



Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING



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

COURSE CONTENTS

Sem. VII

B.Tech. (ELECTRICAL) ENGINEERING

Academic Year: 2019-20

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Course Objectives:

1. Understand fundamentals of electric drives and their control through knowledge of electrical machines and power electronics
2. Discuss basics, dynamics, selection, braking and control of AC/DC drives.
3. Discuss applications of drives in industry
4. Understand the selection of motor as per the torque-speed characteristics of load.

Course Outcomes: Students will demonstrate the ability to

1. Apply the fundamental concept of electrical drives system.
2. Select an electrical drive for a particular application and based on mechanical characteristics of load
3. Control of DC and AC motor using conventional and solid state drives.

Course Contents:

Module	Details	Hours
1	Introduction: Advantages of Electrical Drives, Parts of Electrical Drives, Choice of Electrical Drives, Status of DC and AC Drives	04
2	Dynamics of Electrical Drives: Fundamental torque equations, Speed torque conventions and multi quadrant operation, Equivalent values of Drive parameter, Measurement of moment of Inertia, Components of load torque, Nature and Classification of load torques, Calculation of Time and Energy-Loss in transient operation, Steady state stability, Load equalization..	08
3	Selection of Motor Power Rating: Thermal Model of motor for heating and cooling, Classes of motor rating, Determination of motor rattling.	04
4	Control of Electrical Drives: Modes of operation, Speed control drive classification, Closed loop control of drives. Speed sensing, current sensing, Phase locked loop control	04
5	DC Drives: Speed torque relations for shunt, series, and separately excited motors, Starting, Braking (Regenerative, Dynamic, and Plugging), Speed Control (Armature voltage, Field flux, Armature resistance), Methods of Voltage control (Ward Leonard scheme, Controlled rectifiers, Controlled rectifier fed DC drives (separately excited only), Single phase fully-controlled rectifier, Single phase half-controlled rectifier, three phase fully-controlled rectifier, three phase halfcontrolled rectifier, dual converter control, Chopper control (motoring and braking of separately excited and series motor)	08
6	AC Drives: Induction motor drives, Review of speed-torque relations, Review of starting 6. methods, Braking (Regenerative, Plugging, AC/DC Dynamic braking), Speed control: Stator voltage control variable frequency control from voltage	08

	Source (V/F Control), Wound rotor induction motor control, rotor resistance control, Slip power recovery scheme, State Kramer and Scherbius drive, Vector control (elementary treatment only), Introduction to Synchronous Motor variable speed drive	
7	Special Motor Drives: Stepper motor drives, Types, Torque v/s stepping rate characteristics, Drive circuits, Introduction to Brush-less DC drives, Introduction to Switched reluctance drives. Solar and Battery Drives, Recent trends in Electric Drives.	06

Text/ Reference Books:

1. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall..
2. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall.
3. G. K. Dubey, "Fundamentals of Electrical Drives", CRC Press.
4. W. Leonhard, "Control of Electric Drives", Springer Science & Business Media.
5. Subrahmanyam V, Electrical Drives: Concepts and Applications TMH
6. Pillai S.K, A First course on Electrical Drives Wiley Eastern PH

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

Course Objective:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

Course Code: PE-BTE701 Course:-Wind and Solar Energy Systems (AY 2019-20)

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

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

Text/ Reference Books:

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

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

Course Code: PE-BTE702 Course:-Electrical Machine Design II (AY 2019-20)

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.
4. Use software tools to do design calculations.

Course Contents

Module No.	Content Details	Hours
01	Design of Synchronous machine: Specification. Major considerations in Synchronous machine design - Output Equation – Choice of specific electrical – Choice of specific magnetic loadings. Design of Salient pole Machines: Main Dimensions. Short Circuit Ratio (SCR) – Effect of SCR on machine performance. Length of Air gap. Shape of Pole Face.	04
02	Armature Design: Choice of number of slots – Turns per phase – Conductor section. Armature Windings – Coils and their Insulation. Stator Slot Dimensions Stator Core. Elimination of Harmonics. Armature parameters – Armature Resistance – Armature Leakage Reactance. Estimation of Air gap length.	08
03	Design of Salient pole Rotor: Selection and Type of Pole – pole Height – Damper Winding – Height of Pole Shoe – Mmf for the magnetic circuit – Estimation of full load field mmf – Design of Field Winding. Determination of d & q Synchronous reactances – Short Circuit Characteristic. Estimation of Losses and Efficiency - Temperature Rise.	08
04	Design of turbo alternators: Main Dimensions. Length of Air gap – Stator Design -Rotor design	04
05	Computer Application in Electrical Machine Design: Introduction - Limitations (assumptions) of traditional designs. Computer aided Design (CAD) – Analysis Method - Synthesis Method - Hybrid Method.	08

	Optimization – General Procedure for Optimization – Variables and Constraints – Problem formulation. Computer aided Design of Transformer – Basic Aspects – Flowcharts for Transformer design. Computer aided Design of Induction motor – Basic Aspects – Flowcharts for Induction motor design.	
06	Introduction to FEM based machine design.	04
07	Introduction to complex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.	06

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

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

Course Code: PE-BTE703 Course:-Design Management and Auditing of Electrical Systems
(AY 2019-20)

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

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

Text Books/ Reference Books:

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

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

Prerequisite: Courses Control System, Control System Design

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

Module	Details	Hours
1	Discrete Representation of Continuous Systems Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent, state space system	06
2	Discrete System Analysis Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.	06
3	Stability of Discrete Time System Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design	04
4	State Space Approach for discrete time systems State space models of discrete systems, State space analysis. Lyapunov Stability.	05
5	State Space Approach for discrete time systems Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability	05
6	Design of Digital Control System Nyquist plot for controller design, Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete	08

	compensator.	
7	Discrete output feedback control Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.	08

Text/ Reference Books:

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

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

Course Code: PE-BTE705 Course:-Restructuring and Deregulation of Power

System

(AY 2019-20)

Prerequisite: Power system-I and power system –II

Course Objective:

1. To differentiate between vertically integrated and deregulated power system.
2. Challenges faced in operating restructured power system with reliability, security and economic efficiency.
3. Reforms adopted by developing country like India.

Course Outcomes: Students will demonstrate the ability to

1. Identify different electrical market designs.
2. Understand fundamentals of micro economics.
3. Understand ancillary service and congestion management requirement of restructured power system.

