Scheme & Syllabus for
B.Tech. Electrical Engineering
according to Choice Based Credit System
(CBCS)

(Semester-V and Semester-VI)

Department of Electrical Engineering
(w.e.f Session 2020-21)

School of Engineering & Technology

CENTRAL UNIVERSITY OF HARYANA
MAHENDERGARH-123031
HARYANA

Central University of Haryana
Department of Electrical Engineering, School of Engineering and Technology
B.Tech. 3rd YEAR (SEMESTER – V)

Sl. No.	Course Code	Course Title	Teaching Schedule			Credits
			L	T	P	
1	BT EE50A	Power Electronics	3	1	0	4
2	BT EE502A	Power Electronics Laboratory	0	0	2	1
3	BT EE503A	Control Systems	3	1	0	4
4	BT EE504A	Control Systems Laboratory	0	0	2	1
5	BT EE505A	Electromagnetic Fields	3	1	0	4
6	BT EE506A	Economics for Engineers	3	0	0	3
7	BT EE507A	Internship Presentation	0	2	0	2
8	**Program Elective – 1**					
	BT EE521	Advanced Network Analysis	3	0	0	3
	BT EE522	Electrical Machine Design	3	0	0	3
	BT EE523	Industrial Electrical Systems	3	0	0	3
	BT EE524	Computer Architecture	3	0	0	3
9	**Program Elective – 2**					
	BT EE531	Electrical Engineering Materials	3	0	0	3
	BT EE532	Power Plant engineering	3	0	0	3
	BT EE533	Energy Management	3	0	0	3
	BT EE534	Process Control and Instrumentation	3	0	0	3
Total			**18**	**03**	**04**	**25**

L = Lecture, T = Tutorial, P = Practical, & C = Credits

NOTE: - Examinees will be allowed to use only non-programmable scientific calculators in the examination. Other electronic gadgets and sharing of materials will not be permitted during the examinations.

Applicable for the students enrolled in 2018-19 onwards

Central University of Haryana
Department of Electrical Engineering, School of Engineering and Technology
B.Tech. 3rd YEAR (SEMESTER – VI)

Sl. No.	Course Code	Course Title	Teaching Schedule			Credits
			L	T	P	
1	BT EE601A	Power Systems – II	3	1	0	4
2	BT EE602A	Power Systems Laboratory – II	0	0	2	1
3	BT EE603A	Microprocessor& Micro-controller	3	1	0	4
4	BT EE604A	Microprocessor & Micro-controller Laboratory	0	0	2	1
5	BT EE605A	Electronics Design Laboratory	0	0	4	2
6	BT EE606A	Applications of Psychology in Engineers Life	3	0	0	3
7	**Program Elective – 3**					
	BT EE621	Electromagnetic Waves	3	0	0	3
	BT EE622	Wind & Solar Energy Systems	3	0	0	3
	BT EE623	Electrical Energy Conservation and Auditing	3	0	0	3
	BT EE624	Digital Control Systems	3	0	0	3
8	**Program Elective – 4**					
	BT EE631	Line Commutated and Active Rectifiers	3	0	0	3
	BT EE632	HVDC Transmission	3	0	0	3
	BT EE633	Utilization of Electric Power and Traction	3	0	0	3
	BT EE634	Digital Signal Processing	3	0	0	3
9	**Program Elective – 5**					
	BT EE641	Sensors and Transducers	3	0	0	3
	BT EE642	Fuzzy Systems	3	0	0	3
	BT EE643	Analog and Digital Communication	3	0	0	3
	BT EE644	Optimization Techniques	3	0	0	3
Total			**18**	**03**	**08**	**24**

NOTE: - Examinees will be allowed to use only non-programmable scientific calculators in the examination. Other electronic gadgets and sharing of materials will not be permitted during the examinations. At the end of 6th semester, each student has to undergo Summer Internship of at least 6 weeks from the industry / institute /research lab / training centre, etc. during summer vacation & its evaluation shall be carried out in 7th Semester.

29/4/2020 29/04/2020

POWER ELECTRONICS

Course Code: BT EE 501A **SEMESTER-V**

L	T	P	Credits
3	1	-	4

Course Level Learning Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the differences between signal level and power level devices.
2. Analyse controlled rectifier circuits.
3. Analyse the operation of DC-DC choppers.
4. Analyse the operation of voltage source inverters.

Unit -I

Power switching devices: Diode, Thyristor, MOSFET, IGBT: I-V Characteristics; Firing circuit for thyristor; Voltage and current commutation of a thyristor; Gate drive circuits for MOSFET and IGBT. Protection of Devices.

Diode rectifiers with passive filtering: Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current wave shape, effect of source inductance; commutation overlap.

Unit -II

Thyristor rectifiers: Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R- load and highly inductive load; Three-phase full-bridge thyristor rectifier with R-load and highly inductive load; Input current wave shape and power factor.

Unit -III

DC-DC buck converter: Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

DC-DC boost converter: Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

CHOPPERS : Basic scheme, output voltage control techniques, one, two, and four quadrant choppers, step up chopper, voltage commutated chopper, current commutated chopper, MOSFET and transistor based choppers.

Unit -IV

Single-phase voltage source inverter: Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, bipolar sinusoidal modulation and unipolar sinusoidal modulation, modulation index and output voltage

Three-phase voltage source inverter: Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, three-phase sinusoidal modulation.

