devices”, Second Edition, Tata McGraw- Hill.

Sr. No.	Examination	Modules
1	Test 1	1, 2
2	Test 2	3,4
3	End Semester	1-7

Course Code: OE-BTE704 Course:-Embedded System (AY 2018-19)

Prerequisite: Course Microprocessor and Microcontroller

Course Objectives:

1. Introduction to embedded system design.
2. Study of ARM processor.
3. Study of serial communication, analog interfacing and hardware interrupts.
4. Understand the concept of RTOS.

Course Outcomes: Students will demonstrate the ability to

1. Define the unique characteristics of embedded systems.
2. Discuss the interfacing challenges of embedded processors and peripherqals.
3. Understand the basics of an embedded system, program an embedded system, design, implement and test an embedded system.
4. Distinguish between real time embedded system and embedded system with applications

Course Contents:

Module	Details	Hours
1	Introduction to Embedded systems, Design Metrics, Examples of embedded systems, hardware/software co-design, Embedded micro controller cores (ARM, RISC, CISC, and SOC), embedded memories, sensors and interfacing techniques, Architecture of Embedded Systems.	**06**
2	Introduction to MSP 430 RISC Controllers, parallel I/O, external interrupts. Introduction to ARM 7 instruction set, addressing modes, operating modes with ARM core, ARM7 TDMI modes, ADC, Timers, Interrupt structure. Byte ordering (LE, BE), Thumb mode normal mode instructions changes, Pipeline utilization with all register allocations, Floating to fixed point conversion fundamentals. System design with ARM as key processor.DSP features of ARM Core Digital Signal Controllers-DSC differences with conventional micro controllers.	**06**
3	Serial communications: SCI, SPI, Timing generation and measurements. Analog interfacing and data acquisition. Hardware Interrupts: - Various C ISR Declaration syntaxes - Interrupt Vectors, Priorities and Nesting - Tick Timer Interrupt as heart-beat of embedded system 7-Seg LED, Segment-LCD, Alphanumeric LCD, Graphic LCD displays Communications and Networks - RS485 (2 and3 wire)and Modbus Protocol (Intro only) - Ethernet and TCPIP Stack (Features and Usage only) - CAN features and protocol	**06**
4	Software Programming in Assembly Language (ALP) and in High Level Language 'C', 'C' Program Elements: Header and Source Files and Preprocessor Directives, Program Elements: Macros and Functions, Program Elements: Data Types, Data Structures, Modifiers, Statements,	**06**

	Loops and Pointers, Queues, Stacks, Lists and Ordered Lists, Embedded Programming in C++, 'C' Program Compiler and Cross-Compiler, Source Code Engineering Tools for Embedded C/C++, Optimization of Memory Needs.	
5	Real-time concepts, real-time operating systems, Required RTOS services/capabilities (in contrast with traditional OS). Real-world issues: blocking, unpredictability, interrupts, caching, Benefits of using RTOS - Concepts of Tasks/Threads/Process - Multitasking - Task Scheduling - Task management - Inter-task communication and Synchronization: - Device Drivers - How to choose an RTOS	**06**
6	Fundamentals of Design and Development, Program Modeling tools Testing and Debugging methodologies.	**06**
7	Applications of Embedded Systems: case studies - Industrial and Automation - Medical - Robotics - Access Control Systems (Smart Cards, RFIDs, FingerScan)	**06**

Text/ Reference Books:

1. Rajkamal, Embedded Systems – Architecture, Programming and Design, Tata McGraw Hill
2. Shibu K V , Introduction to Embedded Systems , Tata Mc Graw Hil.
3. SriramIyer and Pankaj Gupta, Embedded Realtime Systems Programming, Tata McGraw Hill
4. Jonathan W. Valvano ,Thomson, Embedded Microcomputer Systems
5. David E. Simon,Pearson Education, An Embedded Software Primer
6. Dr. K.V.K.Prasad, Dreamtech Press, Embedded real time system.