Course contents:

Module	Details	Hours
1	Introduction of restructured power system. Reasons for restructuring and deregulation of power system Entities involved Different model of competition Electrical market vis-à- vis market of commodities	06
2	Fundamentals of micro economics Consumer behaviour Supplier behaviour Market equilibrium Various cost of production Long term and short-term cost Types of markets Markets with imperfection competition	08
3	Introduction to optimization Linear optimisation Convexity Duality KKT condition	06
4	Optimal Power Flow and Congestion Management. Spot Pricing LMP and PX model	08
5	Investigating into generation Consumer perspective Investor perspective	04
6	System security and ancillary service Ancillary service needs Obtaining ancillary service Buying ancillary service	05

	Selling ancillary service	
7	Reforms in Indian Power Sector <ul style="list-style-type: none"> • Frame work of Indian power sector • Availability based tariff (ABT) • Electricity act 2003 • Odisha model • Transmission system cost allocation 	05

Text/Reference books

1. Daniel Krischen and Goran Strbac, “Fundamental of Power System Economics”, John Wiley and Sons Ltd ,2004.
2. Sally Hunt, “Making Competition Work in Electricity”, John Wiley and Sons, Inc.,2002.

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

Course Code: PE-BTE706 Course:-High Voltage Engineering (AY 2019-20)

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

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

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

Sr. No.	Examination	Modules
1	Test 1	1,2
2	Test 2	3,4
3	End Semester	01-06

Course Code: PE-BTE707 Course:-Power Electronics Applications in Power System
(AY 2019-20)

Prerequisite: Course Power Electronics

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

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

Text/ Reference Books:

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

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

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

6	Transport layer: Process to process delivery- client server paradigm, multiplexing, demultiplexing, connection less vs connection oriented service. UDP: user datagram, UDP operation: connectionless services, flow and error control, encapsulation and decapsulation, queuing. TCP: TCP services: process to process communication, stream delivery service, sending and receiving buffers, segments, full duplex communication. TCP features: sequence numbers and acknowledgement number, TCP segment, TCP connection, flow control, error control, congestion control.	08
7	Application layer: Remote logging: TELNET, FTP	03

Text/Reference Books:

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

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

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

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents

Unit	Contents	Hrs.
1	Introduction <ul style="list-style-type: none"> • Economics: Flow in an economy, Law of Supply and Demand, • Concept of Engineering Economics: Definition, Scope, Types of Efficiency • Elements of Costs: Marginal Cost, Marginal Revenue, Sunk Cost, Opportunity Cost • Break-Even Analysis, Profit / Volume Ratio 	03
	Elementary Economic Analysis <ul style="list-style-type: none"> • Basics, Material Selection for a Product, Building Material Selection • Process Planning / Process Modification 	03
2	Interest Formulas and Their Applications <ul style="list-style-type: none"> • Introduction, Time Value of Money • Interest Formulas: Single Payment Compound Amount, Single-Payment Present Worth Amount, Equal-Payment Series Compound Amount, Equal-Payment Series Sinking Fund, Equal-Payment Series Present Worth Amount, Equal-Payment Series Capital Recovery Amount, Uniform Gradient Series Annual Equivalent Amount, Effective Interest Rate • Bases for Comparison of Alternatives 	03
3	Present Worth Method of Comparison <ul style="list-style-type: none"> • Basics, Revenue-dominated Cash Flow Diagram, • Cost-dominated Cash Flow Diagram 	06

	<p>Future Worth Method</p> <ul style="list-style-type: none"> • Basics, Revenue-dominated Cash Flow Diagram • Cost-dominated Cash Flow Diagram <p>Annual Equivalent Method</p> <ul style="list-style-type: none"> • Basics, Revenue-dominated Cash Flow Diagram • Cost-dominated Cash Flow Diagram • Alternate Approach <p>Rate of Return Method.</p> <p>Advantages and disadvantages of each method.</p>	
4	<p>Replacement and Maintenance Analysis</p> <ul style="list-style-type: none"> • Basics, Types of Maintenance, Types of Replacement, • Determination of Economic Life of an Asset • Replacement of Existing Asset with a New Asset: Capital Recovery with Return, Concept of Challenger and Defender • Simple Probabilistic Model for Items Which Fail Completely. 	03
5	<p>Depreciation</p> <ul style="list-style-type: none"> • Methods of Depreciation: Straight Line Method of Depreciation, Declining Balance Method of Depreciation, Sum-of-the-Years-Digits Method of Depreciation, Sinking Fund Method of Depreciation, Service Output Method of Depreciation. <p>Evaluation of Public Alternatives</p>	03 02
6	<p>Inventory Control</p> <ul style="list-style-type: none"> • Basics, Purchase Model with Instantaneous Replenishment and without Shortages, • Manufacturing Model without Shortages • Purchase Model with Shortages (Instantaneous Supply) • Manufacturing Model with Shortages 	04
7	<p>Make or Buy Decision</p> <ul style="list-style-type: none"> • Basics, Criteria for Make or Buy • Approaches for Make or Buy Decision: Simple Cost Analysis, Economic Analysis, Break-even Analysis <p>Value Engineering</p> <ul style="list-style-type: none"> • Basics, Functions, Aim, • When to Apply Value Analysis, Value Analysis vs. Value Engineering • Value Engineering Procedure, Advantages and Application Areas <p>Mathematical Models for Value Engineering</p>	02 02 01

Text Books/ Reference Books:

1. Engineering Economy, DeGarmo, E. Paul, Sullivan and Canada, Collier MacMilan Ltd., USA
2. Engineering Economy, Gerald J. Thuesen, W. J. Fabrycky, 8th Edition, Prentice Hall International Series in Industrial and Systems Engineering
3. Engineering Economics, R. Paneerselvam, PHI Learning Pvt. Ltd. New Delhi.
4. Engineering Economic Analysis, Donald G. Newnan, Jerome P. Lavelle, Ted G.

Eschenbach, Oxford University Press, 12th Edition

5. Basics of Engineering Economy, Leland Blank, Anthony Tarquin, Irwin Industrial Engineering.
6. Contemporary Engineering Economics, Chan S. Park, Pearson Pub., 5th Ed.

