Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

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

COURSE CONTENTS

Sem. V

T. Y. B.Tech. (ELECTRICAL) ENGINEERING

Academic Year: 2019-20

List of Courses

Course Code: PC-BTE501 Course:-Electromagnetic Field and Waves (AY 2019-20)

Course Objectives:

1. To introduce the basic mathematical concepts related to electromagnetic vector fields.
2. To impart knowledge on concepts of electrostatics, electric potential, energy density and its applications.
3. To impart knowledge on concepts of magneto statics, magnetic flux density, scalar and vector magnetic potential and its applications.
4. Explain time varying electric and magnetic fields and wave theory

Course Outcomes: Students will demonstrate the ability to

1. Define and understand different coordinate systems, Fundamental laws governing electromagnetic fields and evaluate the physical quantities of electromagnetic fields (Field intensity, Flux density etc.) in different media using the fundamental laws, Electromagnetic Wave concept.
2. Apply different techniques of vector calculus to understand different concepts of electromagnetic field theory.
3. Determine the electromagnetic force exerted on charged particles, current elements, working principle of various electric and electromagnetic energy conversion devices are based on this force.
4. Design electromagnetic energy storage devices like capacitor, inductor which are frequently used in electrical systems.

Course Contents:

Module	Details	Hours
1	**Review of Vector Calculus** Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, Three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus differentiation, Partial differentiation, integration, vector operator del, gradient, divergence and curl; integral theorems of vectors. Conversion of a vector from one coordinate system to another	04
2	**Static Electric Field** Coulomb's law, Electric field intensity, Electrical field due to point charges. Line, Surface and Volume charge distributions. Gauss law and its applications. Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations. Electric dipole, Electrostatic Energy and Energy density	10
3	**Conductors, Dielectrics and Capacitance** Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations	06

4	**Static Magnetic Fields** Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar 06and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors	**06**
5	**Magnetic Forces, Materials and Inductance** Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.	**06**
6	**Time Varying Fields and Maxwell's Equations** Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces. Boundary Conditions.	**04**
7	**Electromagnetic Waves** Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect. Poynting theorem. Smith chart for impedance matching with open, short and match condition	**06**

Text/ Reference Books:

1. W.Hayt, "Engineering electromagnetic", McGraw Hill.
2. Edminister, "Schaum's series in electromagnetic", McGraw Hill publications.
3. N.NarayanRao, "Elements of electromagnetic", PHI publication.
4. E.C.Jordan &K.G. Balmain, "Electromagnetic Waves and Radiating Systems", Prentice
5. Hall of India.
6. S.seely, "Introduction to electromagnetic fields", McGraw Hill.
7. David K. cheng, "Field and electromagnetic", Addison Wesley.
8. Corson and lerrain, "Electromagnetic", CBS publications

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

Course Code: PC-BTE502 Course:-Control System (AY 2019-20)

Course Objectives:

1. Introduction to control problem
2. Discuss time response, frequency response and state variable analysis
3. Introduction to controllers and compensators
4. Introduction to optimum and nonlinear control

Course Outcomes: Students will demonstrate the ability to

1. Understand the modeling of linear-time-invariant systems using transfer function and state-space representations.
2. Understand the concept of stability and its assessment for linear-time invariant systems.
3. Compare different controllers/compensators
4. Understand non linear systems

Course Contents:

Module	Details	Hours
1	Introduction to control problem Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.	**04**
2	Time Response Analysis Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response.	**06**
3	Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.	**04**
4	Frequency-response analysis Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.	**06**
5	Introduction to Controllers and Compensators Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controller	**10**
6	State variable Analysis Concepts of state variables. State space model. Diagonalization of State	**06**

	Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.	
7	Introduction to Optimal Control and Nonlinear Control Performance Indices. Regulator problem, Tracking Problem. Nonlinear system–Basic concepts and analysis.	**06**

Text/ Reference Books:

1. Norman Nise, "Control Systems Engineering".
2. Katsuhiko Ogata, "Modern Control Engineering", Prentice Hall of India Pvt.Ltd
3. I.G. Nagrath & M. Gopal, "Control Systems Engineering", Wiley Eastern Ltd.
4. J.J. D'Azzo, C.H.Houpis and S.N. Sheldon, "Linear Control System Analysis and Design with MATLAB", Marcel Dekker.
5. G.F Franklin, "Feedback Control of Dynamic Systems", Pearson higher Education.

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

Course Code: PC-BTE503 Course:-Electrical Machines II (AY 2019-20)

Course Objectives:

1. Discuss the principle and operation of generating machine both 1-phase and 3-phase
2. Demonstrate the behavior of generating and motoring machine for different operating conditions.
3. Demonstrate the principle of fractional kilowatt machine
4. Discuss the special types of machines and applications (motors and generators)

Course Outcomes: Students will demonstrate the ability to

1. Illustrate the fundamental concept of electrical machine in electrical power generation
2. Analyze synchronous machine performance using trigonometry, complex algebra, and phasors to find correct solutions.
3. Apply the knowledge of basic machines to understand the operation of single phase induction machines and special machines

Course Contents:

Module	Details	Hours
1	Three Phase Induction Machine: (i) Construction and principle of operation of squirrel cage & slipring Induction motor (ii) Equivalent circuit, phasor diagram, no load and blocked rotor test, circle diagram (iii) Steady state analysis: Torque -speed characteristics, maximum torque, starting torque. Starting methods	06
2	Synchronous Machines: Construction, emf induced, winding factors, Armature reaction, Phasor diagrams of cylindrical pole synchronous generator at different power factor, Methods of voltage regulation of alternator	08
3	(i) Principle of operation of Synchronous Motor, starting methods. Power flow and maximum power of synchronous machines, (ii) Excitation & power circles, V & O curves, power angle characteristics, synchronizing power and torque, hunting, synchronous condenser	06
4	Operation on infinite bus for a change in excitation for motors and generators, Parallel operation of alternators, Load sharing	04
5	Salient pole machine: Blondel's two reaction theory, Measurement of Xd& Xq, Power flow equation.	06
6	Fractional kW machines: Construction, principle of operation. and	06

	applications of Single phase induction motor, capacitor start, capacitor run motor, Shaded pole motor.	
7	Special purpose Machines: Construction, principle of operation and applications of Stepper motor and their types, Permanent Magnet Synchronous Motor, Brushless DC motor.	06

Text/ Reference Books:

1. Nagrath and Kothari, "Electrical Machines", TMH Publicatio.
2. Sen P. C., "Principles of Electric Machines & Power Electronics".
3. Bimbhra P.S, "Electrical Machinery", Khanna Publisher, VII Edition.
4. Bimbhra P.S., "Generalized Theory of Electrical Machines", Khanna Publisher.
5. Gross Charles A., "Electrical Machines", CRC Press.

Sr. No.	**Examination**	**Modules**
1	**Test 1**	**1,2**
2	**Test 2**	**3,4,5**
3	**End Semester**	**1-7**

Course Code: PC-BTE504 Course:-Power System I (AY 2019-20)

Course Objectives:

1. Understand the basic structure, components, growth, and load curves of an electrical power system.
2. Understand the parameters, performance and characteristics of power system components.
3. Understand the behavior of the power system under symmetrical and unsymmetrical fault condition using symmetrical components.
4. To study Neutral grounding , Earthing and safety techniques in power system.

Course Outcomes: Students will demonstrate the ability to

1. Evaluate and compare the load curves of power systems.
2. Identify and select and configure the components of transmission system to improve efficiency and economy.
3. Understand the effect on power system parameters with varying load conditions.
4. Understand the power system behavior under symmetrical and unsymmetrical fault conditions
5. Understand the safety measures of power system.

Course Contents:

Module	Details	Hours
1	Power System Representation Brief introduction to generating stations, Basic structure of power system voltage levels at different stages of power transmission. Need for EHV transmission, Growth of power system in India, present Indian power industry, GRID formation, concept of National GRID. Transmission System Transmission & distribution network systems. Conductor configuration spacing and clearance, span lengths, sag& tension, Types of insulator, Voltage distribution over insulator string, Methods to improve string efficiency. Types of underground cables (including AC and DC) Economics of Power System Load curves, connected load, maximum demand, demand factor, Average load, load factor, diversity factor, Tariff	**06**
2	Overhead Transmission Lines and Cables: Electrical and Magnetic Fields around conductors, Corona. Parameters of lines and cables. Capacitance and Inductance calculations for simple configurations	**07**
3	Sinusoidal Steady state representation of Lines: Short, medium and long lines. Power Transfer, Voltage profile and Reactive Power. Characteristics of transmission lines. Surge Impedance Loading. Series and Shunt Compensation of transmission lines.	**06**

4	Transformers: Three-phase connections and Phase-shifts. Three-winding transformers, autotransformers, Neutral Grounding transformers. Tap-Changing in transformers. Transformer Parameters. Single phase equivalent of three-phase transformers. Synchronous Machines: Steady-state performance characteristics. Operation when connected to infinite bus. Real and Reactive Power Capability Curve of generators. Typical waveform under balanced terminal short circuit conditions – steady state, transient and sub-transient equivalent circuits. Loads: Types, Voltage and Frequency Dependence of Loads. Per-unit System and per-unit calculations.	**08**
5	Symmetrical Components: Unbalanced system Analysis using symmetrical components, Power in terms of symmetrical components, Sequence circuits of transmission lines, transformer and Synchronous Machines, Phase shift in star delta transformer, Formation of Sequence Networks	**05**
6	Symmetrical and Unsymmetrical Fault Analysis: (i) 3 phase Short circuit of a synchronous machine: no load and loaded conditions, 3 phase fault on a transmission line, Short circuit MVA Capacity of a bus. (ii) Fault analysis using symmetrical components, Single line to ground (SLG) fault, Line to line (LL) fault, Double line to ground (LLG) fault, Open conductor fault. Neutral grounding	**06**
7.	Earthing and Safety Techniques Soil resistivity, earth resistance, Tolerable limit of body currents-tolerable step and touch voltage-actual step and touch voltage, Design of tower footing – Resistance, Measurement of earth resistance, soil resistivity-Impulse behavior of earthing.	04

Text/ Reference Books:

1. Kothari D. P Nagrath I. J., "Modern Power System Analysis", TMH Publications.
2. Wadhawa C. L., "Electrical Power Systems", New Age International.
3. Grainger J. J., Stevenson Jr W. D., "Power System Analysis", McGRAW-HILL International
4. George Kausic., "Computer Aided Power System Analysis", Prentice Hall Pub.
5. Saadat Hadi, "Power System Analysis, "TMH Edition.
6. Prabha Kundur, "Power System Stability and Control'', TMH Publication.
7. IEEE 80 – IEEE guide for safety in substation grounding

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

Course Code: PC-BTE505 Course:-Power Electronics (AY 2019-20)

Course Objectives:

1. Explain controlled converters
2. Analyze current and voltage inverters and demonstrate the operation and control of inverter circuits
3. Discuss DC to DC converters
4. Discuss need and application of AC filters

Course Outcomes: Students will demonstrate the ability to

1. Understand the behavior of semiconductor devices operated as power switches.
2. Analyze and design rectifier circuit.
3. Analyze DC/DC converter circuits.
4. Analyze DC/AC inverter circuit.