Sr. No.	Examination	Modules
1	**Test 1**	**1, 2**
2	**Test 2**	**3, 4**
3	**End Semester**	**01-07**

Course Code: OE-BTE705 Course:-Internet of Things (AY 2018-19)

Course Objectives:

1. Explored to the interconnection and integration of the physical world and the cyber space.
2. They are also able to design & develop IOT Devices.

Course Outcomes: Students will demonstrate the ability to

1. Describe the theory related to Internet of things
2. Apply theoretical knowledge of IOT in practice
3. Select the hardware & software for different applications. 4. Develop an application using IOT hardware & software

Course Contents:

Module	Details	Hours
1	Introduction Fundamentals of Internet of Things (IOT), Components in IOT, Architecture of IOT, Security, Privacy, Advantages, Applications: Smart Vehicles, Medical, Smart city, Smart Supply Chain etc.	**06**
2	Enabling Technologies of IOT Technology Roadmap, RFID, Augmented Reality, Blue Tooth, Zigbee, WiFi, RFLinks, MEMS etc	**06**
3	Programming the Microcontroller for IOT Cloud computing and IOT –Arduino/Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors - Communication-Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using WiFi / Etherne	**06**
4	Resource Management Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results	**06**
5	IOT Protocols Network Overview, Various Types of Networks, Network Protocols, Selecting the Right Network for the Right Use case, Network Challenges for IOT: Connecting sensors, Integrating with Application Platform	**06**
6	IOT Platforms Introduction, Necessity of IOT Platform, Industrial Grade Platform, Key IOT Platform Features, IOT Platform Architecture, Getting access to IOT platforms, Introduction to Model based development on IOT platforms	**06**
7	Challenges & Opportunities of IOT New business markets in IOT, IOT Design Challenges, IOT Design Opportunities, Technological challenges faced by IOT device	**06**

Text/Reference Books:

1. Dieter Uckelmann et.al, "Architecting the Internet of Things", Springer, 2011
2. Charalampos Doukas , "Building Internet of Things with the Arduino", Create space, April 2002

Sr. No.	Examination	Modules
1	Test 1	1, 2
2	Test 2	3, 4
3	End Semester	01-07

Value Added Courses

1. Soft Computing I Introduction to MATLAB/SCILAB (VL-BTE01)

Course Objective: Provide knowledge of MATLAB/ SCILAB.

Course Outcome: Students will be able to develop good applications using MATLAB/ SCILAB

Course content: Basic Introduction and Overview, Variables and Data types, Operation,. Control Structure, Function, Introduction to different tool boxes available, introduction to MATLAB simulink

2. Introduction to Python (VL-BTE02)

Course Objective: Provide knowledge of Python

Course Outcome: Students will be able to develop good applications using Python

Course content: Basic Introduction and Overview, Variables and Data types., Operations in Python, Control Structure, List, Tuples and Dictionary, Function, Introduction to turtle and some introduction to modules, Exception handling, Object oriented in python, Numpy, Matplotlib.

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute under Mumbai University) Andheri (W), Mumbai – 400058

COURSE CONTENTS

Sem. VIII

B.Tech. (ELECTRICAL) ENGINEERING

Academic Year: 2018-19

List of Courses

Course Code:HSM-BTE801 Course:-Engineering Economics (AY 2018-19)

Prerequisite: Basics of Project Management, statistics and mathematics, general knowledge about working of organizations

Course Objectives:

1. Learn the basic concepts of engineering economics.
2. Understand some engineering economics methods for solving problems of present worth, annual cost, rate of return, payback, break even, benefit cost ratio, etc.
3. Learn to evaluate the cost effectiveness of engineering projects on the basis of their economic viability.
4. Understand the concepts of depreciation / appreciation of assets / resources and its impact on their value.