Suggested Readings:

1. Bimbhra, P. S., and Surinder Kaur. *Power Electronics*. Khanna publishers, 2012.
2. Erickson, Robert W., and Dragan Maksimovic. *Fundamentals of power electronics*. Springer Science & Business Media, 2007.
3. Mohan, Ned, Tore M. Undeland, and William P. Robbins. *Power electronics: converters, applications, and design*. John wiley & sons, 2007.
4. Rashid, M. H. *Power Electronic Circuits, Devices, and Applications*. University of West Florida. Pearson Prentice Hall, 2014.
5. Umanand L. *Power Electronics: Essentials and Applications*. Wiley India P. Ltd., 2009.

POWER ELECTRONICS LABORATORY

Course Code: BT EE 502A **SEMESTER-V**

L	T	P	Credits
-	-	2	1

LIST OF EXPERIMENTS:

1. To plot the characteristics of diode, thyristor, triac, transistor and MOSFET.
2. Firing angle control of R and R-C firing circuits, UJT firing circuits.
3. Develop the complementary voltage commutation using ring counter.
4. To demonstrate the performance of three phase diode bridge rectifier with filter.
5. To analyse the performance of full wave converter.
6. To verify the performance of A.C. phase control.
7. To analyse the performance of buck, boost chopper.
8. To verify the performance of single phase inverter.
9. To demonstrate the performance of H- bridge inverter.
10. To demonstrate the performance of three-phase inverter.

Suggested Readings:

1. Arora, O. P., and Arora, O. P. *Power Electronics Laboratory: Theory, Practice And Organization*. Alpha Science International, Limited, 2007.

Note:

1. At least 10 experiments are to be performed by students in the semester.
2. At least 8 experiments should be performed from the above list; remaining two experiments may either be performed from the above list or designed and set by the Dept. as per the scope of the syllabus.

CONTROL SYSTEMS

Course Code: BT EE 503A **SEMESTER-V**

L	T	P	Credits
3	1	-	4

Course Level Learning Outcomes:

At the end of this course, students will demonstrate the ability to

1. Characterize a Control system and find its steady state behaviour.
2. Investigate stability of an analog control system using different tests.
3. Design various controllers.
4. Solve various control problems.

UNIT-I

INTRODUCTION TO CONTROL PROBLEM: Industrial Control examples. System / Plant model, types of models, illustrative examples of plants & their inputs and outputs, controller, servomechanism, regulating system, linear time invariant (LTI) system, time-varying system, causal system, open loop & closed loop control system & their illustrative examples, continuous time and sampled data control systems. Effects of feedback on sensitivity (to parameter variations), stability, external disturbance (noise), overall gain, etc. Introductory remarks about non-linear control systems.

MATHEMATICAL MODELLING: Concept of transfer function, relationship between transfer function and impulse response, order of a system, block diagram algebra, signal flow graphs: Mason's gain formula & its application, characteristic equation, derivation of transfer functions of electrical and electromechanical systems. Transfer functions of cascaded and non-loading cascaded elements.

UNIT-II

STATE VARIABLE ANALYSIS: Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, state transition matrix, solution of state equations, concept of controllability & observability.

TIME DOMAIN ANALYSIS: Typical test signals, time response of first order systems to various standard inputs, time response of 2nd order system to step input, relationship between location of roots of characteristics equation and stability, time domain specifications of a general and an under- damped 2^{nd} order system, steady state error and error constants, dominant closed loop poles, concept of stability, pole-zero configuration and stability, necessary and sufficient conditions for stability, Hurwitz stability criterion, Routh stability criterion and relative stability.

UNIT-III

ROOT LOCUS TECHNIQUE: Root locus concept, development of root loci for various systems, stability considerations.

FREQUENCY DOMAIN ANALYSIS: Relationship between frequency response and time-response for 2nd order system, polar, Nyquist, Bode plots, stability, Gain-margin and Phase Margin, relative stability, frequency response specifications.

UNIT-IV

COMPENSATION: Necessity of compensation, compensation networks, application of lag and lead compensation, basic modes of feedback control, proportional (P), integral (I), derivative(D), PI and PID controllers, Tuning of analog PID controllers through Ziegler-Nichols tuning methods (Process reaction curve and Ultimate Gain & Period methods)

CONTROL COMPONENTS & THEIR MODELS: Synchros, dc and ac servomotors, stepper motors, magnetic amplifier, potentiometers, LVDT and techo generators.

Suggested Readings:

1. Dorf, Richard C., and Robert H. Bishop. *Modern Control Engineering*. Pearson Prentice-Hall, 2011.
2. Gopal, Madan. *Control systems: principles and design*. Tata McGraw-Hill Education, 2002.
3. Hussain, A., and Haroon, A. *Control Systems*. Dhanpat Rai Publishers, 2014.
4. Katsuhiko, Ogata. *Modern control engineering*. Pearson, 2010.
5. Kuo, Benjamin C. *Automatic control systems*. Prentice Hall PTR, 2014.
6. Nagrath, I. J., and Madan Gopal. *Textbook of control systems engineering* . New Age International, 2009.
7. Ogata, Katsuhiko, and Yanjuan Yang. *Modern control engineering*. Vol. 5. India: Prentice hall, 2010.
8. Sukhla, R. C. *Control Systems.* Dhanpat Rai Publishers, 2011.