Course Contents:

Module	Details	Hours
1	Silicon Controlled Rectifiers: Principle of operation of SCR, Static & Dynamic characteristics, Gate characteristics, pulse firing	**03**
2	Other Switching Devices: Principle of operation, characteristics, rating and applications of Triac, MOSFET, IGBT and power diodes, IGCT, GTO, SGTO. Comparison of devices on the basis of turn on, turn off time.	**06**
3	Rectifiers: Introduction to Half wave uncontrolled and controlled rectifiers with differnt load Full wave controlled rectifiers with different load (single phase and three phase) Power factor improvements in rectifiers. Effect of load and source inductances	**08**
4	AC Filters: AC filter for grid connected converter, AC inductor design and need of LCL filter, LCL filter design	**04**
5	Inverters: (i) Principle of operation, Performance parameters, Single phase bridge Inverters with RL, R-L-E and pure L load. 3 phase bridge Inverters: 180 degree conduction mode. (ii) Voltage control of single phase and three phase inverters using PWM techniques, Connection of three phase inverter to grid, concept of active and reactive power flow between inverter and grid (iii) Current source inverters (iv) Space vector modulation	**08**
6	Choppers: Switching mode regulators – Buck, Boost, Buck-Boost and Cuk regulators, Bi-directional Chopper	**06**

7	AC Voltage Controllers: Principle of Phase Control, Single Phase bidirectional control with R-L load, Three phase full wave controllers, AC voltage controllers with PWM control, Applications Thermal management of power electronics devices IGBT, thyristors	**07**

Text/ Reference Books:

1. Muhammad H. Rashid, "Power Electronics, Circuits Devices and Applications", Prentice-Hall of India.
2. Ned Mohan et. al,"Power Electronics: Converters, Applications and Design", John Wiley Pub.
3. Alok Jain, "Power Electronics & its Applications," Penram International Publishing (India) Pvt. Ltd.
4. Cyril W. Landers, "Power Electronics", McGraw Hill.
5. M. D. Singh, K. B. Khanchandani, "Power Electronics" Tata McGraw Hill.
6.. P.C.Sen, "Power Electronics", Tata McGraw-Hill Education.

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

Course Code: PC-BTE506 Course:-Control System Laboratory (AY 2019-20)

Course Objectives:

1. Time response, frequency response and state variable analysis
2. Introduction to controllers and compensators
3. Introduction to optimum and nonlinear control
4. Identify the applications of control system.

Course Outcomes: Students will demonstrate the ability to
Simulate and analyze

1. First, second and higher order systems
2. Bode plot, Nyquist plot, solution of state equations, non linear system
3. Compensator controller and observer designs
4. Develop managerial skills

Course Contents:

Module	**Details**	**Hours**
Simulation assignments to study, analyze or design		
1	First, Second and Higher order systems' performance in frequency domain	02
2	Study of second order system with different damping ratio and natural frequency of oscillations	02
3-4	Bode plot, Nyquist plot analysis	04
5-7	Analysis of different compensators	04
7-8	Study of state space model	04
8-10	Analysis of different controllers	04
11	Non linear system analysis	04

Each student will write a technical report on application or further research based on various concepts of control system theory. The student has to present the same.

Course Code: PC-BTE507 Course:-Electrical Machines II Laboratory (AY 2019-20)

Course Objectives:

1. To perform load test on three phase induction motor
2. To observe the effect of rotor resistance and supply voltage on torque speed characteristic of induction motor
3. To study and evaluation of Voltage Regulation for synchronous generator volt
4. To conduct experiment to draw V and inverted V curves for synchronous motor
5. To calculate Xd and Xq of a salient pole synchronous machine.

Course Outcomes: Students will demonstrate the ability to

1. Perform load test on three phase induction motor and understand variation in torque speed characteristics with different parameters
2. Perform experiments on synchronous machines with defined procedures and safety.
3. Understand the voltage regulation in synchronous generator and different methods to find it.
4. Analyze the V curve and inverted V-curve for synchronous motor under various load conditions.
5. Determine Xd and Xq parameters of salient pole synchronous machine.

Course Contents:

Module	Details	Hours
1	To perform load test on 3 Phase Induction Motor.	02
2	To study the effect of rotor resistance on torque speed characteristic of 3 Phase Induction Motor.	02
3	To study the effect of supply voltage on torque speed characteristic of 3 Phase Induction Motor.	02
4	Voltage Regulation of synchronous generator by EMF/MMF method	02
5	Voltage Regulation of synchronous generator by ZPF method	02
6	Voltage Regulation of synchronous generator ASA Method	02
7	Voltage regulation of synchronous generator by direct loading	02
8	Slip Test on salient pole synchronous generator	02
9	V-curves and inverted V- Curves F-curves of synchronous motor	02
10	Performance characteristics of single phase induction motor	02

Course Code: PC-BTE508 Course:-Power Electronics Laboratory (AY 201920)

Course Objectives:

1. To simulate various converter circuits.
2. To familiarize the students by introducing MATLAB simulation and help them to Simulate and analyze different Converters

Course Outcomes: Students will demonstrate the ability to

1. Simulate uncontrolled and controlled rectifiers on software
2. Observe and analyze various converter waveforms for different loads.
3. Apply knowledge of dual converter in DC motor applications.
4. Execute three phase bridge rectifier connections and analyze waveforms
5. Identify difference in ideal and practical power electronics circuits

Course Contents:

Expt No.	Title	Hours
1	Half wave diode converter	02
2	Half wave SCR converter	02
3	Single phase Full wave fully controlled SCR converter with resistive load	02
4	Single phase Full wave fully controlled SCR converter with RL load.	02
5	3 phase full wave fully controlled SCR converter with resistive load	02
6	Separately excited DC motor speed control using Dual Converter	02
7	Single phase Inverter	02
8	Two MATLAB simulations of uncontrolled & controlled converters	02

Course Code: PC-BTE509Course:- Electromagnetic Field and Waves Laboratory

(AY 201920)

Course objective:

1. To understand and concept of vector addition, vector calculus, co-ordinate systems, static and time varying fields and electromagnetic waves more precisely by visualize aid.

2. To familiarize the students by introducing FEMM-4.2 simulation software and help them to Simulate and analyze different Electromagnetic circuit.

Course outcomes: Students will demonstrate the ability to

1. Understand concepts of vector calculus and underlying theories in electrostatics, magneto statics, and time-varying electromagnetic fields using field plots generated by formulae and Finite Element Method (FEM) based computations.
2. Apply knowledge of electromagnetic fields in real time application.
3. Analysis of effect electromagnetic field in electromagnetic circuits.
4. Build and simulate core electromagnetic circuits and power apparatus using FEMM software.

Course Contents:

Expt. No.	List of Experiments	Hours
1.	Addition & Products of two vectors.	02
2.	Coordinate systems (Cartesian, Cylindrical and Spherical).	02
3.	Position vector and distance vector.	02
4.	Curl, Divergence and gradient of a field.	02
5.	Variation of electrostatic fields.	02
6.	Curl free static electric field.	02
7.	Variation of electrostatic fields over multiple dielectric materials.	02
8.	Electric flux density.	02
9.	Force on a single current carrying conductor.	02
10.	Force between two current carrying conductors.	02
11.	Magnetic vector potential.	02
12.	Variations of time varying field.	02

Course Code: PE-BTE501 Course:-Digital Signal Processing (AY 2019-20)

Prerequisite: Course Signals and Systems

Course Objectives:

1. Introduce discrete time signals and systems
2. Frequency analysis including fast algorithms
3. Discuss digital filters and different design methods of digital filters

Course Outcomes: Students will demonstrate the ability to

1. Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
2. Analyze discrete-time systems using z-transform.
3. Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
4. Design digital filters for various applications.
5. Apply digital signal processing for the analysis of real-life signals

Course Contents:

Module	Details	Hours
1	Discrete-time signals and systems Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.	**06**
2	Z-transform z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using z transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.	**06**
3	Discrete Fourier Transform (10 hours) Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Circulation convolution, comparison between linear and circulation convolution,, Circulation convolution using DFT / IDFT, Response of LTI system (linear convolution or linear filtering) using circulation Convolution, Response of LTI system (linear convolution or linear filtering) using DFT / IDFT	**10**
4	Fast Fourier Transform Algorithms Comparison of computation complexity of direct computation of DFT and FFT., Radix-2 Decimation in Time and Decimation in Frequency algorithms, IDFT using FFT algorithms	**04**
5	FIR Filter Designing Introduction: Linear Phase FIR Filters, Frequency response of different types of linear phase FIR Filters, Locations of definite zeros of different types of FIR Filters. Designing of FIR filters using windowing technique, Gibbs Phenomenon (Hamming, Hanning, Rectangular, Bartlett, Kaiser window functions), Designing of FIR filters using frequency sampling	**06**

	technique, Half Band FIR Filers.	
6	IIR Filter Designing Introduction, Designing of analog IIR filters using Butterworth and Chebyshev approximations, Analog to analog spectral transformations, Designing of IIR digital filters using impulse invariance and bilinear transformation methods, stability properties. Designing of IIR digital filters using matched z-transformation method, backward difference algorithm	**06**
7	Applications of Digital Signal Processing Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using, ARMA Model, Linear Mean-Square Estimation, Wiener Filter.	**04**

Text/ Reference Books:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and systems", Prentice Hall India.
2. J. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", Pearson.
3. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education.
4. S. Haykin and B. V. Veen, "Signals and Systems", John Wiley and Sons.

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

Course Code: PE-BTE502 Course:-Computer Architecture (AY 2019-20)

Course Objectives:

1. Introduction to computer, memory and input-output organization
2. Discuss pipelining
3. Explain different architectures

Course Outcomes: Students will demonstrate the ability to

1. Understand the concepts of microprocessors, their principles and practices.
2. Understand various data types, integer and floating point arithmetic, CPU operation and implementation
3. Understand various architectures and microprocessors.

Course Contents:

Module	Details	Hours
1	Introduction to computer organization Architecture and function of general computer system, CISC Vs RISC,	**02**
2	Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.	**06**
3	Memory organization System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks	**06**
4	Input – output Organization Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.	**08**
5	16 and 32 microprocessors 80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, Addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86	**08**
6	Pipelining Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.	**06**
7	Different Architectures VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming	**06**

Text/ Reference Books:

1. V. Carl, G. Zvonko and S. G. Zaky, “Computer organization”, McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, “The Intel microprocessors”, Pearson Education, 2000.
3. J. L. Hennessy and D. A. Patterson, “Computer Architecture A Quantitative Approach”, Morgan Kauffman, 2011.
4. W. Stallings, “Computer organization”, PHI, 1987.
5. P. Barry and P. Crowley, “Modern Embedded Computing”, Morgan Kaufmann, 2012.
6. N. Mathivanan, “Microprocessors, PC Hardware and Interfacing”, Prentice Hall, 2004.
7. Y. C. Lieu and G. A. Gibson, “Microcomputer Systems: The 8086/8088 Family”,Prentice Hall India, 1986.
8. J. Uffenbeck, “The 8086/8088 Design, Programming, Interfacing”, Prentice Hall, 1987.
9. B. Govindarajalu, “IBM PC and Clones”, Tata McGraw Hill, 1991.
10. P. Able, “8086 Assembly Language Programming”, Prentice Hall India.