Course Outcomes: Students will demonstrate the ability to

1. Apply appropriate engineering economics methods for solving problems of present worth, annual cost, rate of return, payback, break even, benefit cost ratio, etc.
2. Evaluate the cost effectiveness of engineering projects on the basis of their economic viability and draw inferences for the investment decisions.
3. Calculate depreciation / appreciation of assets / resources to assess its impact on present or future value.

Course Contents

Module	Details	Hours
1	**Introduction** • Economics: Flow in an economy, Law of Supply and Demand, • Concept of Engineering Economics: Definition, Scope, Types of Efficiency • Elements of Costs: Marginal Cost, Marginal Revenue, Sunk Cost, Opportunity Cost • Break-Even Analysis, Profit / Volume Ratio **Elementary Economic Analysis** • Basics, Material Selection for a Product, Building Material Selection • Process Planning / Process Modification	06
2	**Interest Formulas and Their Applications** • Introduction, Time Value of Money • Interest Formulas: Single Payment Compound Amount, Single-Payment Present Worth Amount, Equal-Payment Series Compound Amount, Equal-Payment Series Sinking Fund, Equal-Payment Series Present Worth	04

	Amount, Equal-Payment Series Capital Recovery Amount, Uniform Gradient Series Annual Equivalent Amount, Effective Interest Rate • Bases for Comparison of Alternatives	
3	**Present Worth Method of Comparison** • Basics, Revenue-dominated Cash Flow Diagram, • Cost-dominated Cash Flow Diagram **Future Worth Method** • Basics, Revenue-dominated Cash Flow Diagram • Cost-dominated Cash Flow Diagram **Annual Equivalent Method** • Basics, Revenue-dominated Cash Flow Diagram • Cost-dominated Cash Flow Diagram • Alternate Approach **Rate of Return Method**	08
4	**Replacement and Maintenance Analysis** • Basics, Types of Maintenance, Types of Replacement, • Determination of Economic Life of an Asset • Replacement of Existing Asset with a New Asset: Capital Recovery with Return, Concept of Challenger and Defender • Simple Probabilistic Model for Items Which Fail Completely.	03
5	**Depreciation** • Methods of Depreciation: Straight Line Method of Depreciation, Declining Balance Method of Depreciation, Sum-of-the-Years-Digits Method of Depreciation, Sinking Fund Method of Depreciation, Service Output Method of Depreciation. **Evaluation of Public Alternatives**	06
6	**Inventory Control** • Basics, Purchase Model with Instantaneous Replenishment and without Shortages, • Manufacturing Model without Shortages • Purchase Model with Shortages (Instantaneous Supply) • Manufacturing Model with Shortages	06
7	**Make or Buy Decision** • Basics, Criteria for Make or Buy • Approaches for Make or Buy Decision: Simple Cost Analysis, Economic Analysis, Break-even Analysis **Value Engineering** • Basics, Functions, Aim,	*06

	• When to Apply Value Analysis, Value Analysis vs. Value Engineering • Value Engineering Procedure, Advantages and Application Areas **Mathematical Models for Value Engineering**	

Text Books/ Reference Books:

1. Engineering Economy, DeGarmo, E. Paul, Sallivan and Canada, Collier MacMilan Ltd., USA
2. Engineering Economy, Gerald J. Thuesen, W. J. Fabrycky, 8th Edition, Prentice Hall International Series in Industrial and Systems Engineering
3. Engineering Economics, R. Paneerselvam, PHI Learning Pvt. Ltd. New Delhi.
4. Engineering Economic Analysis, Donald G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, Oxford University Press, 12th Edition
5. Basics of Engineering Economy, Leland Blank, Anthony Tarquin, Irwin Industrial Engineering.
6. Contemporary Engineering Economics, Chan S. Park, Pearson Pub., 5th Ed.