CONTROL SYSTEMS LABORATORY

Course Code: BT EE 504A **SEMESTER-V**

L	T	P	Credits
-	-	2	1

Course Level Learning Outcomes:

At the end of this Laboratory course, students will be able to have hands on experience of:

1. Using & verifying characteristics of various Control System components.
2. Analyzing the performance of servo motors driven control systems ;
3. Using Lead, lag, lead-lag compensators.
4. designing PID controllers for given Control System.
5. using MATLAB for control system design.

LIST OF EXPERIMENTS:

1. To demonstrate A.C. servo motor and to plot its torque-speed characteristics.
2. To analyse D.C. servo motor and to plot its torque speed characteristics.
3. To realize the magnetic amplifier and to plot its load current v/s control current characteristics for: (a) series connected mode (b) parallel connected mode.
4. To plot the load current v/ s control current characteristics for self-exited mode of the magnetic amplifier.
5. To demonstrate the synchro & to: (a) Use the synchro pair (synchro transmitter & control transformer) as an error detector. (b) Plot stator voltage v/ s rotor angle for synchro transmitter i.e. to use the synchro transmitter as position transducer.
6. To interpret the synchro pair (synchro transmitter & synchro motor) as a torque transmitter.
7. (a) To demonstrate simple motor-driven closed-loop position control system. (b) To study and demonstrate simple closed-loop speed control system.
8. To analyse the lead, lag, lead-lag compensators and to draw their magnitude and phase plots.
9. To demonstrate a stepper motor & to execute microprocessor or computer-based control of the same by changing number of steps, direction of rotation & speed.
10. To implement a PID controller for level control of a pilot plant.
11. To implement a PID controller for temperature control of a pilot plant.
12. To study the MATLAB package for simulation of control system design.

Note:

1. At least 10 experiments are to be performed by students in the semester.
2. At least 8 experiments should be performed from the above list; remaining two experiments may either be performed from the above list or designed and set by the Dept. as per the scope of the syllabus

ELECTROMAGNETIC FIELDS

Course Code: BT EE 505A **SEMESTER-V**

L	T	P	Credits
3	1	-	4

Course Level Learning Outcomes:

At the end of this course, students will demonstrate the ability to

1. To understand the basic laws of electromagnetism.
2. To obtain electric and magnetic fields for simple configurations under static conditions.
3. To analyse time varying electric and magnetic fields.
4. To understand Maxwell's equation in different forms and different media.
5. To understand the propagation of EM waves.

Unit-I

Review of Vector Calculus: Vector algebra-addition, subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus differentiation, partial differentiation, integration, vector operator del, gradient, divergence and curl; integral theorems of vectors, Conversion of a vector from one coordinate system to another.

Static Electric Field: Coulomb's law, Electric field intensity, Electrical field due to point charges, Line, Surface and Volume charge distributions, Gauss law and its applications, Absolute Electric potential, Potential difference, Calculation of potential differences for different configurations, Electric dipole, Electrostatic Energy and Energy density.

Unit-II

Conductors, Dielectrics and Capacitance: Current and current density, Ohms Law in Point form, Continuity of current, Boundary conditions of perfect dielectric materials. Permittivity of dielectric materials, Capacitance, Capacitance of a two wire line, Poisson's equation, Laplace's equation, Solution of Laplace and Poisson's equation, Application of Laplace's and Poisson's equations.

Static Magnetic Fields: Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current carrying conductors.

Unit-III

Magnetic Forces, Materials and Inductance: Force on a moving charge, Force on a differential current element, Force between differential current elements, Nature of magnetic materials, Magnetization and permeability, Magnetic boundary conditions, Magnetic circuits, inductances and mutual inductances.

Time Varying Fields and Maxwell's Equations: Faraday's law for Electromagnetic induction, Displacement current, Point form of Maxwell's equation, Integral form of Maxwell's equations, Motional Electromotive forces, Boundary Conditions.

Unit-IV

Electromagnetic Waves: Derivation of Wave Equation, Uniform Plane Waves, Maxwell's equation in Phasor form, Wave equation in Phasor form, Plane waves in free space and in a homogenous material. Wave equation for a conducting medium, Plane waves in lossy dielectrics, Propagation in good conductors, Skin effect, Poynting theorem.

Suggested Readings:

1. Carter, Geoffrey William. *The electromagnetic field in Its Engineering Aspects*, London, Longmans Pub., 1967.
2. Duffin, William John. *Advanced electricity and magnetism for undergraduates*. McGraw-Hill, 1968.
3. - - -. *Electricity and magnetism*. McGraw-Hill, 1980.
4. Pramanik, Ashutosh. *Electromagnetism: Problems with Solutions*. PHI Learning Pvt. Ltd., 2012.
5. - - -. *Electromagnetism: Theory and Applications*. PHI Learning Pvt. Ltd., 2008.
6. Sadiku, Matthew NO. *Elements of electromagnetics*. Oxford university press, 2018.

ECONOMICS FOR ENGINEERS

Course Code: BT EE 506A **SEMESTER-V**

L	T	P	Credits
3	0	-	3

Course Level Learning Outcomes:

After going through this course, the students shall be able to:

1. Understand the principles of economics that govern the operation of any organization.
2. Understand Comprehend macroeconomic principles and decision making in business set up.
3. Understand the Inflation & Price Change as well as Present Worth Analysis.
4. Apply the principles of economics through various case studies.

Unit I

Economic Decisions Making: Overview, Problems, Role, Decision making process. **Engineering Costs & Estimation**: Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models - Per-Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits. Case Study - Price and Income Elasticity of Demand in the real world

Unit II

Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value of Money, Debt repayment, Nominal & Effective Interest.