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

Prerequisite: Course Microprocessor and Microcontroller

Course Objectives:

1. Introduction to embedded system design.
2. Study of ARM processor.
3. Study of embedded programming and hardware interfacing.
4. Understand the concept of RTOS.

Course Outcomes: Students will demonstrate the ability to

1. Define the unique characteristics of embedded systems.
2. Understand the basics of C and C++.
3. Discuss the interfacing challenges of embedded processors and peripherals.
4. Understand the concepts of Real Time Operating System

Course Contents:

Module	Details	Hours
1	Introduction to Embedded systems: embedded system architecture, classifications of embedded systems, challenges and design issues in embedded systems (Design Metrics), Examples of embedded systems, fundamentals of embedded processor and microcontrollers, CISC vs. RISC, fundamentals of Von-neuman/Harvard architectures, types of microcontrollers, selection of Freelancer microcontrollers.	06
2	Software Programming: C concepts and programming- data types, advanced data types- register, constants, IO operations, operators, operator precedence and associativity, Conditional statements & loops, arrays, single and double dimensional arrays, stings and string operations. Functions: Parameter passing-Pass by Value, Pass by Reference; creating modular programs using functions, Recursive functions. Structures & Unions: declaration, accessing members of structure, difference between structure and union, User Defined Data Types, Enumerated data type. Pointers: pointer basics and concepts, arrays and pointer relation, passing pointers to functions, dynamic memory allocation. Files and file operations. Linked lists, stacks and queues. Pre-processor directives, command line arguments. Basics of C++: features of C++, data types, standard I/O, arrays and strings in C++. Classes in C++.	08
3	Introduction ARM Processor: ARM 7 instruction set, addressing modes, operating modes with ARM core, ARM7 TDMI modes, ADC, Timers, Interrupt structure. Byte ordering (LE, BE), Thumb mode normal mode instructions changes, Pipeline utilization with all register allocations, Floating to fixed point conversion fundamentals. System design with ARM as key processor.DSP features of ARM Core Digital Signal Controllers-DSC differences with conventional micro controllers.	08

4	Hardware Interfacing: SCI, SPI, Timing generation and measurements. Analog interfacing and data acquisition, 7-Seg LED, LCD, Alphanumeric LCD, Graphic LCD displays, Communications and Networks - RS485 (2 and 3 wire) and Modbus Protocol (Intro only) - Ethernet and TCP/IP Stack (Features and Usage only) - CAN features and protocol.	06
5	Real-time concepts: real-time operating systems, Required RTOS services/capabilities (in contrast with traditional OS). Real-world issues: blocking, unpredictability, interrupts, caching, Benefits of using RTOS - Concepts of Tasks/Threads/Process - Multitasking - Task Scheduling - Task management - Inter-task communication and Synchronization: - Device Drivers - How to choose an RTOS.	06
6	Fundamentals of Design and Development: Program Modeling tools Testing and Debugging methodologies.	04
7	Applications of Embedded Systems: case studies - Industrial Automation - Medical - Robotics - Access Control Systems (Smart Cards, RFIDs, Finger Scan)	04

Text/ Reference Books:

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

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

Course Objectives:

1. Students will understand the concepts of Internet of Things and can able to build IoT applications.
2. Explored to the interconnection and integration of the physical world and the cyber space.
3. They are also able to design & develop IOT Devices.

Course Outcomes: Students will demonstrate the ability to

1. Understand the concepts of Internet of Things.
2. Analyze basic protocols in wireless sensor network.
3. Design IoT applications in different domain and be able to analyze their performance.
4. Implement basic IoT applications on embedded platform.

Course Contents:

Module	Details	Hours
1	Introduction to IoT: Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT, Communication models & APIs.	06
2	IoT & M2M: Machine to Machine, Difference between IoT and M2M, Software define Network.	06
3	Network & Communication aspects: Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination.	06
4	Resource Management: Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results.	06
5	Challenges in IoT: Design challenges, Development challenges, Security challenges, Other challenges.	06
6	Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Other IoT applications.	06
7	Developing IoTs: Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python.	06

Text/Reference Books:

1. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011.
2. Charalampos Doukas , “Building Internet of Things with the Arduino”, Create space, April 2002.
3. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach” .
4. Walteneagus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice".

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

Course code: OE-BTM714 Course: Introduction to Micro Electro Mechanical Systems (AY 2019-20)

Course pre-requisites: Engineering sciences

Course Objectives

1. To introduce basic concepts of MEMS and its applications.
2. To introduce sensors and actuators in Micro-domain.
3. To study modelling and simulation techniques for various applications.
4. Apply knowledge of micro fabrication techniques and applications to the design and manufacturing of an MEMS device or a micro system

Course Outcomes: Learner will be able to...

1. Select appropriate sensors and actuators for a given MEMS application.
2. Select a micro-fabrication technique for a specific MEMS fabrication process.
3. Model and simulate a given MEMS system
4. Design MEMS

Course content:

Sr.No.	Description	Hrs.
1	Introduction to MEMS & Applications <ul style="list-style-type: none">• Introduction to Micro-Electro-Mechanical Systems,• Applications and Materials,• Advantages & Disadvantages of Micro-sensors, and micro-actuators.	4
2	Sensors and Actuators in Micro-domain <ul style="list-style-type: none">• Concept of Sensors & Actuators,• Sensing & Actuation Principles: Mechanical Sensing, Capacitive, Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys• Comb Drive Actuation & Sensing, Micro-mechanisms, Air-Bag Sensors.	4
3	Fabrication Methods Microfabrication Methods (VLSI Techniques) <ul style="list-style-type: none">• Positive and Negative Photoresists,• Bulk Micromachining,• Surface Micromachining,• Etching (Isotropic and Anisotropic),• Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques.	4
4	3D High Aspect Ratio Fabrication Techniques <ul style="list-style-type: none">• LIGA,• AMANDA,• Microstereolithography,• IH-Process,• X-Ray Techniques,• Ion-beam Lithography etc	4
5	Modelling and Simulation Techniques <ul style="list-style-type: none">• Scaling Laws, Governing Equations• Modelling of Mechanical Structures via classical methods, Newtons Laws, Thermal Laws, Fluid Flow Analysis.	4