Sr. No.	Examination	Modules
1	**Test 1**	**1, 2, Part of 3**
2	**Test 2**	**Part of 3, 4, Part of 5**
3	**End Semester**	**01-07**

Course Code:PC-BTE801 Course:-Electronic Design Laboratory (AY 2018-19)

Course Outcomes: Students will demonstrate the ability to

4. Understand the practical issues related to practical implementation of applications using electronic circuits.
5. Choose appropriate components, software and hardware platforms.
6. Design a Printed Circuit Board, get it made and populate/solder it with components.
7. Work as a team with other students to implement an application.

Course Contents:

Module	Details
1	Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits;
2	Introduction to electronic instrumentation and PC based data acquisition;
3	Electronic system design, Analog system design, Interfacing of analog and digital systems
4	Embedded systems, Electronic system design employing microcontrollers, CPLDs, and FPGAs
5	PCB design and layout;.
6	System assembly considerations
7	Group projects involving electronic hardware (Analog, Digital, mixed signal) leading to implementation of an application

Text/ Reference Books:

1. A. S. Sedra and K. C. Smith, "Microelectronic circuits", Oxford University Press, 2007.
2. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1997.
3. H.W.Ott, "Noise Reduction Techniques in Electronic Systems", Wiley, 1989.
4. W.C. Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill,1983.
5. G.L. Ginsberg, "Printed Circuit Design", McGraw Hill, 1991.

Course Code: PE-BTE801 Course:-Power System Dynamics and Control

(AY 2018-19)

Course Objectives:

1. To study the stability considerations in power system.
2. To understand the different stability of power system and multi-machine stability concept
3. To study of voltage stability, PV, QV and PQ curves
4. To study of improving the stability of power system

Course Outcomes: Students will demonstrate the ability to

1. Describe and appreciate the stability concept in the power network.
2. Implement and relate the effects of various electrical parameter on stability

Course Contents:

Module	Details	Hours
1	Power system stability considerations – definitions-classification of stability-rotor angle and voltage stability-synchronous machine representation –classical model load modeling concepts modeling of excitation systems-modeling of prime movers	**06**
2	Synchronous machine: Higher order model representation Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine-effect of field circuit dynamics-effect of excitation system-small signal stability of Multi Machine System.	**06**
3	Small signal stability – state space representation – Eigen values-modal matrices small signal stability of single machine infinite bus system	**06**
4	Transient stability-swing equation-equal area criterion-solution of swing equation-Numerical methods-Euler method-Runge- Kutta method-critical clearing time and angle-effect of excitation system and governors	**06**
5	Multi machine stability –extended equal area criterion-transient energy function approach	**06**
6	Voltage stability – generation aspects - transmission system aspects – load aspects – PV curve – QV curve – PQ curve – analysis with static loads – load ability limit – sensitivity analysis-continuation power flow analysis - instability mechanisms examples.	**06**
7	Methods of improving stability – transient stability enhancement – high speed fault clearing – steam turbine fast valving -high speed excitation systems- small signal stability enhancement power system stabilizers – voltage stability enhancement – reactive power control.	**06**

Text/ Reference Books:

1. Kundur, P., “Power System Stability and Control”, McGraw-Hill International Editions.
2. Anderson, P.M. and Fouad, A.A., “Power System Control and Stability”, John Wiley.
3. Van Cutsem, T. and Vournas, C., “Voltage Stability of Electric Power Systems”, Springer
4. P.Sauer & M.A.Pai, Power System Dynamics & Stability, Prentice Hall, 1997

Sr. No.	Examination	Modules
1	Test 1	1, 2
2	Test 2	3, 4
3	End Semester	01-07

Course Code: PE-BTE802 Course:-Smart Grid (AY 2018-19)

Course Objectives:

1. Discuss smart grid characteristics, opportunities and barriers
2. Introduction to smart meters, smart substations
3. Discuss micro grid, distributed energy resources, power quality management in smart grid.
4. Introduce communication technology used in smart grid

Course Outcomes: Students will demonstrate the ability to

1. Understand importance of smart grid
2. Understand various components used in smart grid
3. Understand the concepts of micro grid, distributed energy resources, power quality management in smart grid.
4. Understand communication technology and security for smart grid.