Unit III

Cash Flow & Rate Of Return Analysis: Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks. Case Study

Unit IV

Inflation And Price Change: Definition, Effects, Causes, Price Change with Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.

Present Worth Analysis: End-Of-Year Convention, Viewpoint Of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives.

Suggested Readings:

1. Brown, Thane. *Engineering economics and economic design for process engineers*. CRC Press, 2016.
2. Lindeburg, Michael R. *Engineering Economic Analysis: An Introduction*. Professional Publications Incorporated, 1993.
3. Newnan, Donald G., Ted Eschenbach, and Jerome P. Lavelle. *Engineering economic analysis*. Vol. 2. Oxford University Press, 2004.
4. Panneerselvam, R. *Engineering economics*. PHI Learning Pvt. Ltd., 2013.
5. Riggs, J. L., Bedworth, D. D. and Randhawa, S. U. *Economics for Engineers.* 4th edi. Tata McGraw-Hill, 2004.
6. Sullivan, William G., Elin M. Wicks, and C. Patrick Koelling. *Engineering economy*. Pearson Higher Ed, 2014.
7. White, John A., Marvin H. Agee, and Kenneth E. Case. *Principles of engineering economic analysis*. Wiley, 1989.

INTERNSHIP PRESENTATION

Course Code: BT EE 507A **SEMESTER-V**

L	T	P	Credits
0	0	4	2

Course Level Learning Outcomes:

After going through this course, the students shall be able to:

1. Will expose Technical students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals for the industry.
2. Provide possible opportunities to learn, understand and sharpen the real time technical / managerial skills required at the job.
3. Exposure to the current technological developments relevant to the subject area of training.
4. Experience gained from the 'Industrial Internship' in classroom will be used in classroom discussions.
5. Create conditions conducive to quest for knowledge and its applicability on the job.

During the summer vacation after 4th semester, students are ready for industrial experience. Therefore, they may choose to undergo 4 week Internship / Innovation / Entrepreneurship related activities. Students may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/ NGO's/ Government organizations/ Micro/ Small/ Medium enterprises to make themselves ready for the industry. In case student want to pursue their family business and don't want to undergo internship, a declaration by a parent may be submitted directly to the TPO.

AICTE has taken various initiatives to connect AICTE approved institutions located in a particular district with nearby villages for technological intervention and networking for holistic transformation of the rural population by identifying the possibilities of localized employment, convergence, cost reduction, Youth and Women empowerment etc. Keeping this in view, Rural/ Social Internship Programme has been proposed. It is proposed that if a student chooses any of the suggestive activity under AICTE Activity Programme, devotes 6 months (required Internship duration) and achieve significant goals, during his degree programme, his credit requirement for the internship will be considered fulfilled.

Every student is required to prepare a file containing documentary proofs of the activities done by him. The evaluation of these activities will be done by Programmed Head/Cell In-charge/ Project Head/ TPO/ faculty mentor or Industry Supervisor.

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

- Quality of content presented.
- Proper planning for presentation.
- Effectiveness of presentation.
- Depth of knowledge and skills.
- Attendance record, daily diary, departmental reports shall also be analyzed along with the Internship Report.

Seminar presentation will enable sharing knowledge & experience amongst students & teachers and build communication skills and confidence in students.

ADVANCED NETWORK ANALYSIS

Course Code: BT EE 521A **SEMESTER-V**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, students will demonstrate the ability to

1. Apply network topology and duality for the analysis of electrical circuits.
2. To evaluate Network function of given Electrical circuits.
3. To understand the synthesis of various network functions.
4. To analyze and Design the circuit models using Laplace transform.

UNIT-I

Network Functions: Network functions for single port and two port, calculation of network functions for ladder and general networks, poles and zeros, restriction of poles and zeros for driving point and transfer functions, time domain behaviour from pole zero plot, transfer functions in terms of y and z functions, scaling network functions. Positive real functions and other properties, Hurwitz polynomials, computation of residues, even and odd functions, test for positive real functions.

UNIT-II

Network Synthesis: Elementary synthesis operation, LC network synthesis, properties of RC network functions, foster and cauer forms of RC and RL networks. RLC networks: minimum positive real function, brune's method of RLC synthesis, realization difficulties.

UNIT-III

Network Topology: Network terminology – Graph of a network – Incidence and reduced incidence matrices – Trees –Cutsets – Fundamental cutsets – Cutset matrix – Tie sets – Link currents and Tie set schedules -Twig voltages and Cutset schedules, Duality and dual networks.

UNIT-IV

Application of Laplace Transform to Circuit Analysis: Laplace Circuit Solutions, Circuit Element Models, Analysis Techniques, Transfer Function, Application Example, Design Examples, Variable-Frequency Network Performance, Resonant Circuits Filter Networks (Passive and Active).

Suggested Readings:

1. Alexander, Charles K. *Fundamentals of Electric Circuits*. Tata McGraw-Hill, 2009.
2. DeCarlo, Raymond A., and Pen-Min, L. *Linear Circuit Analysis: Time Domain, Phasor, and Laplace Transform Approaches*. Prentice-Hall, Inc., 2nd edition, 2003.
3. Hayt Jr, William H., Jack E. Kemmerly, and Steven M. Durbin. *Engineering Circuit Analysis (Eigth Edition)*. McGraw Hill Education, 2013.
4. Kuo, Franklin. *Network analysis and synthesis*. John Wiley & Sons, 2006.
5. Valkenburg V., and Mac E. *Introduction to Modern Network Synthesis*, Wiley, 1965.
6. Van Valkenburg, Mac E. *Network Analysis.* 3rd ed., Pearson India, 2015.