Sr. No.	Examination	Modules
1	Test 1	1,2,3
2	Test 2	4,5
3	End Semester	1-7

Value Added Courses

1. **Soft Computing I (VA-BTE01)**

   Course Objective: Provide knowledge of MATLAB/ SCILAB.

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

   Course content: 1. Basic Introduction and Overview, 2.Variables and Data types, 3.Operation,. Control Structure, 4.Function, Introduction to different tool boxes available, 5. Introduction to MATLAB simulink

2. **Introduction to Python (VA-BTE02)**

   Course Objective: Provide knowledge of Python

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

   Course content: 1. Basic Introduction and Overview, 2.Variables and Data types., 3.Operations in Python, Control Structure, List, Tuples and Dictionary, 4.Function, Introduction to turtle and some introduction to modules, Exception handling, 5.Object oriented in python, Numpy, Matplotlib.

3. **Finite Element Methods for Electrical Engineering (VA-BTE05)**

   Course objective: Introduce how the finite element method can be used as a numerical tool to solve differential equations.

   Course Objective: Students will be able to solve Electrical engineering problems using finite element methods

   Course content: 1. Introduction to the mathematical description of Electrical engineering problems, 2. Revision of numerical solutions to differential and algebraic equations, Overview of the finite element method - Variational approach, 3. Ritz technique, Galerkin method, Approximation functions for one, two and three-dimensional elements, 4. Application of the FEM to Analyzing electrical circuits 5. Programming FEM in open source

Value Added Courses by Industry

Course code: VA- BTI01 Course: Basic Automation – 1 (PLC and HMI) (AY2019-20)

Course Duration: 40 hours

Prerequisite: Basic Knowledge of Automation technology, relay logic essential but not mandatory

Course Objectives : The participants will
1. understand working of PLC
2. understand basic concepts of HMI

Course Outcomes: The participants will be able to
1. use Siemens PLC by understanding installation and by applying the knowledge of programming

Course Contents:

Module	Details
1	**Basic constituents of PLC**: Signal modules, CPU, Power Supply, mounting rail and MMC
2	**Working** of PLC, Installation guidelines, powering and wiring of modules with information on addressing.
3	**Programming:** Programming language and representation in STL,FBD and LAD, Hardware Configuration and setting object Properties of Modules in STEP, Programming instruction: AND, OR, AND-before-OR, OR-before-AND, NO / NC contacts, Edge detection instructions, Set/ Reset, Elementary data type.
4	**Overview of SIMATIC S7 – PLC:** Programming Units and using PC as Programming Unit, Hardware Configuration and setting object Properties of Modules in STEP, Step 7 Instructions and programming: Set/ Reset, Elementary data type, Load/Transfer, comparison, basic math instructions, Timers/ Counters List etc
5	**Using Symbol Table and VAT**.

Course code VA-BTI 02 Course: Basic Automation – 2 (Network and SCADA) (AY2019-20)

Course Duration: 40 hours

Prerequisite: Basic course on Automation with PLC programming knowledge is essential.

Course Objectives:

1. To understand networking and SCADA

Course outcome:

1. Students will be able to know the networking and SCADA with hands on practice.

Course Contents:

Module	Details
1	**System overview** of SIMATICW in CC, Creating a project , Configuring connections to the SIMATIC S7
2	**How to link** Digital and Anaglog address in Scada software, Tag management
3	**Graphics Designer** and graphics displays for human machine interfacing
4	**Alarm logging** for message representation, message archiving
5	**Tag logging** for curve representation, measured value archiving Practical exercises for the above

Course code VA- BTI03 Course: Basics of Process Instrumentation (AY2019-20)

Duration: 40 Hours

Pre-requisite : Basic relay logic knowledge and academics information is essential

Course Objectives:

To understand methods of measurement of different signals

Course Outcome:

Student will be able to understand and use various technologies for measurement of parameters.

Course Contents:

Module	**Details**
1	**FLOW measurement :** Magnetic Flow meter technology, Mass Flow meter technology , Ultrasonic Flow meter technology (Inline & Clamp On)
2	**LEVEL measurement** Ultrasonic Level Technology, Radar Level Technology, Capacitance Level Technology
3	**PRESSURE Measurement**
4	**TEMPERATURE Measurement**
5	**ELECTROPENUMATIC POSITONER** Topics for all above Measurements. · Various Technology · Working Principles · Product over view · Live demo & Hands on trial for Pressure, Temperature & Positioners, etc

Course code VA-BTI 04 Course: Basic Mechatronics (AY2019-20)

Duration: 96 Hours
Prerequisite: Basic knowledge of electrical, electronics & mechanical

Course Objective:

Learn concepts and applications of Mechatronics

Course Outcomes:

Students can apply mechatronics concepts to develop applications.

Course Content:

Module	Details
1	**Introduction** What is Mechatronics?, Material, Energy and Signal flow diagram, Brief Introduction to Electrical Components, Power supply, Fuses, Circuit breakers, Relays, Contactors, Solenoids, Switches, Indicators, Sensors: Inductive, Capacitive, Photoelectric, Ultrasonic, Reed type, Brief Introduction to Mechanical Components, Motor Drives, Belts and Pulley, Chain and Sprocket, Gears, Clutch, Shaft& Axel, Bearings& Threaded Fasteners
2	**Brief Introduction to Pneumatic Components** Air generation and Distribution, Directional Control Valve (2/2, 3/2,4/2,5/2,5/3way etc.), Flow Control Valves, Pneumatic Actuators
3	**Reading and Interpretation of Technical Documents** Sequential Function Flow Chart Displacement-Step Diagrams, Displacement-Time Diagrams, Assembly diagrams, E-Pneumatic Diagrams, Electrical wiring diagrams
4	**Digital Fundamentals and PLC** ·Number systems and Logic Gates, Introduction to PLC Troubleshooting Strategies
5	**General introduction to Industry 4.0 I**ntroduction to Industrial revolutions – 1.0, 2.0, 3.0 & 4.0, Introduction to general concepts of Cloud and IOT Gateways, Various Siemens solutions to cloud connectivity, Siemens PLC's and SCADA Portfolio with Information Regarding Licensing of Software with TIA Portal V15.X, Brief discussions on communication protocols for connecting devices, Profinet, Demonstration of communication with PLC

Course code VA-BTI 05 Course : Basic LV - Switchgear and Motor (AY2019-20)

Duration: 40 Hours

Course Objectives:

Making participants familiar with SIEMENS Switchgear & motor System, Key features of the product

Course Outcomes: Students will be able to do testing and fault diagnostics.

Training Methodology: Explanation, demonstration and hands-on practice.

Course Content:

Module	Details
1	**Switchgear:** Introduction to ACB + MCCB + SDF , Basic Concepts of fault level, current carrying capacity etc. Equipments used in LV network , Standards Definitions, · ACB – Concept, Rating, Fault Capacity, Protection , MCCB – Concept, Fault Capacity, Protection, SDF – Concept, Fault Capacity, Protection
2	**Product Information :** Where to use ACB / MCCB / SDF – Selectivity / Discrimination, Principle of selectivity and cascading Siemens range, ACB -3WL / 3WT , Range Overview,ETU Overview, Cubicle Bus, BSS , DI/DO , ZSI etc MCCB - 3VL , Range Overview ,ETU Overview, Cubicle Bus SDF -Range Overview , ·Installation guidelines of ACB, MCCB and SDF, Maintenance guidelines for ACB, Replacement, cleaning of contacts of ACB, · Modification and retrofitting accessories ACB , Fault Diagnosis, Troubleshooting ACB, Hands On Training ACB, Application example, Accessory Fitment ACB , Setting of ETU, Fitment ACB , Do's and Don'ts of ACB
3 .	**Motor protection circuit breaker**- why MPCB needs to be used Soft starter- overview of soft starter use · MCB · RCCB · Pushbutton & Indication Lamps
4	**Motor** Definition, meaning, History regarding invention, onstruction: Description of various parts & their significance in motor operation, operation, working principle & basic equations, · Speed Torque Characteristics, Effects of supply variations over , the motor performance, Transformer equivalent circuit of induction motor, Efficiency of induction motor-Various losses in the induction motor, Types of insulating materials used & their temperature ranges, Product spectrum of Siemens motor, Comparison of normal & inverter driven motor. Comparison of normal and energy efficient motor, Various reasons of high starting current of an induction motor & their effects on supply system.
5	Starters- DOL & star delta etc. · Soft starter – brief verview, VFD – brief overview, Advance control of induction , motor-SIMOCODE overview, Installation &

	commissioning guidelines, Maintenance guidelines, General faults in the induction motor & their countermeasures i.e. Leads Overheating, Vibration, Abnormal sound etc

Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

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

COURSE CONTENTS

Sem. VI

T. Y. B.Tech. (ELECTRICAL) ENGINEERING

Academic Year: 2019-20

List of Courses

Course Code: PC-BTE601 Course:-Power System II (AY 2019-20)

Prerequisite: Courses: Power System I:

Course Objectives:

1. Understand the mathematical model of power system network
2. To study load flow analysis using different computational methods.
3. To understand the behaviour of power system during transient condition.
4. To study the behaviour of power system with different receiving end conditions under steady state
5. To study different methods of control and monitoring power system parameters.
6. To understand the basic pricing principle in power system economics and management.

Course Outcomes: Students will demonstrate the ability to

1. Derive mathematical model of the power system network.
2. Analyze the power system behaviour under steady state and transient conditions.
3. Suggest suitable methods to control power system parameters.
4. Suggest suitable pricing method to have power system economy and management

Course Contents:

Module	Details	Hours
1	Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications	**04**
2	**Load Flow Studies**: Power Flow Problem, Gauss Seidel (GS) method, Newton Raphson (NR) method, Decoupled & Fast Decoupled method, Comparison of different load flow methods	**06**
3	**Stability and Stability Constraints in synchronous grids** Power System Stability: Classification of Stability, Dynamics of synchronous machine, Power angle equation, Node elimination technique, Stability study of simple systems, Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of wing equations (using methods like Forward Euler, Runge-Kutta 4th order methods), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability. Travelling waves in transmission lines: wave equation, reflection and refraction of waves, Bewely Lattice Diagram, typical cases of line terminations.	**10**

4	**Control of Voltage:** Voltage and Reactive Power Flow Control: Production and absorption of reactive power, means of voltage control in power systems, Automatic Voltage Regulators, generator excitation systems and reactive power characteristics of power system components Droop Control and Power Sharing. Shunt Compensators, Static VAR compensators and STATCOMs Tap Changing Transformers. Power flow control using embedded dc links, phase shifters	**08**
5	**Control of Frequency** • Relationship between generator rotor speeds and "system frequency" during transients, • Calculation of system frequency, frequency control, speed governor, automatic generation control (AGC) Frequency dependence of loads.	**05**
6	**Monitoring and Control** Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control.	**04**
7	**Power System Economics and Management** Basic Pricing Principles: Generator Cost Curves, Utility Functions, Power Exchanges, Spot Pricing. Electricity Market Models (Vertically Integrated, Purchasing Agency, Whole-sale competition, Retail Competition), Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.	**05**

Text/ Reference Books:

1. Kothari. D. P, Nagrath. I. J., "Modern Power System Analysis", TMH Publication.
2. Chakrabarti .A, Halder. S, "Power System Analysis- Operation and Control", PHI.
3. Prabha Kundur,"Power System Stability and Control", TMH Publication.
4. Hingorani N.G.., "Understanding of Facts", Wiley Publications.
5. Allen. J. Wood., Bruce. F. Wollenberg, "Power Generation operation and Control", Wiley India.