Course Contents:

Module	Details	Hours
1	Introduction to Smart Grid Evolution of Electric Grid, concept of Smart Grid, definitions, need of Smart Grid, functions of Smart Grid, opportunities and barriers of Smart Grid, difference between conventional and Smart Grid, concept of resilient and self healing Grid, present development and international policies in Smart Grid, Case studies of Smart Grid, CDM opportunities in Smart Grid.	**06**
2	Smart Grid Technologies Part I Introduction to Smart Meters, real time prizing, Smart appliances, Automatic Meter Reading (AMR), Outage Management System (OMS), Plug in Hybrid Electric Vehicle (PHEV), Vehicle to Grid, Smart sensors, Home and building automation, Phase shifting transformers.	**06**
3	Smart Grid Technologies Part II Smart substations, substation automation, feeder automation, Geographic Information Systems (GIS), Intelligent Electronic Devices (IED) & their application in monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro Compressed Air Energy Storage, Wide Area Measurement System (WAMS), Phase measurement unit (PMU).	**06**
4	Micro grids and Distributed Energy Resources Concepts of micro grid, need and applications of micro grid, formation of micro grid, issues of interconnection, protection and control of micro grid, Plastic and organic solar cells, thin film solar cells, variable speed wind generators, fuel cells, micro turbines, captive power plants, integration of renewable energy sources.	**06**

5	Power Quality Management in Smart Grid Power quality & EMC in Smart Grid, power quality issues of grid connected renewable energy sources, power quality conditioners for Smart Grid, Web based Power Quality monitoring, Power quality Audit.	**06**
6	Information & Communication Technology for Smart Grid Advanced Metering Infrastructure (AMI), Home Area Network (HAN), 6. Neighbourhood Area Network (NAN), Wide Area Network (WAN), Bluetooth, Zigbee, GPS, Wi-Fi, Wi-Max based communication, Wireless mesh network.	**06**
7	Security for Smart Grid Basics of CLOUD computing and cyber security for Smart Grid, Broadband over Power Line (BPL), IP based protocols.	**06**

Text/ Reference Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai, Integration of Green and Renewable Energy in Electric Power Systems, Wiley.
2. Clark C. Gellings, The Smart Grid – Enabling Energy Efficiency and Demand Response CRC press.
3. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, Smart Grid – Technology and Applications, Wiley.
4. Jean Claude Sabonnadière, NouredineHadjsaid, Smart Grids, Wiley Blackwell.
5. Peter S. Fox, Penner, Smart Power – Climate Changes, the Smart Grid and the Future of Electric Utilities, Island Press, 1st Edition 8th June 2010.
6. Stuart Borlase, Smart Grids (Power Engineering) CRC Press.
7. S.Chowdhury, S. P. Chowdhury, P. Crossley, Microgrids and Active Distribution Networks, Institution of Engineering and Technology, 30th June 2009.

Sr. No.	Examination	Modules
1	**Test 1**	**1,2**
2	**Test 2**	**3,4**
3	**End Semester**	**01-07**

Course Code: PE-BTE803 Course:-HVDC Transmission System (AY 2018-19)

Course Objectives:

1. Understand the advantages of dc transmission over ac transmission.
2. Understand the operation of Line Commutated Converters and Voltage Source Converters.
3. Understand the control strategies used in HVdc transmission system.
4. Understand the improvement of power system stability using an HVdc system

Course Outcomes: Students will demonstrate the ability to

1. Understand the advantages of dc transmission over ac transmission.
2. Understand the operation of Line Commutated Converters and Voltage Source Converters.
3. Understand the control strategies used in HVDC transmission system.
4. Understand the improvement of power system stability using an HVDC system.