ELECTRICAL MACHINE DESIGN

Course Code: BT EE 522A **SEMESTER-V**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, the students will be able 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 principles of machine design and carry out a basic design of an AC machine.
4. Use software tools to do design calculations.

UNIT-I

Introduction of electrical machine design: Introduction Major Considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

Transformers: Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

UNIT-II

Induction Motors: Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly- phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

UNIT-III

Synchronous Machines: Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

UNIT-IV

Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to complex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Suggested Readings:

1. Murthy, Vishnu, K. M. *Computer-Aided Design of Electrical Machines*. Hyderabad, India: BS Publications, 2008.
2. Narang, K. L. *A Text Book of Electrical Engineering Drawings.* Satya Prakashan, 1969.
3. Sawhney A. K., and Chakrabarti. A. *Course in Electrical Machine Design*. Dhanpat Rai Pub. 2010.
4. Sawhney, A. K. *A Course in Electrical Machine Design*, Dhanpat Rai Pub. 1999.
5. Say, M. G. *Performance and Design of AC Machines*. English LBS., 1995.
6. Sen, S. K. *Principles of Electrical Machine Design with Computer Programs.* 2nd ed., Oxford and IBH Publishing, 2006.
7. Shanmugasundaram, A. *Electrical Machine Design Data Book*. New Age International, 1979.

INDUSTRIAL ELECTRICAL SYSTEMS

Course Code: BT EE 523A **SEMESTER-V**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, 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.
4. Understand the illumination systems and schemes for residential and commercial consumers.

UNIT-I

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

UNIT-II

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.

UNIT-III

Industrial Electrical Systems: HT connection, Industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Power factor correction – KVAR calculations, type of compensation, Introduction to PCC, MCC panels, Specifications of LT Breakers, MCB and other LT panel components, UPS System, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

UNIT-IV

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.

Suggested Readings:

1. Joshi, H. *Residential Commercial and Industrial Systems*. Tata McGraw-Hill Education, 2008.
2. *National Electrical Codes*. Bureau of Indian Standards, 2011.
3. Raina, K. B. *Electrical Design Estimating and Costing*. New Age International, 2007.
4. Singh, S., and Singh, R. D. *Electrical Estimating and Costing.* Dhanpat Rai and Co., 1997.
5. Uppal, S. L., and Laroia, J. M. *Electrical Wiring, Estimating and Costing*. Khanna Publishers, 2008.

COMPUTER ARCHITECTURE

Course Code: BT EE 524A **SEMESTER-V**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

After going through this course, students will be able to:

1. Understand hierarchy of memory units and their application.
2. Know about the process of pipelined execution and instruction scheduling.
3. Interface different types of I/O and memory units with the main system.
4. Program different microprocessors using their particular instruction sets.
5. Identify functional units, bus structure and addressing modes of different processors.

UNIT - I

Basic Concepts and Computer Evolution: Organization and Architecture, Structure and Function, A brief history of Computers, Evolution of Intel x86 Architecture, Embedded Systems, ARM Architecture, Cloud Computing, Designing for performance, Ahmdahl's Law, Little's Law, Basic Measures of Computer Performance, Calculating the Mean, Benchmarks and Spec.

Computer Arithmetic: The Arithmetic and Logic Unit, Integer Representation, Integer Arithmetic, Floating-point Representation, Floating-point Arithmetic; Control Unit Operation: Micro-operations, control of the processor, hardwired implementation, Microprogrammed Control, Microinstruction Sequencing and Execution.

UNIT – II

Memory Organization: Cache Memory: computer memory system overview, cache memory principles, elements of cache design, Pentium 4 cache organization, Internal Memory: Semiconductor main memory, error correction, DDR DRAM, flash memory, newer non-volatile solid-state memory technologies, External Memory: magnetic disk, RAID 204, solid state drives, optical memory, magnetic tape.

Input-output Organization: External Devices, I/O Modules, Programmed I/O, Interrupt-Driven I/O, Direct Memory Access, Direct Cache Access, I/O Channels and Processors, External Interconnection Standards.

UNIT – III

Central Processing Unit: Machine Instruction Characteristics, Types of Operands, Intel x86 and ARM Data Types, Types of Operations, Intel x86 and ARM Operation Types, Addressing Modes, x86 and ARM Addressing Modes, Instruction Formats, x86 and ARM Instruction Formats, Assembly Language, Processor Organization, Register Organization, Instruction Cycle, Instruction Pipelining, The x86 processor family, ARM Processor, Reduced Instruction Set Architecture, RISC Pipelining 555, RISC vs CISC.

UNIT – IV

Pipelining: Basic Concepts, Data Hazards, Instruction Hazards, Influence on Instruction Sets, Datapath and Control Considerations, Superscalar Operations, Performance Considerations: Effect of Instruction Hazards, Number of Pipeline Stages.

Alternate Machine Architectures: Register Machine, Register Implicit Machine, Accumulator Machine, Stack Machine.