6	Characterization Techniques Topography Methods (Optical, Electrical and Mechanical Methods) • Microscopy, STM (Scanning Tunneling Microscopes), • SEM (Scanning Electron Microscopes), SPM (Scanning Probe Microscopes), AFM (Atomic Force Microscopes) Mechanical Structure Analysis	4
7	Introduction to Advances of MEMS and Nanotechnology • CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method, • Nano-mechanical Systems (NEMS), • Domestic and Industrial Applications of nanotechnology • Social and Ethical Implications of nanotechnology in Society	4

Recommended Books:

1. Julian W. Garden, Vijay K. Varadan and Osama O. Awadelkarim “Microsensors MEMS and Smart devices”, John Wiley and sons, Ltd.
2. NadimMulaf and Kirt Williams, “An Introduction to Microelectromechanical systems Engineering”, Artech House.
3. NicolaeLobontiu and Ephraim Garcia, “Mechanics of Microelectromechanical systems”, Kluwer Academic Publication.
4. Stanley Wolf and Richard Tauber, “Silicon Processing for the VLSI era Volume -1 Technology”, Lattice press.
5. Vijay K. Varadan, K.J.Vinoy and S. Gopalkrishnan, “Smart Material Systems and MEMS: Design and Development Methodologies”, John Wiley and sons Ltd.
6. Bhushan, “Springer Handbook of Nanotechnology”, Springer Inc.

Term Work/Tutorial

1. Assignments on each module
2. Case studies on applications of Micro-electromechanical Systems
3. Seminar on recent advances in Micro-electromechanical Systems
4. Exercises on layout of Integrated circuits on L-Edit software

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

Course Code: OE-BTM715 Course: Solar and Wind Technology (AY2019-20)

Course pre-requisites: General Engineering

Course Objectives:

In India, solar and wind power based system are finding wide acceptance. Government is also promoting their use to meet the increasing demand of energy. The objective of the course to provide fundamental knowledge of this domain and equip students to design, develop and work in this area.

Course Outcomes:

On successful completion of the course students will

1. have knowledge of fundamentals of solar and wind as a source of energy,
2. understand the working principle, components, system performance of solar and wind based power generating system,
3. be able to select and recommend an optimum power solution to an application,
4. be able to design a solar powered system.

Course Contents:

Module	Description	Hrs.
1	<i>Fundamental of Solar Radiation:</i> Properties of sunlight. Absorption by the atmosphere. Calculation of solar irradiance at surfaces.	04
2	<i>Solar Thermal:</i> Thermodynamic description of solar collectors. Optical properties of solar collectors and technologies for fabrication. Solar thermal systems for different applications. Storage of solar generated heat and its economics.	06
3	<i>Solar Cells and Modules:</i> Function of a solar cells from semiconductor physics. Different solar cell technologies and fabrication methods. <i>Solar cell systems</i> - System components and their functions. Calculating output and dimensioning of solar cell systems. Concentrated sunlight and solar power (CSP). Properties of optical concentration systems. Solar cells in concentrated sunlight.	06
4	<i>Hybrid Systems:</i> Combinations of solar thermal and solar cell systems. Overview of different applications. Design of a solar powered system for a specific application.	06
5	<i>Fundamental of Wind Energy:</i> Characteristics of different state of wind, Fluid mechanics of power generation from wind, Power characteristics.	08
6	<i>Technology of Wind Power:</i> Types of wind turbine- Horizontal axis and vertical axis, and their functioning Subsystems - Nacelle, Rotor, Hub and blades	06
7	<i>Development in Solar and Wind Technology</i> Assessment of present issues, Assessment of economics of solar and wind projects, Improving performance & reliability and reducing cost, Novel designs, Environment and Government Policy.	06

Term work: Assignments containing numerical problems based on each module.
Seminar based on recent advances in subject.

Recommended Books:

1. John Twidell and Tony Weir, “*Renewable Energy Resources*”, John Wiley & Sons, 8ed.
2. Mukund R Patel, “*Wind and solar powersystem*”, CRC Press, 2ed.
3. Johnson, G.L., *Wind Energy Systems*, Prentice Hall, London,
4. Yogi Goswami, D., Kreith, F., and Kreider, J.F., *Principles of Solar Engineering*, Taylor & Francis, 2000
5. Sukhatme S.P, "Principles of Solar Energy Collection and Storage", Tata-McGraw Hill

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-BTM716 Course: Internet of Things (IOT) (AY2019-20)

Course pre-requisites: General knowledge of networking, sensing, databases, programming, and related technology

Course Objectives:

Upon successful completion of the course, students will be

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

Course Outcomes:

After successful completion of the course student should be able to

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

Course Content:

Module No	Details	Hrs.
Module 01	Introduction Fundamentals of Internet of Things (IOT), Components in IOT, Architecture of IOT, Security, Privacy, Advantages, Applications: Smart Vehicles, Medical, Smart city, Smart Supply Chain, Industrial Internet of things (IIOT) etc.	04
Module 02	Enabling Technologies of IOT Technology Roadmap, RFID, Augmented Reality, Blue Tooth, Zigbee, WiFi, RFLinks, MEMS etc	04
Module 03	Programming the Microcontroller for IOT Cloud computing and IOT –Arduino/Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors - Communication-Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using WiFi / Ethernet	04
Module 04	Resource Management Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results	04
Module 05	IOT PROTOCOLS Network Overview, Various Types of Networks, Network Protocols, Selecting the Right Network for the Right Use case, Network Challenges for IOT: Connecting sensors, Integrating with Application Platform	04
Module 06	IOT Platforms Introduction, Necessity of IOT Platform, Industrial Grade Platform, Key IOT Platform Features, IOT Platform Architecture, Getting access to IOT platforms, Introduction to Model based development on IOT platforms	04

Module 07	Challenges & Opportunities of IOT New business markets in IOT, IOT Design Challenges, IOT Design Opportunities, Technological challenges faced by IOT devices	04
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Term Work:

- It consists of **at least one** tutorial and/or assignments and/or hands-on exercises from each module of the curriculum mentioned for the course.
- One Presentation / Seminar related to IOT
- Mini Project

TEXT BOOKS:

1. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011

REFERENCE BOOKS:

1. Charalampos Doukas , “Building Internet of Things with the Arduino”, Create space, April 2002

Internet of Things (IOT) Course Evaluation Scheme:

Students shall select an Mechanical or any interdisciplinary application & apply concepts of IOT, learned during theory & tutorial/Practical. Following evaluation scheme will be adopted for the evaluation of the course.