Course Contents:

Module	Details	Hours
1	Transmission Technology Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVDC Systems. Components of a HVdc system. Line Commutated Converter and Voltage Source Converter based systems.	**05**
2	Analysis of Line Commutated and Voltage Source Converters Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links. Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.	**10**
3	Control of HVdc Converters: Principles of Link Control in a LCCHVdc system. Control Hierarchy, Firing Angle Controls– Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC HVdc system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation	**10**
4	Components of HVdc systems:	**08**

	Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line: Corona Effects. Insulators, Transient Over-voltages. dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Monopolar Operation. Ground Electrodes.	
5	Stability Enhancement using HVdc Control Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems	**05**
6	MTdc Links Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTdc systems using LCCs. MTdc systems using VSCs. Modern Trends in HVdcTechnology. Introduction to Modular Multi-level Converters.	**04**

Text/ Reference Books:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience, 1971.

Sr. No.	Examination	Modules
1	**Test 1**	**1, Part of 2**
2	**Test 2**	**Part of 2, Part of 3**
3	**End Semester**	**01-07**

Course Code: PE-BTE804 Course:-Power Quality and FACTS (AY 2018-19)

Course Objectives:

1. Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
2. Understand the working principles of FACTS devices and their operating characteristics.
3. Understand the basic concepts of power quality.
4. Understand the working principles of devices to improve power quality.

Course Outcomes: Students will demonstrate the ability to

1. Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
2. Understand the working principles of FACTS devices and their operating characteristics.
3. Understand the basic concepts of power quality.
4. Understand the working principles of devices to improve power quality.

Course Contents:

Module	Details	Hours
1	Transmission Lines and Series/Shunt Reactive Power Compensation Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.	**04**
2	Thyristor-based Flexible AC Transmission Controllers (FACTS) Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.	**06**
3	Voltage Source Converter based (FACTS) controllers Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM andSpace Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Fault Current Limiter.	**08**
4	Application of FACTS Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a	**06**

	STATCOM.	
5	Power Quality Problems in Distribution Systems Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.	**04**
6	DSTATCOM Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM	**08**
7	Dynamic Voltage Restorer and Unified Power Quality Conditioner Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.	**06**

Text/ Reference Books:

1. J. Arrillaga, M. R. Watson, S. Chan, Power System Quality Assessment, John Wiley and Sons.
2. M. H. J. Bollen, Understanding Power Quality Problems, Voltage Sag and Interruptions, New York IEEE press, 2000 Series on Power Engineering.
3. R. C. Dugan, Mark F. McGranghan, Surya Santoso, H. Wayne Beaty, Electrical Power System Quality, McGraw Hill Publication:
4. EnriquesAcha, Manuel Madrigal, Power System Harmonics – Computer Modeling and Analysis, John Wiley and Sons Ltd.
5. Ewald F. Fuchs, Mohammad A. S. Masoum, Power Quality in Power Systems and Electrical Machines. 3. G. J. Heydt, Electric Power Quality, Stars in Circule publications.
6. IEEE Std. 519-1992, IEEE recommended practices and requirements for harmonics control in electrical power system

Sr. No.	Examination	Modules
1	**Test 1**	**1,2**
2	**Test 2**	**3,4**
3	**End Semester**	**01-07**

Course Code: PE-BTE805 Course:-Advanced Electric Drives (AY 2018-19)

Course Objectives:

1. Discuss the operation of power electronic converters and their control strategies.
2. Introduce vector control strategies for ac motor drives
3. Discuss the implementation of the control strategies using digital signal processors.

Course Outcomes: students will demonstrate the ability to

4. Understand the operation of power electronic converters and their control strategies.
5. Understand the vector control strategies for ac motor drives
6. Understand the implementation of the control strategies using digital signal processors.