Suggested Readings:

1. Barry, Peter, and Crowley, P. *Modern Embedded Computing: Designing Connected, Pervasive, Media-Rich Systems*. Elsevier, 2012
2. Brey, B., and Sarma, C. R. *The Intel microprocessors*. Pearson Education, 2000.
3. Govindarajalu, B. *IBM PC and Clones*. Tata McGraw-Hill, 1991.
4. Hamacher, C., Zvonko V., and Safwat, Z. *Computer Organization*. McGraw-Hill, 5th Edition 2002.
5. Hamacher, V. Carl. *Computer organization and embedded systems.* New York, NY: McGraw-Hill, 2012.
6. Hennessy, John L., and Patterson, D. A. *Computer Architecture: A Quantitative Approach*. Elsevier, 2017.
7. Lieu Y. C., and Gibson, G. A. *Microcomputer Systems: The 8086/8088 Family*. Prentice-Hall, 1986.
8. Mathivanan, N. *Microprocessors, PC Hardware and Interfacing*. Prentice-Hall, 2004.
9. Stallings, W. *Computer Organization and Architecture: Designing for Performance*, 10 th ed., PHI, 2016.
10. Uffenbeck, J. *The 8086/8088 Design, Programming, Interfacing*. Prentice Hall, 1987.

ELECTRICAL ENGINEERING MATERIALS

Course Code: BT EE 531A **SEMESTER-V**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, the students will be able to:

1. Make students familiar with different types of Electrical Engineering materials
2. Understand the properties of electrical conducting, semi-conducting, insulating, magnetic and special purpose materials.
3. Select suitable materials for diff. applications of Electrical Engineering.
4. Use materials for energy saving but with environmental concerns.

UNIT- I

CONDUCTORS: Free electron theory of metals, factors affecting electric conductivity of metals, thermal conductivity of metals, heat developed in current Carrying conductors, thermoelectric effect, super conductivity. Properties of electrical conductivity.

CONDUCTING MATERIALS: High conductive materials-copper, Aluminium, Tungsten, Nickel, Brass, Bronze and other alloys; contact materials-Murcurry, other alloys; High resistivity materials-carbon, graphite, Nichrome; Fuses.

UNIT-II

DIELECTRICS: Dielectric properties of insulators in static fields. The static dielecric constant. Polarization and dielectric constant. Dielectric constant of monatomic gases and polyatomic molecules. Internal fields in solids and liquids. Ferroelectric materials, spontaneous polarization, piezoelectricity.

INSULATING MATERIALS: Gaseous Materials-Oxide gases, electronegative gases, hydrocarbon gases; Liquid materials-mineral oils, silicon liquids, hydrocarbon liquids; Solid Materials-Paper & boards, Resins, Rubbers-natural & synthetic, glass, ceramics, asbestos.

UNIT- III

MAGNETIC PROPERTIES OF MATERIALS: Magnetic dipole moment of current loop. Magnetisation from a macroscopic viewpoint. Orbital magnetic dipole moment and angular momentum of two simple atomic models. Lenz's law and induced dipole moments. Classification of magnetic materials. Diamagnetism. Origin of permanent magnetic dipole moments. Paramagnetism, ferromagnetic domains, magnetic anisotro. Magnetostriction, anti-ferromagnetism, ferromagnetism, magnetic materials for electrical devices.

UNIT-IV

SEMICONDUCTORS & THEIR PROPERTIES: Introductions to semiconductor materials, classifications of element semiconductors, Growth of semiconductor materials methods, conductivity of semiconductor.

PROPERTIES: Electron-hole concentration, Fermi level, Generation and recombination, carrier life-time, diffusion length. Scattering and mobility of carriers. Einstein relation. LASER.

Suggested Readings:

1. Dekker, Adrianus J. *Electrical Engineering Materials*. Prentice-Hall of India, 1959.
2. Gupta, J. B. *Electrical Engineering Materials & Semiconductor Devices.* Katson Pub. 2009.
3. Seth, S. P., and Gupta, P. V. *Electrical Engineering Materials*. Dhanpat Rai Pub, 2011.
4. Shukla, R. K., and Singh, A. *Electrical Engineering Materials*. Tata McGraw-Hill, 1993.
5. Streetman, Ben G., and Sanjay Banerjee. *Solid State Electronic Devices*. Prentice-Hall of India, 2001.

POWER PLANT ENGINEERING

Course Code: BT EE 532A **SEMESTER-V**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, the students will be able to:

1 To provide an overview of power plants and the associated energy conversion issues.
2 To introduce students to different aspects of power plant engineering.
3 To familiarize the students to the working of power plants based on different fuels.
4 To expose the students to the principles of environmental issues.

UNIT- I

Introduction: Conventional & Non-Conventional Sources of Energy, their availability in India, Types of Power Plants, Choice of Type of Power Generation, Power Plants in India.

Hydro Power Plants: Hydrology – Hydrographs, Flow Duration Curve, Mass Curve; Principle of working, Classification, Site selection; Different components & their functions; Types of Dams; Types, Characteristics & Selection of Hydro-Turbines; Specific Speed of Hydro-Turbines; Power Output Equation; General arrangement and Operation of Hydroelectric Power Plant, Mini & Micro Hydro Power Plants, Pumped Storage Power Plants; Advantages of Hydroelectric Power Plants; Hydro Power in India & future trends.

UNIT- II

Nuclear Power Plants: Principle of Nuclear Energy, Nuclear Power Plant Components & their Functions; Nuclear Fuels, Radioactivity, Nuclear Reaction & Classification; Nuclear Reactors – Types & Classification, Main Parts; Problems in Reactor Operation; Radiation Hazards; Safety Measures; Nuclear Waste & its Disposal; Nuclear Power in India.