Test 1: 20% (Theory paper)

Test 2: 20% (Theory paper)

In-semester evaluation: 60%

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-BTM717 Course: Introduction to Augmented Reality (AY2019-20)

Course pre-requisites: General knowledge of CAD Modeling

Course Objectives:

Upon successful completion of the course, students will be

- Explore the basic concepts of Augmented Reality.
- They are also able to design & develop AR application.

Course Outcomes:

After successful completion of the course student should be able to

5. Describe the theory related to Augmented Reality
6. Apply theoretical knowledge of AR in practice
7. Select the hardware & software for different applications.
8. Develop interactive augmented reality applications for both PC based mobile devices using a variety of novel input devices

Course Content:

Module No	Details	Hrs.
Module 01	Introduction History of AR, Basics of Augmented Reality, Architecture/Framework, Marker & Marker less AR	04
Module 02	Enabling Technologies of Augmented Reality Mobile, Camera, webcam, Cloud Computing, Unity, SDK, Augment, display of digital content, tracking, registration, recognition, rendering etc.	04
Module 03	Applications of AR in Industries & Education Remote Maintenance, Product Development, Logistics, NDT, Architecture, civil building works & training, Manufacturing resource planning, Sales & marketing, Assembly, education etc.	04
Module 04	Lighting and Illumination Issues in AR Conversion of CAD Model to AR Model	04
Module 05	Hardware HOLOLENS INTERFACE	04
Module 06	Integration scenarios of AR with other IT Technologies <ul style="list-style-type: none">• IOT+ AR Integration	04
Module 07	Challenges & Opportunities of AR New business & Revenue models, Technological challenges faced by AR	04

Term Work:

- It consists of **at least one** tutorial and/or assignments and/or hands-on exercises from each module of the curriculum mentioned for the course.
- One Presentation / Seminar related to AR
- Mini Project

TEXT BOOKS:

Augmented Reality A Practical Guide Paperback – 2008,by Cawood (Author)

REFERENCE BOOKS:

Augmented Reality: Principles and Practice by Tobias Höllerer, Dieter Schmalstieg

Augmented Reality (AR) Course Evaluation Scheme:

Students shall select an Mechanical or any interdisciplinary application & apply concepts of AR, learned during theory & tutorial/Practical. Following evaluation scheme will be adopted for the evaluation of the course.

Test 1: 20% (Theory paper)

Test 2: 20% (Theory paper)

In-semester evaluation: 60%

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-BTM718 Course: Fundamentals of AI and Machine Learning (AY2019-20)

Course pre-requisites: Mathematics, Knowledge of programming language (Python preferred)

Course Objective:

The students after studying these topics should be able to

1. understand applications of Artificial Intelligence and Machine Learning for engineering applications
2. apply suitable algorithms for simple engineering problems

Course Outcomes:

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

1. discuss applications of Artificial Intelligence for engineering problem solving
2. apply fundamental concepts in machine learning and select popular machine learning algorithms for engineering problem solving
3. compose computer code for solving problems using machine learning algorithms
4. explain advanced machine learning concepts such as Neural Network, Reinforcement Learning.

Course Content:

Module No.	Details	Hrs.
01	Fundamental Concepts of AI, Agents, Environments, General Model, Problem Solving Techniques, uninformed search techniques, Heuristic search, adversarial search and game trees	4
02	Knowledge representation, Propositional and predicate calculus, semantics for predicate calculus, inference rules	2
03	Introduction to Machine Learning Learning algorithm: Supervise and Unsupervised Learning, Regression Algorithms Classification Algorithms: Logistic, Bayes, NN Classifiers Clustering: K-Means, DBSCAN, and Hierarchical Clustering Linear regression, Decision trees, overfitting, Instance based learning, Feature reduction, Collaborative filtering-based recommendation	6
04	Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM	4
05	Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network, deep learning	6
06	Clustering: k-means, adaptive hierarchical clustering	4
07	Introduction to Reinforcement Learning	2

Term Work/Laboratory:

- Journal work shall consist of e-folder with computer code for solution to problems based on each module.
- Seminar
- Mini-project

Text Books/Reference Books:

1. Tom Mitchell, Machine Learning, First Edition, McGraw- Hill (1997).
2. Stuart Russel and Peter Norvig, Artificial Intelligence – A modern approach, Pearson (2015)
3. Ethem Alpaydin, Introduction to Machine Learning, PHI (2015).
4. Gopal M., Applied Machine Learning, McGraw Hill (2018)

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 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: Basic Introduction and Overview, Variables and Data types, Operation, Control Structure, Function, Introduction to different tool boxes available, introduction to MATLAB simulink

2. Introduction to Python (VA-BTE02)

Course Objective: Provide knowledge of Python

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

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

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 Analog 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	ELECTROPNEUMATIC POSITONER Topics for all above Measurements. <ul style="list-style-type: none">· 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& Axle, 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 Introduction 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-Variou 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
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Course code VA-BTI 06 Course Title: Basic Drives (AC – DC Drives) (AY2019-20)

DURATION: 40 hours

PREREQUISITE: Engineers in Electrical / Electronic Engineering with Power Electronics Background

Course Objectives: The participants will

1. have a basic or fundamental knowledge of various DC/AC Variable speed drives
2. know about the product specifications, range, hardware / constructional details and features of the product

Course Outcomes: The participants will be able to

1. perform drive start-up and parameterize drive for different configurations including use of programmable digital and analog inputs and outputs

TRAINING METHODOLOGY: Explanation, demonstration and hands-on practice

COURSE CONTENTS:

Module	Details
1	Brief Basics Power Electronics (including Thyristors, Power-Transistors and IGBTs. DC Motor Basics (construction, principle of operation, T-N Characteristic etc).
2	DC Drives Basics (Block diagram, 1Q-4Q principle of operation, T-N Curves etc) Selections, calculations & applications of typical DC drives, Siemens DC Drives (6RA80) - Ratings, Specs, features, options & applications.
3	AC Motor Basics (construction, principle of operation, T-N Characteristic etc)., AC Drives Basics (Block diagram, 1Q-4Q principle of operation, T-N Curves etc)
4	Selections, calculations & applications of typical AC drives. AC Drives (Sinamics V, G & S) - Ratings, Specs, features, options , applications
5	Hands on practice on DC and AC drive

Course code: VA- BTI07 Course: Digitalization with industry 4.0 (AY2019-20)

Duration: 32 hours

Prerequisites: Participants should have the knowledge of programming a PLC with the use of basic instructions of various communication protocols

Course Objectives: Students will

1. be aware of Industrial revolutions and its implementation.
2. Understand communication protocols and their use during configuring, interfacing etc.