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

Course Code: PC-BTE602 Course:-Switchgear and Protection (AY 2019-20)

Course Objectives:

1. Discuss components of a protection system and types of relays
2. Discuss equipment and system protection, digital protection
3. Discuss principles of circuit breakers and different types of circuit breakers

Course Outcomes: Students will demonstrate the ability to

1. Understand the different components of a protection system.
2. Understand the protection schemes for different power system components.
3. Understand the basic principles of digital protection.
4. Understand principles of circuit breakers.

Course Contents:

Module	Detail	Hours
1.	**Basics of protection** Protective zones. Attributes of relays, Primary and back up protection, remote and local back up, Desirable qualities. CT and PT **Typical relays:** Electromagnetic type, static type and numerical relay	04
2.	**Principle and characteristics of:** Over current Relays - Time setting, plug setting, Different characteristics like IDMT, very Inverse etc., Directional Relay, Distance Relay- Reactance, Impedance, MHO relay, Differential Relay, Earth Fault Protection **Introduction to Analogue and Digital Static Relays:** Comparison of static and electro-mechanical relays, Static Over Current Relays, Static Distance Relays	04
3.	**Power Apparatus Protection:** **Protection of Transmission lines & feeders**- over current protection and relay coordination, Distance relay application, Power swings and distance relaying, Pilot protection **Protection of Transformer**-The problems and hazard in transformer, Differential relay for 3 phase transformer winding protection, Magnetizing inrush, Restricted Earth fault protection, Buchholz relay. **Protection of Generator**-The problems and hazard in generator, Differential protection for stator faults, Protection against loss of prime mover and loss of excitation, field suppression, out of step protection. **Motor Protection**- The problems and hazards in Induction motor, Protection against single phasing, Thermal over load and short	12

	circuit protection using Type 2 coordination, Under voltage protection **Synchronous motor protection**. **Bus Protection**- Different bus arrangements with breakers, Ring bus arrangement, One and a half breaker arrangement and High impedance bus differential relay.	
4.	**Principles of Circuit Braking:** D.C and A.C. circuit breaking, arc voltage and current waveforms in an A.C. circuit., Definition of transient recovery voltage, rate of rise of TRV, expression for TRV for different values of arc resistance, current chopping, capacitance switching, ratings and specifications of circuit breakers, making and breaking capacity	04
5.	**Basics of Arc Extinction**: Ionisation of Gases, Deionization, Arc Formation in AC Circuit Breakers, Modes of Arc Extinction, Arc Interruption Theories, Arc Extinction in Oil, Vacuum, Air Blast and SF6 Gas, Arc Time Constant **Air Break Circuit Breaker**: Construction, arc control devices, Lengthening of Arc, Operating Mechanism, Series Connected Over-Load Trip Coil Arrangement **Fundamentals of:** a) Air Blast Circuit Breaker b) SF6 Circuit Breaker c) SF6 Insulated Metal Clad Switchgear – Sub Station d) MOCB i.e. Minimum Oil Circuit Beaker and Bulk Oil Circuit Breaker e) Vacuum Interrupter and Vacuum Circuit Breaker	06
6.	**HRC Fuses and their Applications:** Characteristic of a Fuse, Protection of Motor, Discrimination, Equipment Incorporating Fuses, High Voltage Current Limiting Fuses, Expulsion Type High Voltage Fuse, Drop Out Fuse, Test On Fuse. Metal Enclosed Switchgear, Control Gear and Contactor: Medium Voltage Metal Enclosed Switchgear with SF6 CB and VCB	04
7.	Modern Protection System, Microprocessor Based Substation Protection Control and Monitoring Application of Switch-Gear & Electrical Safety Short Circuit Testing of Circuit Breakers: Direct and Indirect testing concepts in detail. **Protection against over voltage surges:** Lightening phenomenon, over voltages due to lightning, different types of lighting arresters, Insulation Co-ordination between different devices, BIL.	08

Text/ Reference Books:

1. J. L. Blackburn, “Protective Relaying: Principles and Applications”, Marcel Dekker,New York, 1987.
2. Y. G.Paithankar and S. R. Bhide, “Fundamentals of power system protection”, Prentice Hall, India, 2010.
3. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley & Sons, 1988.
4. A. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer, 2008
5. D. Reimert, “Protective Relaying for Power Generation Systems”, Taylor and Francis,2006.

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: PC-BTE603 Course:-Switchgear and Protection Laboratory (AY 2019-20)

Course Objectives:

1. To demonstrate theoretical knowledge.
2. To conduct experiment based on overcurrent protection scheme.
3. To conduct experiment based on generator protection, earth fault protection.

Course Outcomes: Students will demonstrate the ability to

1. Understand operating characteristics of electromagnetic relays, circuit breaker and other protective devices.
2. Understand various protection scheme used in power system equipments.
3. Analyze performance of electromagnetic, numerical and microprocessor based relay.
4. To develop an ability and skill to design the feasible protection systems needed for each main part of a power system

Course Contents:

Module	Details	Hours
1	IDMT characteristic of non-directional over voltage relay	02
2	Study of Miniature Circuit Breaker HRC fuse, MCCB: components identification and Applications	02
3	Study of Power Contactor	02
4	Air Circuit Breaker: components identification and Applications.	02
5	Simulation of 2O/C+ 1E/F protection scheme.	02
6	Numerical Relay: Study and Application	02
7	Generator protection	02
8	Differential protection using static relay	02
9	Microprocessor based distance protection	02

Course Code: PC-BTE604 Course:-Electrical Simulation Laboratory(AY 2019-20)

Course Objectives:

1. To demonstrate theoretical knowledge.
2. To conduct simulations for analysis of different concepts in Electrical Engineering

Course Outcomes: Students will demonstrate the ability to

1. Acquire skills of using software for Electrical Engineering studies.
2. Analyze different theories studied in electrical networks, power electronics, control system, power system and electrical machines.

Course Contents:

Module	Details	Hours
1	Verification of network theorems	02
2	Transient responses of series RLC, RL, RC circuits with Sine and Step inputs.	02
3	Transfer function analysis using time and frequency responses.	02
4	Filter Design	
5	Simulation of three phase converters	02
6	Fundamentals of switching behaviour	02
7	Harmonic Analysis, network resonances	
8	Single line diagram of given power system network	02
9	Evaluation of transmission line parameters	02
10	Load flow analysis	02
11	Fault Analysis	02
12	Transient Stability Analysis	02
13	Economic Power Scheduling:	02
14	Machine Modeling	02

Course Code: PE-BTE601 Course:-Electrical Machines Design I (AY 2019-20)

Prerequisite: Courses: Electrical Machines I and II

Course Objectives:

1. Discuss the design of transformers, induction motors and synchronous machines
2. Introduction to computer aided design

Course Outcomes: Students will demonstrate the ability to

1. Understand the construction and performance characteristics of electrical machines.
2. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines
3. Understand the principles of electrical machine design and carry out a basic design of an ac machine.

Course Contents:

Module No.	Content Details	Hours
01	Fundamental aspects of Electrical Machine Design: Design of machines: Design factors - Limitations in design - modern trends in Design of Electrical machines - Modern machine manufacturing techniques. Materials used in Transformers and Rotating Machines: Electrical conducting materials – High conductivity materials. Magnetic materials: Soft magnetic materials – Solid core materials – Sheet steels – Special purpose alloys. Insulating Materials: Electrical properties of insulating material – Temperature rise of insulating material – classification of insulating material - Insulating materials used in Modern Electric machines.	06
02	Thermal Design aspects of Electrical machines: Thermal state in electrical machines – Theory of Solid Body Heating – Heating – Cooling. Cooling of Rotating machines: Methods of cooling - cooling system -quantity of Cooling medium (coolant).	06
03	Design of Transformers: (Core Type Transformers). Sizing of a transformer. Design Details: Output for single & three-phase transformers – Output Equation – Volt per Turn. Optimum Designs. Design of Core – Rectangular core – Square and stepped cores – Variation of core diameter. Selection of Core area and Type of Core. Choice of flux density. Design of windings – Selection of Type winding – Position of winding relative to core. Window space factor – Window dimensions – Width of window for optimum output. Design of Yoke. Overall Dimensions. Simplified Steps for Transformer Design.	08

04	Transformer Design Operating Characteristics: Resistance of Winding – Leakage reactance of winding – Regulation – No-load current. Temperature Rise of Transformers - Methods for cooling of transformers – Transformer oil as cooling medium – Temperature rise in plain walled Tanks. Design of Tank - with Tubes with Radiators.	04
05	Design of Induction Motors: Introduction - Sizing of an induction motor. Relation between Rating and Dimensions of Induction Motor – Specifications - Output Equation – Main Dimensions - Factors affecting the size of the machine – Specific electrical Loading – Specific Magnetic loading – Choice of specific electrical and magnetic loadings – Efficiency and Power Factor.	04
06	Induction motor Design Details: Calculation of Main Dimensions – Separation of D and L – Peripheral velocity – Ventilating Ducts. Design of Stator Core - Stator winding Design - Stator slot design – Stator Teeth Design – Depth of Stator Core. Determination of Air gap length. Design Rotor: Design of Squirrel cage Rotor - Rules for selecting rotor slots - Design of rotor bars and slots - design of end rings. Design of wound rotor – Number of Slots - Number of Turns – Rotor current and conductor section. Design of rotor core.	10
07	Estimation of Operating Characteristics of Induction Motor: No-load current – Short circuit current – Stator and Rotor Resistance – Leakage Reactance – Circle diagram – Starting Torque – Losses and Efficiency.	04

Text/ Reference Books:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programs", Oxford and IBH Publishing, 2006.

Sr. No.	Examination	Modules
1	**Test 1**	**1, Part of 2**
2	**Test 2**	**Part of 2, 3**
3	**End Semester**	**01-05**

Course Code: PE-BTE602 Course:-Control System Design (AY 2019-20)

Prerequisite: Control System

Course Objectives:

1. Discuss design specifications
2. Design of classical control system in time and frequency domain
3. Explain PID controller design and controller design in state space
4. Introduction to controllability, observability and non linearities

Course Outcomes: Students will demonstrate the ability to

1. Understand various design specifications.
2. Design controllers/ compensators to satisfy the desired design specifications in time domain and using frequency response
3. Design controllers and observers using the state-space approach.
4. Understand phase plot analysis for non linear systems

Course Contents:

Module	Details	Hours
1	Design Specifications Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response.	**06**
2	Design of Classical Control System in the time domain Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.	**08**
3	Design of Classical Control System in frequency domain Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.	**08**
4	Design of PID controllers Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.	**06**
5	Control System Design in state space Review of state space representation.	**02**
6	Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design. Design of Observer. Reduced order observer. Separation Principle.	**06**

7	Nonlinearities and its effect on system performance Various types of non-linearities. Effect of various non-linearities on system performance. Singular points. Phase plot analysis.	**06**

Text/ Reference Books:

1. N. Nise, "Control system Engineering", John Wiley, 2000.
2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000.
3. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
4. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.
5. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.
6. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional and modern)", McGraw Hill, 1995.
7. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems", Saunders College Pub, 1994.