Course Contents:

Module	Details	Hours
1	**Power Converters for AC drives** PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter	**05**
2	**Power Converters for AC drives** Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.	**05**
3	**Induction motor drives** Different transformations and reference frame theory, modeling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control(DTC).	**08**
4	**Synchronous motor drives** Modeling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.	**06**
5	**Permanent magnet motor drives** Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM	**06**
6	**Switched reluctance motor drives** Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM	**06**
7	**DSP based motion control** Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.	**06**

Text/ Reference Books:

1.. K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education, Asia, 2003.
2. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, “Analysis of Electric Machinery and Drive Systems”, John Wiley & Sons, 2013.
3. H. A. Taliyat and S. G. Campbell, “DSP based Electromechanical Motion Control”, CRC press, 2003.
4. R. Krishnan, “Permanent Magnet Synchronous and Brushless DC motor Drives”, CRC Press, 2009

Sr. No.	Examination	Modules
1	Test 1	1, 2, Part of 3
2	Test 2	Part of 3, 4
3	End Semester	01-07

Course Code: PE-BTE806 Course:-Industrial Automation (AY 2018-19)

Course Objectives:

1. Understand architecture of Industrial Automation system.
2. Overview of industrial control system.
3. Overview of elements of automation system.
4. Understand performance objectives of process automation.

Course Outcomes: students will demonstrate the ability to

1. Able to understand Architecture of Industrial Automation Systems.
2. Able to understand the process of tuning and draw P & I diagrams.
3. Able to understand elements of industrial automation.
4. Get knowledge of design methodology for industrial automation systems

Module	Details	Hours
1	Introduction Industrial Automation and Control and Architecture of Industrial Automation Systems	**05**
2	Industrial Control System: P, I, D & Tuning with reference to Process Control & Drives Control	**05**
3	Process representation: P & I Diagrams and Interpretation, block diagrams	**08**
4	Design methodology User Requirement Specifications (URS) System (Or Software) Requirement Specifications (SRS) Factory & Site Acceptance Tests (FAT & SAT) Quality Assurance System	**06**
5	Elements Industrial Automation (a) Five tier concept (Sensors to Boardroom) Field Devices (Instruments, IEDs, Lab Equipment etc, Smart & Conventional) Controllers (PLC, DCS, RTU, DDCs) SCADA/HMI & Database Elements Industrial Automation (b) Higher level applications (MIS/MES/Optimization / ERP etc) IT Infrastructure (Servers, Work Stations, Engineering Stations, Gateways, FEP, Communication Networks etc…) Protocols: 7 layer model, TCP/IP Ethernet, Modbus TCP/IP & RTU, -Profibus, IEC61850, BACNet , OPC etc	**06**
6	Performance objectives: Response times (At various levels) Availability Calculation for the System (MTBF & MTTR) Resolution, Linearity, Accuracy	**06**

7	Case Study(Any one) –Electric Drives : Introduction, Energy Saving with Adjustable Speed Drives - Introduction to Production Control Systems - Introduction to CNC Machines	**06**

Text/ Reference Books:

1. John Webb: Programmable Logic Controllers Principles and applications, PHI.
2. T. A. Hughes: Programmable Controllers.
3. C.D. Johnson: Process Control Instrumentation.

Sr. No.	Examination	Modules
1	**Test 1**	**1,2, Part of 3**
2	**Test 2**	**Part of 3, 4**
3	**End Semester**	**01-07**

Course Code: OE-BTE801 Course:-Robotics (AY 2018-19)

Course Objectives:

1. This course familiarizes students with the concepts and techniques in robot manipulator control.
2. Its main objective is to make students familiar with the Kinematics and Dynamics involved.in robotic manipulator used in automation industry.
3. To study and appreciate the need of control theory to control such a complex nonlinear.