Course Outcomes: students will be able to

1. Configure PLCs
2. Implement basic programming via tasks / mechatronic system

Course Contents

Module	Details
1	General introduction to Industry4.0 : Introduction to Industrial revolutions – 1.0, 2.0, 3.0 and 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
2	Brief discussions on communication protocols for connecting devices: Profinet, Demonstration of communication b/w PLC & Connectivity hardware.
3	Identification of Data points and configuring Data availability on PLC and SIMATICIoT2040 : TIA portal programming interface and hands-on (Configuring PLCs, FC, FB, DB concepts, Implementing basic programming via tasks / mechatronic system, Setting up Data points) , Setting up the SIMATIC/ Mind Connect IOT 2040, Establish internet connection on device – wireless /LAN
4	Connection with Automation system and Data visualization: Connectivity with Automation System, Setting up Mind Sphere account and aspects, Data Visualization on Mind Sphere
5	Hands on Practice



Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING



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

COURSE CONTENTS

Sem. VIII

B.Tech. (ELECTRICAL) ENGINEERING

Academic Year: 2019-20

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Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

Text/ Reference Books:

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

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

(AY 2019-20)

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

Text/ Reference Books:

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

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

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

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

Text/ Reference Books:

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

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

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

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

Text/ Reference Books:

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

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

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

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

Text/ Reference Books:

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

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

Course Objectives:

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

Course Outcomes: students will demonstrate the ability to

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

Course Contents:

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

Text/ Reference Books:

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

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

Course Objectives:

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

Course Outcomes: students will demonstrate the ability to

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

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

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

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

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

Course Code: PE-BTE807 Course:-Industrial Electrical Systems (AY 2019-20)

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

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

Text/ Reference Books:

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

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

Course Code: PE-BTE808 Course:- Advanced techniques in Power System Protection
(AY 2019-20)

Course Objectives

1. Understand the art and science of numerical relay technology.
2. Demonstrate the hardware description of relaying system.

Course Outcomes Students will demonstrate the ability to

1. Apply the modern protection practices.
2. Appreciate new trends in relay technologies.

Course contents:

Mdule No.	Content	Hours
1.	Review of Relaying Practices: Evolution of digital relays from electromechanical relays, Review of protection philosophies for transmission lines, generators and transformers. Modeling of Current and voltage transformers	5
2.	Mathematical background to protection algorithms: Finite difference Techniques, Interpolation formulae: Forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier series and Fourier transform	8
3.	Numerical Relay : architecture, sampling theorem, anti-aliasing filter, Fourier Algorithm, Full cycle window algorithm for phasor estimation	5
4.	Transmission Line Protection: Distance relay scheme for three phase line, Different relay algorithms for distance protection, Out of step blocking and tripping schemes.	8
5.	Digital differential Protection: protection of generator, transformer, bus bar protection, Travelling wave based protection schemes.	8
6.	Adaptive Relaying: Need for adaptive relaying, Adaptive relaying for transmission lines, transformer, Auto-reclosing.	4
7.	Wide Area Measurement Applications: WAMS architecture, WAMS based out of step relaying, supervision of back up zones, Intelligent load shedding, Intelligent islanding.	4

Text/Reference Books

1. A.G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, Wiley/Research studies Press, 2009
2. A.T. Johns and S. K. Salman, “Digital Protection of Power Systems”, IEEE Press,1999
3. Gerhard Ziegler, “Numerical Distance Protection”, Siemens Publicis Corporate Publishing, 2006
4. S.R. Bhide “Digital Power System Protection” PHI

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

Pre-requisite: Control System**Course Objective**

1. To introduce the nature of nonlinearities found in systems and control
2. To learn standard methods of analysis and design in nonlinear system.

Course Outcome: Students will demonstrate the ability to

1. Understand and apply concepts of linear algebra for system analysis.
2. Understand mathematical models of various nonlinear systems.
3. Analyze performance of linear and nonlinear system and design controller.

Course Contents:

Module	Details	Hrs.
1.	Non-linear systems: Introduction, behavior of non-linear system, common physical non linearity- saturation, friction, backlash, dead zone, relay, multi variable non-linearity.	04
2.	Phase Plane Analysis: Concept of phase plane, constructing phase portrait, Phase plane analysis of linear systems, Phase plane analysis of nonlinear systems, Existence of limit cycles.	07
3.	Fundamentals of Lyapunov theory: equilibrium points, concept of stability, linearization of nonlinear systems, Local stability, Lyapunov Equation, Lyapunov's direct method, Stability and instability theorems.	08
4.	System analysis based on Lyapunov's direct method and Control Design based on Lyapunov's direct method.	06
5.	Describing Functions: Stability analysis and limit cycles, Linear compensation methods, General describing functions of common nonlinearities, Relative stability.	05
6.	Feedback linearization: feedback linearization and canonical form, Input-state linearization, Input- output linearization.	05
7.	Control design for nonlinear system: Control design using linearized model, Lyapunov method of control design, control design using feedback linearization and back stepping.	07

Text/ Reference Books:

1. Slotine, J. E. & Weiping Li, Applied Nonlinear Control, Prentice-Hall, [1991]
2. Khalil, Hasan K., Nonlinear Systems, Macmillan Publishing, [1992]
3. Chi-Tsong Chen, "Linear Systems Theory and Design", Oxford University Press New York, 1999.
4. T. Kailath, "Linear Systems", Prentice-Hall, New Jersey, 1980, Science and Business Media 2008.
5. Gilbert Strang, "Linear Algebra and its Application", Fourth Edition CENGAGE Learning
6. Ogata, K., Modern Control Engineering, Prentice-Hall, [2002]
7. Gopal, M., Modern Control System Theory, John Wiley Eastern Ltd. New Delhi, [1984]

8. Friedland, B., Control System Design, McGraw-Hill, [1986]
9. Ogata, K., State Space Analysis of Control Systems, Prentice-Hall, [1967]
10. Kuo, B. C., Automatic Control Systems, Prentice-Hall, [1987]

SR.NO.	EXAMINATION	MODULE
1.	T1	1 , 2
2.	T2	3 , 4
3.	END SEMESTER	1 TO 7

Course Objectives:

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

Course Outcomes:

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

Course Contents:

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

Text/ Reference Books:

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

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

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

Text/ Reference Books:

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

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

Course Code: OE-BTE803 Course:-Electrical Engineering Materials (AY 2019-20)

Course Objectives:

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

Text Books:

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

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

Course Code: OE-BTE804 Course:-Medical Electronics (AY2019-20)

Course Objectives:

1. Discuss bioelectric potentials generated in human body
2. Understand the basic principle, working and design of various automated diagnostic equipments.
3. To study various medical instrumentation systems, drug delivery systems and health management systems.