UNIT- III

Gas Power Plants: Operating Principle; Classification – Open Cycle, Closed Cycle, Combined Cycle; Fuels for Gas Turbine Power Plants; Different Components and their functions; Gas Turbine Characteristics, Cycle Efficiency, Operational Aspects, Advantages and Limitations.

Diesel Power Plants: Working principle, Types of Diesel Engines, Different parts / systems and their functions, Performance of Diesel Engine, Plant Operation and Efficiency, Advantages and Disadvantages.

UNIT- IV

Thermal Power Plants: Operating Principle, Site selection, Coal to Electricity, General Layout of Thermal Power Plant, Brief description of different parts/systems and their functions, Advantages and Limitations.

Co-Generation: Concept; Schemes; Brief Description;

Non-Conventional Energy Sources: Types, Brief Description, Advantages & Limitations.

Suggested Readings:

1. El-Wakil, M. M. *Power Plant Technology*. Tata McGraw-Hill, 2010.
2. Elliot T.C., Chen K and Swanekamp R.C., *Power Plant Engineering*. 2nd ed., Tata McGraw-Hill,1998.
3. Kothari, D. P., and I. J. Nagrath. *Power System Engineering*. Tata McGraw-Hill, 2008.
4. Nag, P. K. *Power Plant Engineering*. 3rd ed., Tata McGraw-Hill, 2008.
5. Rai G. D. *Power Plant Engg.* Khanna Publications, 1988.
6. Soni, M. L., Gupta, P. V., and Bhatnagar, U. S. *A Course in Electric Power System*. Dhanpat Rai Pub., 1987.
7. Uppal, S. L. *Electric Power.* Khanna Publications, 1998.

ENERGY MANAGEMENT

Course Code: BT EE 533A **SEMESTER-V**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the importance of energy monitoring and targeting.
2. Understand concepts of financial management techniques and investment appraisal criteria.
3. Understand the principles of project planning relevant to energy management.
4. Understand the key elements for successful energy management.

UNIT-I

Energy Action Planning: Energy Policy, key elements, formulation, ratification, organizing –location of energy management, top energy management commitment and support, roles and responsibilities of energy manager, requirement for energy action planning, evaluating energy performance, management tools for effective energy implementation.

UNIT-II

Financial Management: Introduction, need for investment, appraisal and criteria, financial analysis techniques for energy management-simple payback period, return on investment, net present value, internal rate of return, cash flow, sensitivity and risk analysis, financing options, energy performance contracting and role of ESCOs developing a typical ESCO contract, A case study for energy efficiency in buildings through ESCO.

UNIT-III

Project Management: Definition and scope of project, project development cycle-technical design, financing, contracting, implementation and performance monitoring, project planning techniques, implementation plan for energy management, planning budget, procurement procedures, construction, measurement and verification.

UNIT-IV

Energy Monitoring and Targeting: Definition of energy monitoring and targeting, setting up monitoring and targeting, key elements of energy monitoring and targeting system, data and information analysis, techniques related to energy consumption and production, energy management information system (EMIS).

Suggested Readings:

1. Goldthau, Andreas, ed. *The handbook of global energy policy*. John Wiley & Sons, 2016.
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
3. Smith, Craig B., and Kelly E. Parmenter. *Energy, management, principles: Applications, benefits, savings*. Elsevier, 2013.
4. *Success stories of Energy Conservation*. BEE, New Delhi (www.bee-india.org)
5. Tripathy, S. C. *Electric energy utilization and conservation*. Tata McGraw-Hill, 1991.
6. Turner, Wayne C., and Steve Doty. *Energy management handbook*. The Fairmont Press, Inc., 2007.

PROCESS CONTROL AND INSTRUMENTATION

Course Code: BT EE 534A **SEMESTER-V**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

After going through this course, students will be able to:

1. Apply various measurement techniques in process control applications.
2. Know about characteristics of different sensors and transducers.
3. Model the behaviour of different physical processes.
4. Check the stability of systems and design the controllers accordingly.
5. Judge the best possible sensors for particular process control applications.

UNIT - I

Introduction to Sensor-based Measurement Systems: General concepts and terminology, Sensor classification, General input-output configuration, Static characteristics of measurement systems: accuracy, precision, sensitivity, linearity, resolution, systematic errors and random errors, Dynamic characteristics: zero-order, first-order and second-order measurement systems, Other sensor characteristics: input characteristics and reliability.

UNIT – II

Measurement of Parameters in Process Industries: Process control, Elements in control loop, Process facility considerations, Pressure measurement: basic concept, measuring instruments and application considerations, Level measurement: basic concept, level sensing devices and application considerations, Flow measurement: basic concept, flow measurement instruments and application considerations, Temperature and Heat measurement: basic concept, temperature measuring devices and application considerations, Measurement of humidity, density, viscosity and pH, Measurement of position, motion and force.

UNIT – III

Process Control Modelling: Introduction, Process model, Physical model, Control model, process modelling: uses and types of process models, Differential equations, Difference equations, Laplace transform, Transfer function representations, Frequency-domain modelling, Time-domain modelling: state variables representation, state differential equation, state variables and state equations for a chemical process, z-transform, inverse z-transform, Modelling procedure.

Linear Open-Loop Systems: Response of First-order systems, Physical examples of first order systems, Response of first-order systems in series, Second-order systems, Transportation Lag.