Course Outcomes:

1. Able to appreciate the importance of robotic arm and its applications in automation industry.
2. Able to appreciate the importance of control system theory to control such a complex nonlinear robotic arm.
3. Able to describe the kinematic and dynamic model of robotic arm.
4. Able to appreciate the importance of path, task and trajectory planning

Course Contents:

Module	Details	Hours
1	Introduction to Robotics Automation and Robots, Classification, Application, Specification, Notations.	**06**
2	Direct Kinematics Dot and Cross Products, Co-ordinate frames, Rotations, Homogeneous Co-ordinates, Link Coordinates, Arm Equation (Three axis, Four axis and Five axis robots).	**06**
3	Inverse Kinematics General properties of solutions, Tool configuration, Inverse Kinematics of Three axis, Four axis and Five axis robots.	**06**
4	Workspace Analysis Workspace analysis of four axis and Five axis robots, Work envelope, Workspace fixtures	**06**
5	Trajectory Planning Trajectory Planning, Pick and Place operations, Continuous path motion, Interpolated motion, Straight-Line motion.	**06**
6	Task Planning Task level programming, Uncertainty, Configuration space, Gross motion Planning, Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation	**06**
7	Robot Arm Dynamics Lagrange-Euler Formulation, Newton-Euler Formulation, Computational Algorithm, A two Link Manipulator Example, control Techniques applied to Robotic Arm.	**06**

Text/ Reference Books:

1. Robert Shilling, Fundamentals of Robotics-Analysis and Control, Prentice Hall of India.
2. Fu, Gonzales and Lee, Robotics, McGraw Hill.
3. J.J. Craig, Introduction to Robotics, Pearson Education.
4. Curtis D. Johnson, Process Control Instrumentation Technology, PHI publication.

Sr. No.	Examination	Modules
1	Test 1	1,2
2	Test 2	3,4
3	End Semester	01-07

Course Code: OE-BTE802 Course:-Power Plant Engineering (AY 2018-19)

Course Objectives:

To provide an overview of power plants and the associated energy conversion issues

Course Outcomes: Students will demonstrate the ability to

Understand the principles of operation for different power plants and their economics

Course Contents:

Module	Details	Hours
1	Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates	**06**
2	Subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems	**06**
3	Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems	**06**
4	Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants.	**06**
5	Hydroelectric power plants, classification, typical layout and components, principles of wind,tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems	**06**
6	Energy, economic issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies	**06**
7	Energy environmental issues including waste disposal options for coal and nuclear plants.	**06**

Text/ Reference Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

Sr. No.	Examination	Modules
1	Test 1	1, 2
2	Test 2	3, 4
3	End Semester	01-07

Value Added Courses

1. **PLC (VL-BTE03)**

Course Objective:

1. Discuss the purpose, functions, and operations of a PLC
2. Explain basic components of the PLC and how they function

Course Outcome: Students will be able to

1. Generate and print out a ladder logic report using PLC software
2. Create a PLC project using PLC
3. Configure the I/O for a PLC project using PLC

Course content: Introductions to the purpose, functions, and operations of the PLC, Identification of various components of the PLC, Introduction to PLC ladder logic and basic programming concepts, Establishing communications with the PLC, Definitions of conditional inputs and outputs, Electrical continuity versus logical continuity, PLC timer and counter concepts and programming applications, Programming applications using sequencers.

2. Soft Computing II ETAP and WAMS (VL-BTE06)

Course Objective:

1. Introduce ETAP software
2. Discuss the synchro phasor measurement techniques in a Wide Area Control through the basic building blocks of GPS satellite synchronized clocks, the architecture of the Phasor Measurement Units (PMUs), and The communications equipment.

Course Outcome: Students will be able to

1. Use ETAP as an analysis platform for the designing, simulating, operating and automation of generation and distribution of power systems.
2. Understand the synchro phasor measurement techniques in a Wide Area Control

Course content: Build power systems and simulate the power, current and voltage flow, Single Line diagram creation and analysis, run and Analyze AC power circuits, Run load flow analysis on one line diagram, run Short Circuit analysis.

Introduction to Synchro Phasor & WAMS Technologies, Synchro Phasor needs and benefits for Operations, Planning and Control Vision for Synchro Phasor & Online Stability Solutions Fundamental building blocks for WAMS and Synchro Phasor Platform Architecture, PMU standard and communications