Course Outcomes: Students will demonstrate the ability to

1. Understand bioelectric potentials generated in human body
2. Use modern methodologies, multi-disciplinary skill set and knowledge while working on real time projects
that demand convergence of engineering, science and technology

Course Contents

Sr. No.	Details	Hours
1	Fundamentals of Medical instrumentation Generation of Bioelectric Potentials: Basic cell physiology, Physiological systems of body, Sources of biomedical signals. Basic Medical instrumentation system: Performance requirements, intelligent systems	06
2	Biophysical signal capture, processing Recording electrodes, Electrodes for ECG, EMG, Microelectrodes Physiological Transducers: Classification, Performance characteristics and types of transducers used in medical instrumentation.	06
3	Biomedical Recorders Electrocardiograph, Vectorcardiograph, Phonocardiograph, Electroencephalograph, Electromyograph	06
4	Monitoring System Patient monitoring system: Cardiac Monitor, Central Monitors, Measurement of heart rate, temperature, respiratory rate Ambulatory monitoring system: Arrhythmia monitors, ambulatory monitoring instruments Foetal monitoring instrument	06
5	Modern imaging system Digital radiography, Magnetic Resonance imaging system, Ultrasonic Imaging System	06
6	Therapeutic Equipment Cardiac Pacemakers, Cardiac Defibrillators, Ventilators	06
7	Telemetry, Telemedicine Single and multi channel telemetry systems, Implantable telemetry system, Essential parameters of telemedicine, telemedicine system, transmission of still and video images, Cyber medicine.	06

Text/ Reference Books:

1. Handbook of Biomedical Engineering by R.S. Khandpur, PHI
2. Medical Instrumentation, Application and Design by J.G. Webster, TMH.
3. Encyclopaedia of medical devices and instrumentation - J.G. Webster Vol I, II, III, IV (John Willey)

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

Prerequisite: Course Digital Signal Processing**Course Objectives:**

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

Course Outcomes: Students will demonstrate the ability to

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

Course Contents:

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

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

Text/ Reference Books:

1. Rafael C. Gonzalez and Richard E. Woods, „Digital Image Processing“, Pearson Education Asia, Third Edition, 2009,
2. S. Jayaraman, E. Esakkirajan and T. Veerkumar, “Digital Image Processing” Tata McGraw Hill Education Private Ltd, 2009,
3. Anil K. Jain, “Fundamentals and Digital Image Processing”, Prentice Hall of India Private Ltd, Third Edition

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

Course Code: OE-BTM712 Course: Introduction to Research Methodology (AY2019-20)

Course pre-requisites: General Engineering, Communication Skills

Course Objectives:

1. To learn research methodology
2. To learn research methodology tools and techniques
3. To learn research report writing

Course Outcomes:

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

1. understand the basics of Research Methodology
2. understand the Tools and techniques in Research Methodology
3. use the knowledge of data collection methods
4. write the research report

Course Contents:

Sr. No.	Details	Hrs.
Module 01	Definition of research: Research – Definition; Types of Research methods Pure and applied research. Descriptive and explanatory research, Qualitative and quantitative approaches	03
Module 02	Research procedure: Formulating the Research Problem, research design including sample Design, Sample size. Considerations in selecting research problem	06
Module 03	Literature survey, Guidelines for Literature survey	06
Module 04	Data Collection methods: Interview, experimental methods, case study	09
Module 05	Regression Equation and Curve fitting	06
Module 06	Hypothesis tests: z test , F test , t Test, Chi Sq test	06
Module 07	Outcome of research: Preparation of the Report on conclusions reached. Testing validity of research outcomes. Suggestions and recommendations, identifying future scope.	06

PRACTICAL:

Term work shall consist of one assignment on each module.

Text Books:

1. Kothari C R, Research Methodology, Wiley Eastern
2. Research Methodology: A Step-by-Step Guide for Beginners by by Ranjit Kumar

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

Course Code: OE-BTM719 Course: Value Engineering (AY 2019-20)

Course pre-requisites: General Engineering

Course Objectives:

1. To understand and analyse the theory and methodology of Value Engineering with the Guidelines
2. To understand the step by step application of the technique to the current industrial problems.
3. To provide the knowledge about Value engineering Principles, the various models and implementation method, which are adopted in the industries.

Course Outcomes:

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

1. To understand the concepts of value engineering, identify the advantages, applications.
2. To analyze the function, approach of function and evaluation of function. Determine the worth and value.
3. Appraise the value engineering operation in maintenance and repair activities.
4. To improve management skill

Course Content

Module No.	Course content	Hours
1	What is Value Engineering Myths on Value Engineering, History of Value Engineering. Why Value Engineering. Understanding Value and different types of Values, Introduction of Function and its importance in Value creation	04
2	Identifying Functions and Job Plan Methodology, Projects identification and Techniques	04
3	Function Analysis System Technique. (FAST) with exercises, Function – Cost – Worth. (FCW)	04
4	Team building and its Role in success of projects, Creativity & Innovation. Different methodologies for Ideas generation	04
5	Evaluation of Ideas and various Techniques, Implementation of Ideas and Logical conclusions of projects	04
6	Hands on practice on Implementation of Projects by students	04
7	Value engineering Projects in Construction Industry, Manufacturing Industry and Service Industries	04

Distribution of Term Work marks shall be as follows: (total 25 marks).