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

Course Code: OE-BTE601 Course:-Project Management (AY 2019-20)

Prerequisite:

Basics of Electrical Engineering, Basics of statistics and mathematics, general knowledge about working of organizations

Course Objectives:

1. Get familiarized with basics of project management, its organization and project management framework.
2. Learn five important project management process groups, namely: initiating, planning, executing, monitoring & control, closing and ten important project management knowledge areas.
3. Understand the relationship between project management process groups and knowledge areas.

Course Outcomes: Students will demonstrate the ability to

1. Explain basics of Project Management, its organization and project management framework.
2. Perform project management process group and knowledge area mapping.
3. Solve a case study using step-by-step process of managing projects and explain why each step is necessary.

Course Contents

Unit	Contents	Hrs.
1	**Introduction** • Basics of project management, operations management and organizational strategy, • Project management framework, organizational structures, • Project Management Processes – Initiating, Planning, Executing, Monitoring & Control, Closing.	03
2	**Project Integration Management** • Integrated change control, Developing project management plan and project charter, • Project selection, corrective action, preventive action, defect repair, change control board, • Cost benefit analysis, Net present value, internal rate of return, payback period, present value, economic value added, • Opportunity costs, sunk costs, law of diminishing returns, working capital, depreciation. **Project Scope Management** • Scope baseline, WBS, Project scope statement, WBS dictionary, benefits and uses of WBS • Requirement documentation, requirements traceability matrix, requirements management plan	04
3	**Project Time Management** • Schedule baseline, schedule compression, Network diagram, • Precedence Diagramming Method (PDM), Three point estimating, analogous estimating, parametric estimating,	09

	• Schedule management plan, resource optimization, Critical path method, Program Evaluation Review Technique (PERT). **Project Cost Management** • Earned value measurement, Earned value monitoring, cost baseline, cost budget, Cost management plan, • Reserve analysis, contingency reserve, management reserves, cost risk, • Variable / fixed costs, direct / indirect costs, life cycle costing, value analysis, control thresholds, cost of quality, Return of Interest (RoI), and discounted cash flow. **Project Quality Management** • Seven basic quality improvement tools – control chart, Pareto diagram, Cause and effect diagram, flow chart, scatter diagram, histogram. Use of s-curve in project monitoring. • Quality assurance tools and techniques – Affinity diagram, tree diagrams, process decision program charts, matrix diagrams, prioritization matrices, network diagrams.	
4	**Project Human Resource Management** • Role of PM, sponsor, stakeholders, functional manager, portfolio manager, program manager, • HR management plan, recognition and reward systems, team building, stages of team formation and development, team types. • Conflict Management, • Responsibility Assignment Matrix (RAM), RACI Chart, • Motivation theory, Management and Leadership styles, **Project Communication Management** • Communication models, channels, method, communication blockers.	04
5	**Project Risk Management** • Risk management plan, risk response strategies, threats, opportunities, risk register, contingency plans, fallback plans, residual risks, secondary risks, • Risk types and categories, SWOT analysis, **Project Procurement Management** • Procurement management plan, types of agreements and contract types, advantages and disadvantages of each contract type, • PM's role in procurement, procurement documents : RFP, IFB, RFQ, RFI, • Types of procurement, procurement negotiations, centralized / decentralized contracting, contract interpretation, price, profit, cost, target price, sharing ratio, ceiling price	06
6	**Project Stakeholder Management** • Stakeholder analysis, stakeholder register, stakeholder expectations, stakeholder engagement, • Power and interest grid, stakeholders engagement assessment matrix	03
7	**Professional and Social Responsibility** • Project management traits in professional and social responsibility, • Code of Ethics and Professional conduct w. r. t. responsibility, respect, fairness, honesty. **Project Management Case Study / Activity**	05

Text/ Reference Books:

1. Gower Handbook of People in Project Management, Dennis Lock and Lindsay Scott, Routledge Publishers, NY, USA, 2016.
2. Project Management – Essentials You Always Wanted to Know, Kalpesh Ashar, Vibrant Publishers, 2012.
3. Projects: Planning, Analysis, Selection, Financing, Implementation and Review, Prasanna Chandra, McGraw Hill India, 2014.

4. A Guide to the Project Management Body of Knowledge (PMBOK Guide), 5th Ed., Project Management Institute, USA.
5. Project Management: Processes, Methodologies and Economics, 2nd Ed., Avraham Shtub, J. F. Bard, S, Globerson, PH Inc., USA.
6. Project Management Handbook,, 2nd Ed., David Cleland, Wiley, 1988.

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

Course Code:OE-BTE602 Course:-Artificial Intelligence (AY 201920)

Course Outcome: Students will demonstrate the ability to

1. Develop a basic understanding of AI building blocks presented in intelligent agents
2. Choose an appropriate problem solving method and knowledge representation technique
3. analyze the strength and weaknesses of AI approaches to knowledge – intensive problem solving
4. Design models for reasoning with uncertainty as well as the use of unreliable information

Module	Details	Hours
1	Introduction to Artificial Intelligence (AI) History of Artificial Intelligence, Intelligent Systems: Categorization of Intelligent System, Components of AI Program, Foundations of AI, Sub-areas of AI, Applications of AI, Current trends in AI	04
2	Intelligent Agents Agents and Environments, The concept of rationality, The nature of environment, The structure of Agents, Types of Agents, Learning Age	04
3	Problem solving 1 Solving problem by Searching: Problem Solving Agent, Formulating Problems, Example Problems. Uninformed Search Methods: Breadth First Search (BFS), Depth First Search (DFS), Depth Limited Search, Depth First Iterative Deepening(DFID), Informed Search Methods: Greedy best first Search ,A* Search , Memory bound edheuristic Search.	07
4	Problem solving 2 Local Search Algorithms and Optimization Problems: Hill-climbing search Simulated annealing, Local beam search, Genetic algorithms. Adversarial Search: Games, Optimal strategies, The minimax algorithm, Alpha-Beta Pruning.	07
5	Knowledge based Agents, The Wumpus World, The Propositional logic, First Order Logic: Syntax and Semantic, Inference in FOL, Forward chaining, backward Chaining, Knowledge Engineering in First-Order Logic, Unification, Resolution, Introduction to logic programming (PROLOG), Uncertain Knowledge and Reasoning: Uncertainty, Representing knowledge in an uncertain domain, The semantics of belief network, Inference in belief network.	10
6	Planning and Learning The planning problem, Planning with state space search, Partial order planning, Hierarchical planning, Conditional Planning, Learning: Forms of Learning, Inductive Learning, Learning Decision Tree, Expert System: Introduction, Phases in building Expert Systems, ES Architecture, ES vs Traditional System.	06
7	Applications Natural Language Processing(NLP), Expert Systems.	04

Text/Reference Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach "Second Edition" Pearson Education.
2. SarojKaushik "Artificial Intelligence" ,Cengage Learning.
3. George F Luger "Artificial Intelligence" Low Price Edition , Pearson Education., Fourth edition.
4. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
5. Elaine Rich and Kevin Knight "Artificial Intelligence" Third Edition
6. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
7. Hagan, Demuth, Beale, "Neural Network Design" CENGAGE Learning, India Edition.
8. Patrick Henry Winston , "Artificial Intelligence", Addison-Wesley, Third Edition.
9. Han Kamber, "Data Mining Concepts and Techniques", Morgann Kaufmann Publishers.
10. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press

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-BTE603 Course:-Communication Engineering (AY 2019-20)

Course Objectives:

1. Discuss analog and digital modulation
2. Discuss importance and methods of source and channel coding
3. Explain utilization of media bandwidth

Course Outcomes: Students will demonstrate the ability to

1. Apply different analog and digital modulation demodulation techniques
2. Understand source and channel coding
3. Select different media based on application and appreciate use of multiplexing and spreading methods

Course Contents:

Module	Details	Hours
1	Amplitude Modulation Systems Need for modulation, normal AM, generation and demodulation (envelope & synchronous detection), modulation index, DSBSC: generation and demodulation, Effect of phase and frequency offset on demodulation, SSB: Generation using filter and phasing method, detection. Frequency division multiplexed systems using SSB.	08
2	Angle Modulation Systems Concept of frequency and phase modulation, frequency deviation and modulation index, FM spectra, Carson‟s rule, narrowband FM, generation of Wideband FM Armstrong method, direct FM generation. Demodulation of FM-discriminatory, PLL	08
3	Sampling and Discrete time Modulations Sampling Theorem – low pass and band pass, Pulse Amplitude Modulation (PAM), Pulse Width Modulation (PWM), Pulse Position Modulation (PPM) their generation and detection-phase time division multiplying.	04
4	Digital Communication PCM, quantization noise, bandwidth, advantages over analog communication, PCM system, Differential PCM, Delta Modulation, Digital Modulation – ASK, FSK, PSK, DPSK, QAM	06
5	Information theory – Information, Entropy, Rate of information, Channel capacity, Shannon theorem, Huffman coding	06
6	Channel Coding – Linear block code, Cyclic code, Convolution code.	06
7	Utilization of Media Bandwidth Guided and unguided media – Twisted pair cable, Coaxial cable, Fiber optic, Radio waves, Microwaves, Infrared waves, Light waves, Multiplexing – FDM, TDM Spreading – DSSS, FHSS,	04

Text/ Reference Books:

1. Haykin S., "Communications Systems", John Wiley and Sons.
2. Proakis J. G. and Salehi M., "Communication Systems Engineering", Pearson Education.
3. Taub H. and Schilling D.L., "Principles of Communication Systems", Tata McGraw Hill.
4. Wozencraft J. M. and Jacobs I. M., ``Principles of Communication Engineering",John Wiley.
5. Barry J. R., Lee E. A. and Messerschmitt D. G., ``Digital Communication", Kluwer Academic Publishers..
6. Proakis J.G., ``Digital Communications'', McGraw Hill.