1. Case study presentation : 15 marks
2. Group Discussion : 05 marks
3. Attendance: 05 marks

Text Book:

1. Anil Kumar Mukhopadhyaya, “Value Engineering: Concepts Techniques and applications”, SAGE Publications 2010

References:

1. Alphonse Dell’Isola, “Value Engineering: Practical Applications for Design, Construction, Maintenance & Operations”, R S Means Co., 1997.
2. Richard Park, “Value Engineering: A Plan for Invention”, St. Lucie Press, 1999.
3. Del L. Younker, “Value Engineering analysis and methodology”, Marcel Dekker Inc, New York, 2004.

4. Miles, L.D., "Techniques of Value Analysis and Engineering", McGraw Hill second Edition, 1989.
5. Khanna, O.P., "Industrial Engineering and Management", DhanpatRai& Sons, 1993.
6. Anil Kumar Mukhopadhyaya, "Value Engineering Mastermind: From concept to Value Engineering Certification", SAGE Publications, 2003.

Course Code: OE-BTM720 Course: Fire and Safety Management in Industry (AY2019-20)

Course pre-requisites: General Engineering

Course Objectives:

1. To understand Fire, its character knowledge areas and tool – techniques Fire Management.
2. Understand the role of Fire Management in an Industry.
3. Develop an understanding of various techniques used to avoid fire and safety techniques
4. To understand various regulation norms and their safety requirements

Course Outcomes:

Upon successful completion of the course, students should be able

1. To describe the basic knowledge of Fire Management.
2. To describe the various tools and Techniques used in Fire Management.
3. To understand the various precautionary concepts and Tools in Fire Management for Industries.
4. To investigate and assess fire regulatory norms and inspect the study cases.

Course Content:

Module No	Details	Hrs
1	Introduction: Introduction to Industrial study, safety management in Chemical industry, Hazard identification and analysis.	06
2	Accident Prevention principles & investigation, Job safety analysis, Behavioral based safety, Process safety management, Various regulatory norms existed in industrial fire & safety, Government regulations, authorities & permissions	06
3	Fire management system, effective fire safety, tools & techniques, ISO 14001 – 2015 – Environment management system, Protect and sustainability, ISO 45001 – 2018 – Occupational Health & safety management system, Personal Protective equipments	08
4	Various Industrial processes of fire potential, Nature of Fire and fire protection, Sulfuric acid plant process, sulfuric acid plant visit Safety norms in acidic plant & industry	06
5	Governing body, work permit, inspection, authority, Hazard prevention plan, disaster management: Disaster preparedness and relief plan, emergency control plan	04
6	Industrial safety management, Fire safety, Fire Prevention, Principles, Techniques and mitigation, Human behavior in disasters, Mass control techniques	06
7	Types of fires, techniques of different fire extinguishers, Fire extinguishing Demonstration, safety and fire audit, Course evaluation	06

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

Teaching Methods:

1. The course will use the following pedagogical tools:
2. Discussion on concepts of fire management in an organization.
3. Understanding chemistry of fire and environmental issues.
4. Case studies of great disasters, causes and faults and negligence, fire Management tools and techniques.
5. Projects/ Assignments/ Quizzes/ Class participation etc.

References:

1. A. Maurice Jones, Jr. Fire Protection Systems, Jones & Barlett Publishers, 2016
2. Eugene Meyer, Chemistry of Hazardous Materials, Pearson Publishers, 2013
3. D S S Ganguly & C S Changeriya, Fire engineering, Fire technology, Chetan Prakashan, , 2011.

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

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 Analog 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	ELECTROPNEUMATIC POSITONER Topics for all above Measurements. <ul style="list-style-type: none">· 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: 96Hours

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& Axle, 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 Introduction 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-Variou 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
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Course code VA-BTI 06 Course Title: Basic Drives (AC – DC Drives) (AY2019-20)

DURATION: 40 hours

PREREQUISITE: Engineers in Electrical / Electronic Engineering with Power Electronics Background

Course Objectives: The participants will

1. have a basic or fundamental knowledge of various DC/AC Variable speed drives
2. know about the product specifications, range, hardware / constructional details and features of the product

Course Outcomes: The participants will be able to

1. perform drive start-up and parameterize drive for different configurations including use of programmable digital and analog inputs and outputs

TRAINING METHODOLOGY: Explanation, demonstration and hands-on practice

COURSE CONTENTS:

Module	Details
1	Brief Basics Power Electronics (including Thyristors, Power-Transistors and IGBTs. DC Motor Basics (construction, principle of operation, T-N Characteristic etc).
2	DC Drives Basics (Block diagram, 1Q-4Q principle of operation, T-N Curves etc) Selections, calculations & applications of typical DC drives, Siemens DC Drives (6RA80) - Ratings, Specs, features, options & applications.
3	AC Motor Basics (construction, principle of operation, T-N Characteristic etc)., AC Drives Basics (Block diagram, 1Q-4Q principle of operation, T-N Curves etc)
4	Selections, calculations & applications of typical AC drives. AC Drives (Sinamics V, G & S) - Ratings, Specs, features, options , applications
5	Hands on practice on DC and AC drive

Course code: VA- BTI07 Course: Digitalization with industry 4.0 (AY2019-20)

Duration: 32 hours

Prerequisites: Participants should have the knowledge of programming a PLC with the use of basic instructions of various communication protocols

Course Objectives: Students will

1. be aware of Industrial revolutions and its implementation.
2. Understand communication protocols and their use during configuring, interfacing etc.

Course Outcomes: students will be able to

1. Configure PLCs
2. Implement basic programming via tasks / mechatronic system

Course Contents

Module	Details
1	General introduction to Industry4.0 : Introduction to Industrial revolutions – 1.0, 2.0, 3.0 and 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
2	Brief discussions on communication protocols for connecting devices: Profinet, Demonstration of communication b/w PLC & Connectivity hardware.
3	Identification of Data points and configuring Data availability on PLC and SIMATICIoT2040 : TIA portal programming interface and hands-on (Configuring PLCs, FC, FB, DB concepts, Implementing basic programming via tasks / mechatronic system, Setting up Data points) , Setting up the SIMATIC/ Mind Connect IOT 2040, Establish internet connection on device – wireless /LAN
4	Connection with Automation system and Data visualization: Connectivity with Automation System, Setting up Mind Sphere account and aspects, Data Visualization on Mind Sphere
5	Hands on Practice