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

Course Code: OE-BTE604 Course:-VLSI Circuits (AY 2019-20)

Course Objectives:

1. To introduce the fundamental principles of VLSI circuit design and layout techniques.
2. To highlight the circuit design issues in the context of VLSI technology.
3. To examine the basic building blocks of large-scale digital integrated circuits

Course Outcomes: Students will demonstrate the ability to

1. Demonstrate a clear understanding of choice of technology and technology scaling.
2. Design MOS based circuits and draw layout.
3. Realize logic circuits with different design styles.
4. Demonstrate a clear understanding of system level design issues such as timing and power dissipation

Course Contents:

Module	Details	Hours
1	**Introduction and overview:** History, basic transistor technology, NMOS and CMOS technology. **Fabrication process and layout:** NMOS, LOCOS, CMOS, CMOS Design rules, MOSFET Scaling: Types of scaling, MOSFET capacitances.	**06**
2	**MOSFET Inverters:** **Circuit Analysis**: Static and dynamic analysis (Noise, propagation delay and power dissipation) of resistive load and CMOS inverter, comparison of all types of MOS inverters, design of CMOS inverters, CMOS Latch-up. **Logic Circuit Design**: Analysis and design of 2-I/P NAND and NOR using equivalent CMOS inverter.	**06**
3	**MOS Circuit Design Styles:** **Design Styles:** Static CMOS, pass transistor logic, transmission gate, Pseudo NMOS. **Circuit Realization:** SR Latch, JK FF, D FF.	**06**
4	**Semiconductor Memories:** ROM Array**,** SRAM (operation, design strategy, leakage currents, read/write circuits), DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation, Input-Output circuits).	**08**
5	**Low Power CMOS Circuits:** Various components of power dissipation. CMOS, Limits on low power design, low power design through voltage Scaling.	**04**
6	**Hardware Description Languages for VLSI Design:** Managing concurrency and time in Hardware Description Languages, Introduction to VHDL, Basic Components in VHDL, Structural Description in VHDL, Behavioral Description in VHDL, and Introduction to Verilog.	**08**

7	**VLSI Clocking:** CMOS clocking styles, Clock generation, stabilization and distribution.	**04**

Text/ Reference Books:

1. Sung-Mo Kang and Yusuf Leblebici, "CMOS Digital Integrated Circuits Analysis and Design", Tata McGraw Hill.
2. Neil H. E. Weste, David Harris and Ayan Banerjee, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson Education
3. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", Pearson Education.
4. Etienne Sicard and Sonia Delmas Bendhia, "Basics of CMOS Cell Design", Tata McGraw Hill.
5. Debaprasad Das, "VLSI Design", Oxford.
6. Kaushik Roy and Sharat C. Prasad, "Low-Power CMOS VLSI Circuit Design", Wiley, Student Edition.

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

Course code:OE-BTC 611 Course: Human Resources Development and Organizational Behavior (AY 2019-20)

Course Objectives:

The learning objectives of this course are:

1. to develop a systematic and planned approach through which the efficiency of employees is improved.
2. development of the integrated use of training, organization, and career development efforts to improve individual, group, and organizational effectiveness.
3. To understand the key competencies that enable individuals in organizations to perform current and future jobs through planned learning

Course Outcomes:

At the end of this course students will be able:

1. to set the future goals and objectives for the entire organization and for self.
2. to apply integrated use of training, organization, and career development efforts
3. to understand the importance of key competencies that enable individuals in organizations to grow.

Module No.	Content	Hrs.
1	Introduction to Human Resource Development: Emergent of HRD, Critical roles, challenges, HRD Process Model: identification of needs and Design and development of HRD programmes, Process Model: Methods of Implantation, Evaluation of programmes.	5
2	HRD interventions: Mentoring for employee development: Role of mentoring in development, Employee counseling for HRD: Overview of counseling programmess, employee assistance programme, stress management, employee wellness and health promotion, Competency framework of HRD: steps in competency mapping.	6
3	Career Planning, management, and development: Career development stages and activities, role of individual and organization in career planning, Organizational Learning, and learning organizations.	5
4	The future of HRD and Ethics: Research, practice and education of HRD for innovation and talent development and management, Role of HRD in developing ethical attitude and behavior and development, Ethical problems with HRD roles.	5
5	Organizational Behavior: Introduction, What is organizational Behavior? Diversity in Organizations, Attitudes and Job Satisfaction, Emotions and Moods, Personality and Values, Perception and Individual Decision Making, Motivation Concepts.	5
6	Foundations of Group Behavior: Understanding Team work, Communication, Leadership, Power and Politics, Conflict and Negotiation, Foundations of Organization Structure, Organizational Culture, Human Resource Policies and Practices, Organizational Change and Stress Management.	5
7	Case Studies: Based on survey done with various industries	5

References:

1.Werner and DeSimone (2006). Human Resource Development. Thomson Press, Network.
2. David Mankin (2009). Human Resource Development, Oxford University Press: Delhi.
3. Rosemary Harison (2000). Employee Development. University Press: Hyderabad.
4. John P. Wilson (2005). Human Resource Development. Kogan Page.
5. Stephen P. Robbins and Timothy A. Judge (2013) Organizational behavior, Copyright © 2013, Pearson Education, Inc., publishing as Prentice Hall

Course Code: OE-BTC 613 Course Watershed Development and Management (AY 2019-20)

Course Objectives:

The main objectives of the course are

1. To explain the concept of watershed and its management.
2. To study watershed hydrology and its behavior.
3. To describe erosion process.
4. To summarize the engineering measures for soil and water conservation

Course Outcomes:

At the end of the course the students shall be able to

1. Apply the engineering measures for soil and water conservation
2. Develop watershed management plan

Module No	Details	Hrs.
1	Components of watershed and need of watershed management; Principal factors influencing watershed operations; Delineation of watersheds; Engineering surveys; Data requirement	**4**
2	Watershed hydrology, water resources assessment in watershed, hydrological cycle; Surface water assessment- rainfall-runoff analysis; Groundwater assessment, infiltration and its measurement	**4**
3	Watershed Behavior- Physical elements of watershed, effects of land use changes on hydrological cycle components, watershed experiments, Land capability classification; Erosion process- factors affecting erosion, types of erosion, soil erosion models	**6**
4	Engineering measures for soil and water conservation- Contour bunding, graded bunding, bench terracing, land leveling and grading; Small storage structures- Types and design data requirement, loose boulder dams, gabions, check dams and their design criteria	**6**
5	Rainwater harvesting, direct and indirect methods, filter design, planning and design; Layout and execution; Impact assessment, operation and maintenance issues	**6**
6	Watershed management plan- Methodology of planning a watershed, identification of watershed problems, socio-economic issues.	**6**
7	Case studies: Application of Remote sensing and GIS in watershed management	**4**

References:

1. Das, G., "Hydrology and Soil Conservation Engineering", Prentice Hall.(2002)
2. Debarry, P. A., "Watershed: Processes, Assessment and Management", John Wiley.(2004)
3. Lyon, J. G., "GIS for Water Resources and Watershed Management", Taylor and Francis.(2003)
4. Schwab, G.O., Fangmeier, D.D., Elliot, W. J., Frevert, R. K., "Soil and Water Conservation Engineering", John Wiley.(2002)
5. Suresh, R., "Soil and Water Conservation Engineering", Standard Publishers.(2006)

Course Code: OE-BTC 614 Course: Artificial Intelligence Techniques (AY 2019-20)

Course Objectives:
Course Outcomes:

Module No.	Content	Hrs.
1.	**Introduction to Soft computing techniques**- soft computing techniques, importance, types of soft computing techniques, advantages and limitations**.**	3
2	**Fuzzy logic**: Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations-Operations on Fuzzy relations-Properties of Fuzzy relations- Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification-Deffuzzification methods- Fuzzy logic controller, applications to water resources engineering	5
3	**Artificial Neural Networks**: Basic concepts- Biological foundations, ANN models, Types of activation function, Neural network Architectures-Single layer feed forward network-Multilayer feed forward network, Perceptron networks-Back Propagation networks-Radial base function network, applications to water resources engineering, applications to water resources engineering	6
4	**Fundamentals of genetic algorithms and Genetic programming:**Intuition behind Genetic Algorithms, Biological Inspiration, What is Genetic Algorithm?, Steps Involved in Genetic Algorithm, Initialization, Fitness Function, Selection, Crossover, Mutation, Application of Genetic Algorithm, Feature Selection, Difference between GA & GP, applications to water resources engineering	6
5	**Model Trees:** Introduction, model trees, CART, Building initial tree, Standard deviation reduction, Pruning the tree, Smoothing, M5 algorithm and M5P algorithms.	5
6	**Support Vector Machine:** Margins: Intuition, functional and geometric margins, the optimal margin classifier, Lagrange duality, Lagrange multipliers, Karush-Kuhn-Tucker (KKT) conditions, Kernals, applications to water resources engineering.	5
7	Case studies: case studies on FL, ANN, GA, GP ,MT, SVM	6

References:

1.S.Rajasekharan, G.A.VijayalakshmiPai, *Neural Network, Fuzzy Logic andGeneticAlgorithms Synthesis and Applications*, Prentice Hall India.
2. S.N.Sivanandam, S.N.Deepa, *Principles of Soft Computing*, Wiley India.
3. Timothy J Ross, *Fuzzy logic with Engineering Applications*, McGraw Hill, NewYork.
4. S.Haykins, *Neural Networks a Comprehensive foundation*, Pearson Education.
5. D.E.Goldberg, *Genetic Algorithms in Search Optimization and Machine Learning*,Pearson Education.
6. Breiman, L., Friedman, J.H., Olshen, R.A. & Stone, C.J. (1984). Classification and regression trees. Belmont CA: Wadsworth.
http://www.genetic-programming.org/

Course Code:OE-BTC 616 Course: Engineering System and Development (AY 2019-20)

Course Objectives:

1. To introduce the basic principles of engineering for a developing society,
2. To develop an ability to formulate problem, analyze, solve and report to the stakeholders, and
3. To practice the ability to design, conduct and report field-work in a particular discipline of engineering contributing to the development

Course Outcomes:

At the end of the course the student will be able to:

1. understand the basic principles of engineering for a developing society,
2. formulate problem, analyze, solve and report to the stakeholders, and
3. design, conduct and report field-work in engineering contributing to the development of the society.

Course content:
Module 1. Engineer and Society: Basics of Engineering Profession, engineering services, understanding the values of equity, efficiency and sustainability.
Module 2. The Engineer as a change agent: Interdisciplinary, the need for design and synthesis
Module 3. Development Indices: Human Development Index (HDI) and Organization for Economic Co-operation and Development (OECD) indices, The data needed to compute these, Core values of equity, efficiency and sustainability, Paradigms of development.
Module 4: Role of Engineer as a change agent: Understanding Rural and Urban divide and its economy, Wholesale vs. Retail markets, the role of knowledge, practices, science and technology.
Module 5: A Sectoral Engineering System. Example: Drinking water, Irrigation, Electricity, Diesel pumps, non-conventional energy, solar system, community services, water pipe networking, education, health services, road networking, road development, drainage system, energy audit, telecommunication, small scale industries, agricultural sector, effect of seasonal variation on development, understanding service and manufacturing sector, understanding local and global scenario, any other as per engineering sector (Civil, Mechanical, Electrical, Computer, Agricultural, Health etc.)
Module 6: Project through case studies (Rural/Urban): Framing the project, Understanding the demand, needs analysis, Studying the options available, measurement of social and economic parameters as inputs, The activities and the analysis, picking case-study, analyzing, solving and reporting solutions to the stakeholders.

References:

https://unfoundation.org
http://www.undp.org
http://hdr.undp.org
http://www.oecd.org
http://unnatbharatabhiyan.gov.in
http://www.ctara.iitb.ac.in

Course Code: OE-BTM612 Course: Introduction to Nanotechnology (AY2019-20)

Course pre-requisites: Applied Physics, Applied Chemistry

Course Objectives

1. To acquaint learner with fundamental multidisciplinary nature of nanotechnology
2. To study applications and implementation of nanotechnology

Course Outcomes: Learner will be able to

1. Discuss basics of nanotechnology
2. Identify various nanostructured materials
3. Illustrate properties of nanomaterials
4. Illustrate characterization techniques for nanomaterials

Modules	Detailed Content	Hrs.
01	**Introduction to Quantum mechanics, Nanostructural Materials and Low dimensional structures:** Basic principles of Quantum mechanics (why and how classical mechanics fails), probability amplitude, wave functions, Nano clusters and Nano crystals.	**6**
02	**Two-Dimensional Nanostructures: Thin Film:** Introduction, Fundamentals of Film Growth, Vacuum Science, Physical Vapor Deposition (PVD) i.Evaporation, ii. Molecular beam epitaxy, iii. Sputtering; Chemical Vapor Deposition (CVD), i. Types of chemical reactions, ii. Reaction kinetics, iii. Transport phenomena, iv. CVD methods, v. Diamond films by CVD; Atomic Layer Deposition (ALD), Electrochemical Deposition, Sol-Gel Films, Solution growth, Electrochemical deposition, Electrophoretic deposition, Template filling, Electrospinning, Lithography.	**6**
03	**Special Nanomaterials and applications:** Introduction; Carbon Fullerenes and Nanotubes: Carbon fullerenes, Fullerene- derived crystals, Carbon nanotubes; Micro and Mesoporous Materials: Ordered mesoporous materials, Random mesoporous materials, Crystalline porous materials (zeolites); Core-Shell Structures: Metal-oxide structures, Metal-polymer structures, Oxide-polymer structures	**6**
04	**Types of nano particles and applications** Nanocontainers, Nanoshells, Nanohorns, Nanowires, Nanosprings, Nanorods, Nanofilters, Nanopens, Nanopencils, Nanopipettes, Nanoplotter, Nanobalance, Nanobeads, Nanoguitar	**6**
05	**Characterization of Nanomaterials** Introduction, Structural Characterization, X-ray diffraction (XRD), Small angle X-ray scattering (SAXS), Scanning electron, microscopy (SEM), Transmission electron microscopy (TEM), Scanning probe microscopy (SPM) Gas adsorption. Chemical Characterization, Optical spectroscopy, Electron spectroscopy, Ionic spectroscopy,	**6**
06	**Properties of Nanomaterials** Physical Properties: Thermal stability and lattice constant, Mechanical properties, Optical properties, Electrical conductivity, Ferroelectrics and dielectrics, Superparamagnetism, Emission spectroscopy, luminescence spectroscopy.	**6**
07	**Application of nano chemistry** Semiconductor and Microelectronics including MEMS, Optical Magnetic including memory, readwrite, flash, bubble memories etc. Mechanical including	**6**

	Nanocomposites, thermal barriers etc.Biomedical including Pharmacology, Virology etc.	

Tutorial

1. Assignments on each module
2. Case studies on applications of nanotechnology
3. Seminar on recent advances in nanotechnology

Recommended Books:

1. Introduction to nanotechnology, Charles P Poole Jr and Frank J Owens, Wiely
2. Introduction to Nanosciences and Nanotechnology, Chattopadhyay K K, Banerjee A N, PHI Learning
3. Nanotechnology: The science of small, Shah K A and Shah M A, Wiely
4. Nanotechnology, Rathi R K, S Chand
5. Nano: The essentials Understanding Nanosciences and Nanotechnology, TMH
6. Nanotechnology, Lynn E Foster, Pearson
7. Micromanufacturing and Nanotechnology, Mahalik N P, New Age International
8. Handbook of Nanoscience, Engineering, and Technology, William A Goddard, Donald Brenner, Sergey Edward Lyshevski, Goddard III, CRC Press
9. Hanbook of Nanotechnology, Bharat Bhushan, 3rd Edition, Springer

Sr. No.	Examination	Module
1.	T-I	1,2
2.	T-II	3,4
3.	End Sem	1 to 7

Course Code: OE-BTM613 Course: Entrepreneurship Development and Start Up (AY2019-20)

Course pre-requisites: General Engineering

Course Objectives:

In this Course Students will:

1. Know different aspects of Entrepreneurships, Business models.
2. Demonstrate the idea generation techniques, Planning of Marketing process, prototyping methods,
3. Apply engineering knowledge to develop prototype of their ideas and innovations.
4. Demonstrate different aspects of Techno-Economic Feasibility, Intellectual Property Rights and Institutional Support for Start-Ups

Course Outcomes:

Upon successful completion of the course, students should be able to:

1. Know different aspects of Entrepreneurships, Business models.
2. Demonstrate the idea generation techniques, Planning of Marketing process, prototyping methods,
3. Apply engineering knowledge to develop prototype of their ideas and innovations.
4. Demonstrate different aspects of Techno-Economic Feasibility, Intellectual Property Rights and Institutional Support for Start-Ups

Module No.	Course Contents	Hrs
1	**Entrepreneurship:** Introduction to Entrepreneurship, Need for Entrepreneurship, Types of Entrepreneurs, Types of Leaders, Entrepreneurship Development.	4
2	**Idea generation & Creativity:** Invention and Innovation, Types of Innovations, Idea Generation techniques: Brain storming. SCAMPER Technique, Morphological Matrix; Evaluation Strategies.	4
3	**Market Research and Planning:** Purpose of market research, Techniques of Market Survey, Procedure of market research and research process, Limitations of Market Survey.	4
4	**Prototyping & Rapid Prototyping:** Roles of Prototyping, Phases of Prototyping**,** Fundamentals of Rapid Prototyping, Benefits of Rapid Prototyping, Classification of Rapid Prototyping,	4
5	**Intellectual Property Rights:** Fundamentals of IPR, Legislations on IPR in INDIA, International Organization and Treaties, Types of IPRs: Patents, Trademarks, Copyrights, Trade Secret	4
6	**Techno-Economic Feasibility Analysis:** Types of Analysis: Economic Feasibility, Marketing Feasibility, Financial Feasibility, Technical Feasibility.	4
7	**Institutional & Financial Support for Start-Ups:** Government Policies for small scale industries, Different financial institutions for small scale industries and Incentives by government schemes. International Schemes	4

Tutorial will consist of one Assignment on each module and Case Studies.

Reference Books:

1. "Entrepreneurship Development", S. Anil kumar, New Age International Publishers.
2. "Entrepreneurial Development", S. S. Khanka, S. Chand & Company Ltd.
3. "Entrepreneurship Development", A. Nirjar, Word-Press.

4. “Rapid Prototyping, Principles and Applications”, Chua C. K., Leong K. F. and Lim C. S., World Scientific Publishing Company Ltd.
5. Intellectual Property Rights”, Neeraj Pandey and Khushdeep Dharni, PHI Learning Pvt. LTd.
6. Intellectual Property Rights, Texts and Cases”, Dr. R. Radhakrishnan and Dr. S. Balasubramanium, Excel Books.

Sr. No.	**Examination**	**Module**
1.	**Test – I**	Module 1, 2
2.	**Test – II**	Module 3, 4
3.	**Endsem**	Module 1 to 7

Course Code: OE-BTM614 Course: Introduction to Optimization Methods (AY2019-20)

Course pre-requisites: Engineering Mathematics

Course Objectives:

1. To introduce tools and techniques for optimization to engineering applications
2. To understand the formulation of design equations for engineering systems.
3. To understand algorithms and methods used for optimization

Course Outcomes:

At the end of the course the students shall be able to

1. Explain different approaches to optimize engineering systems.
2. Create programs based on different optimization algorithms using IT tools, such as Minitab, MATLAB, etc.
3. Calculate optimum solution to linear and non-linear problems.
4. Apply the numerical and optimization understanding for finalizing design of engineering systems.

Course content:

M. No	Description	Hrs
1	Need for optimization and historical development, classification and formulation of optimization problem, objective function and constraints	04
2	Calculus based methods, function of single, two and multiple variables, Hessian matrix formulation, Kuhn-Tucker condition	04
3	Linear programming (LP) based methods, standard form of LP problem, graphical method for two variables, simplex algorithm, examples for transportation and assignment problems	04
4	Enumerative schemes, Random search algorithms	04
5	Integer programming, integer linear programming, mixed integer programming	04
6	Evolutionary algorithms, Genetic algorithms, Nature inspired optimization methods	04
7	Use of software tools for solving linear optimization problems	04

Text Books:

1. Rao, Singiresu S., and S. S. Rao. *Engineering optimization: theory and practice*. John Wiley & Sons, 2009.
2. Deb, Kalyanmoy. *Optimization for engineering design: Algorithms and examples*. PHI Learning Pvt. Ltd., 2012.

Reference Books

1. Mital, K.V., 1996. *Optimization methods in operations research and systems analysis*. New Age International.
2. Taha, Hamdy A. *Operations Research: An Introduction (For VTU)*. Pearson Education India, 1982.

Term work: Assignments containing numerical problems based on each module.
Seminar based on recent advances in subject.
At least one case study based on any one optimization method.

Sr. No.	Examination	Module
1.	**T-I**	1,2 and part of 3
2.	**T-II**	Remaining part of 3,4 and part of module 5
3.	**End Sem**	1 to 7

Course Code: OE-BTM615 Course: Project Management (AY2019-20)

Course pre-requisites: Nil

Course Objectives:

1. To understand knowledge areas and tool – techniques for efficient Project Management.
2. Understand the role of Project Management in an organization.
3. Develop an insight as to how Project Management tool/techniques are used strategically for the betterment of organization.
4. To improve management skills

Course Outcomes:

Upon successful completion of the course, students should be able

1. To describe the basic concepts in Project Management.
2. To describe the various tools and Techniques in Project Management.
3. To apply the various concepts and Tools in & Project Management for Industrial cases
4. To investigate the factors for improving the process and Managing the Project successfully.

Course Content:

Module No	Details	Hrs
1	**Introduction:** Introduction to Project Management, the triple constraint, Stakeholders, Project Management Knowledge Area, tools and techniques, Role of a Project Manager, job description, Suggested Skills, Importance of people and leadership skills.	**04**
2	Project Management: Overview, Organizational Structure, Project vs Operational Work, Organizational influences on Project Management, Project Life Cycle, Phases and Nature of Mechanical Engineering projects, Trends affecting Mechanical Engineering Project Management, Globalization, Outsourcing, and Virtual Teams.	**04**
3	Project Time Management, Defining and Sequencing Project Activities and Dependencies, Developing Schedule, Gantt Chart, Critical Path Method, Project Uncertainty – PERT, Critical Chain Method, Resource loading and Resource Leveling, Schedule Controlling.	**04**
4	Project Cost Management, Estimating Techniques, Earned Value Management, Project Quality Management, Planning Quality, Performing Quality Assurance, Quality Control – Tools and Techniques	**04**
5	Project Resource Management, Development of Human Resource Plan, Project Organizational Chart and Responsibility Assignment, Multi project Scheduling and Resource Allocation	**04**
6	Project Communication Management, Identifying Stakeholders, Planning Communication, Project Risk Management, Identifying Risks; Common Sources of Risk in Mechanical Engineering Projects, Qualitative Risk Analysis: Probability and Impact Matrix, Quantitative Risk Analysis: Decision Trees, Planning Risk Response	**04**
7	Project Procurement Management Plan Procurements, Conduct Procurements, Administer Procurements, SLA	**04**

Term work

1. Assignments based on above modules
2. Seminar based on recent advances in the course
3. At least one Case study conducted at industry
4. MCQ on each module

Teaching Methods:

The course will use the following pedagogical tools:

1. Discussion on concepts and issues of Project Management in an organization.
2. Case discussion covering a cross section of gaining strategic advantage by applying Project Management tools and techniques.
3. Projects/ Assignments/ Quizzes/ Class participation etc.

References:

1. Meredith, Jack R., and Samuel J. Mantel Jr. Project management: a managerial approach. John Wiley & Sons, 2011.
2. Lewis, James P. Project Planning, Scheduling & Control, 4E. McGraw-Hill Pub. Co., 2005.
3. Larson, Erik W., and Clifford F. Gray. "Project management: The managerial process." (2011).
4. Meredith, Jack R., and Samuel J. Mantel Jr. Project management: a managerial approach. John Wiley & Sons, 2011.

Sr. No.	Examination	Module
1	T-I	1 to 2
2	T-II	3 to 4
3	End Sem	1 to 7

Course Code: MC-BTE03 Course: Environmental Science (AY 2019-20)

Course Objectives:

1. To sensitize to the ever-increasing environment problems.
2. To acquire knowledge about environmental pollution.
3. To acquire knowledge with respect to renewable energy and its positive impact on environment.
4. To be aware of the national and international concern for environment for protecting the environment.

Course Outcomes: Students will demonstrate the ability to

1. Propose specifications to comply with norms of environment engineering
2. Describe laws and regulations pertaining to health, safety and environment
3. Apply evaluation tool such as GRIHA to help design, build, operate, and maintain a resource efficient environment management system

Course Contents:

Module	Details	Hours
1	**Introduction to Environmental Engineering**: Biotic and Abiotic Environment, Adverse effects of environment, Types of environmental pollution - Water pollution, Air pollution, Solid waste management, Control Strategies of different environmental problems	06
2	**National Legislation for Environment**: Constitutional provisions for safeguarding the environment, The Environmental (Protection) Act, The Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, The Wild life (Protection) Act, Forest Act, Biodiversity Act	06
3	**Introduction to Ecology**: Definition, Structure and function of an ecosystem-Ecological succession-primary and secondary succession. Ecological pyramid of number, pyramid of energy and pyramid of biomass	06
4	**Introduction to Renewable Energy.** Solar, Wind, Geothermal, Ocean (Tidal), Biomass – Basics, Conservation of natural resources. Environmental and economic impact of each type of renewable energy.	06
5	**Hazard Assessment, Prevention, and Control:** Stress and Safety, Safety and Health Training, Mechanical Hazards and Machine Safeguarding, Fire Hazards and Life Safety, Ethics and Safety, Hazard Analysis/Prevention and Safety Management, Environmental Safety and ISO 14000 (Environmental Management).	06
6	**Introduction to National Rating System** GRIHA (Green Rating For Integrated Habitat Assessment): An evaluation tool to help design, build, operate, and maintain a resource-efficient built environment. Case studies of GRIHA registered buildings	06

7	**International Concerns: Conventions and Treaties**-RAMSAR Convention, CITES, Convention on Biological Diversity, Convention to Combat Desertification, Convention on Climate Chang.	06

Recommended Books:

1. GRIHA Manual Volume 1 - Ministry of New and Renewable Energy, Government of India, New Delhi.
2. ISO 14001:2004(E) - Environmental management systems Requirements with guidance for use.
3. Jagdish Krishnawamy, R J Ranjit Daniels," Environmental Studies", Wiley India Private Ltd. New Delhi. 4. An Indita Basak, Environmental S

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

Value Added Courses

1. PLC **(VA-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: 1. Introductions to the purpose, functions, and operations of the PLC, Identification of various components of the PLC, 2. Introduction to PLC ladder logic and basic programming concepts, Establishing communications with the PLC, 3. Definitions of conditional inputs and outputs, Electrical continuity versus logical continuity, 4. PLC timer and counter concepts and programming applications, 5. Programming applications using sequencers.

2. Soft Computing II ETAP and WAMS (VA-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: 1. Build power systems and simulate the power, current and voltage flow, Single Line diagram creation and analysis, run and Analyze AC power circuits, 2. Run load flow analysis on one line diagram, run Short Circuit analysis.

3. Introduction to Synchro Phasor & WAMS Technologies, Synchro Phasor needs and benefits for Operations, 4. Planning and Control Vision for Synchro Phasor & Online Stability Solutions Fundamental building blocks for WAMS and Synchro Phasor Platform Architecture, 5. PMU standard and communications

Value Added Courses by Industry

Course code: VA- BTI01 Course: Basic Automation – 1 (PLC and HMI) (AY2019-20)

Course Duration: 40 hours

Prerequisite: Basic Knowledge of Automation technology, relay logic essential but not mandatory

Course Objectives : The participants will
1. understand working of PLC
2. understand basic concepts of HMI

Course Outcomes: The participants will be able to
1. use Siemens PLC by understanding installation and by applying the knowledge of programming

Course Contents:

Module	Details
1	**Basic constituents of PLC**: Signal modules, CPU, Power Supply, mounting rail and MMC
2	**Working** of PLC, Installation guidelines, powering and wiring of modules with information on addressing.
3	**Programming:** Programming language and representation in STL,FBD and LAD, Hardware Configuration and setting object Properties of Modules in STEP, Programming instruction: AND, OR, AND-before-OR, OR-before-AND, NO / NC contacts, Edge detection instructions, Set/ Reset, Elementary data type.
4	**Overview of SIMATIC S7 – PLC:** Programming Units and using PC as Programming Unit, Hardware Configuration and setting object Properties of Modules in STEP, Step 7 Instructions and programming: Set/ Reset, Elementary data type, Load/Transfer, comparison, basic math instructions, Timers/ Counters List etc
5	**Using Symbol Table and VAT**.

Course code VA-BTI 02 Course: Basic Automation – 2 (Network and SCADA) (AY2019-20)

Course Duration: 40 hours

Prerequisite: Basic course on Automation with PLC programming knowledge is essential.

Course Objectives:

1. To understand networking and SCADA

Course outcome:

1. Students will be able to know the networking and SCADA with hands on practice.

Course Contents:

Module	Details
1	**System overview** of SIMATICW in CC, Creating a project , Configuring connections to the SIMATIC S7
2	**How to link** Digital and Anaglog address in Scada software, Tag management
3	**Graphics Designer** and graphics displays for human machine interfacing
4	**Alarm logging** for message representation, message archiving
5	**Tag logging** for curve representation, measured value archiving Practical exercises for the above

Course code VA- BTI03 Course: Basics of Process Instrumentation (AY2019-20)

Duration: 40 Hours
Pre-requisite : Basic relay logic knowledge and academics information is essential

Course Objectives:

To understand methods of measurement of different signals

Course Outcome:

Student will be able to understand and use various technologies for measurement of parameters.

Course Contents:

Module	**Details**
1	**FLOW measurement :** Magnetic Flow meter technology, Mass Flow meter technology , Ultrasonic Flow meter technology (Inline & Clamp On)
2	**LEVEL measurement** Ultrasonic Level Technology, Radar Level Technology, Capacitance Level Technology
3	**PRESSURE Measurement**
4	**TEMPERATURE Measurement**
5	**ELECTROPENUMATIC POSITONER** Topics for all above Measurements. · Various Technology · Working Principles · Product over view · Live demo & Hands on trial for Pressure, Temperature & Positioners, etc

Course code VA-BTI 04 Course: Basic Mechatronics (AY2019-20)

Duration: 96 Hours
Prerequisite: Basic knowledge of electrical, electronics & mechanical

Course Objective:

Learn concepts and applications of Mechatronics

Course Outcomes:

Students can apply mechatronics concepts to develop applications.

Course Content:

Module	Details
1	**Introduction** What is Mechatronics?, Material, Energy and Signal flow diagram, Brief Introduction to Electrical Components, Power supply, Fuses, Circuit breakers, Relays, Contactors, Solenoids, Switches, Indicators, Sensors: Inductive, Capacitive, Photoelectric, Ultrasonic, Reed type, Brief Introduction to Mechanical Components, Motor Drives, Belts and Pulley, Chain and Sprocket, Gears, Clutch, Shaft& Axel, Bearings& Threaded Fasteners
2	**Brief Introduction to Pneumatic Components** Air generation and Distribution, Directional Control Valve (2/2, 3/2,4/2,5/2,5/3way etc.), Flow Control Valves, Pneumatic Actuators
3	**Reading and Interpretation of Technical Documents** Sequential Function Flow Chart Displacement-Step Diagrams, Displacement-Time Diagrams, Assembly diagrams, E-Pneumatic Diagrams, Electrical wiring diagrams
4	**Digital Fundamentals and PLC** ·Number systems and Logic Gates, Introduction to PLC Troubleshooting Strategies
5	**General introduction to Industry 4.0 I**ntroduction to Industrial revolutions – 1.0, 2.0, 3.0 & 4.0, Introduction to general concepts of Cloud and IOT Gateways, Various Siemens solutions to cloud connectivity, Siemens PLC's and SCADA Portfolio with Information Regarding Licensing of Software with TIA Portal V15.X, Brief discussions on communication protocols for connecting devices, Profinet, Demonstration of communication with PLC

Course code VA-BTI 05 Course : Basic LV - Switchgear and Motor (AY2019-20)

Duration: 40 Hours

Course Objectives:

Making participants familiar with SIEMENS Switchgear & motor System, Key features of the product

Course Outcomes: Students will be able to do testing and fault diagnostics.

Training Methodology: Explanation, demonstration and hands-on practice.

Course Content:

Module	Details
1	**Switchgear:** Introduction to ACB + MCCB + SDF , Basic Concepts of fault level, current carrying capacity etc. Equipments used in LV network , Standards Definitions, · ACB – Concept, Rating, Fault Capacity, Protection , MCCB – Concept, Fault Capacity, Protection, SDF – Concept, Fault Capacity, Protection
2	**Product Information :** Where to use ACB / MCCB / SDF – Selectivity / Discrimination, Principle of selectivity and cascading Siemens range, ACB - 3WL / 3WT , Range Overview,ETU Overview, Cubicle Bus, BSS , DI/DO , ZSI etc MCCB -3VL , Range Overview ,ETU Overview, Cubicle Bus SDF -Range Overview , ·Installation guidelines of ACB, MCCB and SDF, Maintenance guidelines for ACB, Replacement, cleaning of contacts of ACB, · Modification and retrofitting accessories ACB , Fault Diagnosis, Troubleshooting ACB, Hands On Training ACB, Application example, Accessory Fitment ACB , Setting of ETU, Fitment ACB , Do's and Don'ts of ACB
3 .	**Motor protection circuit breaker**- why MPCB needs to be used Soft starter- overview of soft starter use · MCB · RCCB · Pushbutton & Indication Lamps
4	**Motor** Definition, meaning, History regarding invention, onstruction: Description of various parts & their significance in motor operation, operation, working principle & basic equations, · Speed Torque Characteristics, Effects of supply variations over , the motor performance, Transformer equivalent circuit of induction motor, Efficiency of induction motor-Various losses in the induction motor, Types of insulating materials used & their temperature ranges, Product spectrum of Siemens motor, Comparison of normal & inverter driven motor. Comparison of normal and energy efficient motor, Various reasons of high starting current of an induction motor & their effects on supply system.

5	Starters- DOL & star delta etc. · Soft starter – brief verview, VFD – brief overview, Advance control of induction , motor-SIMOCODE overview, Installation & commissioning guidelines, Maintenance guidelines, General faults in the induction motor & their countermeasures i.e. Leads Overheating, Vibration, Abnormal sound etc