UNIT – IV

Response Analysis of Control System and Stability: Introduction, Stability analysis: General conditions for stability, Stability criterion, Routh-Hurwitz stability criterion, Performance specifications, Root-locus method, stability in the z-plane, Frequency response of first order system, Nyquist plots, Bode diagram.

Process Control: Introduction, Basic terms, Control modes: ON/OFF action, Differential action, Proportional action, Derivative action, Integral action, PID action, Implementation of control loops: ON/OFF action pneumatic controller, ON/OFF action electrical controller, PID action pneumatic controller, PID action control circuits, PID electronic controller, Digital controllers.

Suggested Readings:

1. Dunn, W. C. *Fundamentals of Industrial Instrumentation and Process Control*, 2nd ed., Tata McGraw Hill, 2018.
2. Eckman, D. P. *Industrial Instrumentation*. CBS Publishers & Distributors, 2006.
3. LeBlanc, S. E., and Coughanowr, D. R. *Process Systems Analysis and Control*. Tata McGraw Hill, 2013.
4. Morris, A. S. *Measurement and Instrumentation Principles*. Butterworth-Heinemann, 2001.
5. Padmanabhan, T. R. *Industrial Instrumentation: Principles and Design*. Springer Science & Business Media, 2012.
6. Pallas-Areny, R., and Webster, J. G. *Sensors and signal conditioning*. John Wiley & Sons, 2012.
7. Patranabis, D. *Principles of Industrial Instrumentation*. 2nd ed., Tata McGraw Hill, 2007.
8. Singh, S. K. *Process Control: Concepts, Dynamics and Application*. PHI Learning Pvt. Ltd., 2009.
9. Stephanoupoulis, G. *Chemical Process Control: An Introduction to Theory and Practice.* Prentice-Hall, 1984.

POWER SYSTEM -II

Course Code: BT EE 601A **SEMESTER-VI**

L	T	P	Credits
3	1	-	4

Course Level Learning Outcomes:

At the end of this course, students will demonstrate the ability to

1. Use numerical methods to analyse a power system in steady state.
2. Understand methods to control the voltage, frequency and power flow.
3. Understand the monitoring and control of a power system.
4. Understand the basics of power system economics.

UNIT-I

POWER FLOW ANALYSIS: Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of nonlinear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.

UNIT-II

LOAD FREQUENCY CONTROL: Control of Frequency and Voltage: Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control.

UNIT-III

MONITORING POWER SYSTEM AND EXCITATION CONTROL: Overview of Energy Control Centre Functions: SCADA systems and its components, protocol. Phasor Measurement Units. and Wide-Area Measurement Systems. Normal, Alert, Emergency, Extremis states of a Power System.

Excitation System Control in synchronous generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers. Three phase Induction regulators, Voltage Stability, Voltage Collapse.

UNIT-IV

BASIC PRICING PRINCIPLES: Generator Cost Curves, Vertically Integrated Utility and restructured Power System, Role of Different entities in restructured market. Market clearing price, Single sided and double sided linear bid market. Transmission and Distributions charges.

Suggested Readings:

1. Bergen A. R. and Vittal V. *Power System Analysis.* Pearson Education Inc., 1999.
2. Elgerd O. I. *Electric Energy Systems Theory.* Tata McGraw-Hill Edition, 1995.
3. Grainger J. & Stevenson W. D. *Power System Analysis.* Tata McGraw-Hill Edition, 1994.
4. Gupta S. K. *Power System Operation Control and Restructuring Analysis.* IK International Publication, 2015.
5. Hadi Saadat. *Power System Analysis.* Tata McGraw-Hill Edition 2002.
6. Singh, Lakneshwar P. *Advanced Power System Analysis and Dynamics*. New Age International, 2006.
7. Stevenson, William D. *Elements of power System Analysis.* Tata McGraw-Hill, 1955.
8. Weedy B. M., Cory B. J., Jenkins N., Ekanayake J. and Strbac G. *Electric Power Systems.* Wiley, 2012.
9. Wood, Allen J., Bruce F. Wollenberg, and Gerald B. Sheblé. *Power Generation, Operation, and Control*. John Wiley & Sons, 2013.

POWER SYSTEM LABORATORY II

Course Code: BT EE 602A **SEMESTER-VI**

L	T	P	Credits
-	-	2	1

LIST OF EXPERIMENTS:

1. (a) To study some of the commands used in MATLAB.
   (b) Compute the voltages of the given network using MATLAB.
2. Draw the flow chart for forming Y-BUS. Write the computer program in MATLAB. Take any solved numerical question from book and from the Y-BUS. Solve it for the voltage and currents injected in the buses. Match the result.
3. Draw the flow chart for power system analysis of Gauss Siedel Method. Write program in MATLAB for performing load flow analysis using Gauss-Siedel method and solve the given problem, solve the problem by hand for one iteration.
4. Write a MATLAB program for the Newton Raphson Method to find the intersection of the curves.
5. Calculating market clearing price for single sided bidding & obtain share of participating Gencos (Generating Companies).
6. Obtain power solution of the given problem using Fast Decoupled Newton Raphson method then write program for FDNR method using MATLAB and solve this numerical problem.
7. To obtain dynamic response of single area load frequency control using Integral Controller.
8. To develop the Boost Buck Exciter System steady state model & steady state model of IEEE Type-1 Excitation system with compensator Block & PID controller and compare their responses.
9. Stability analysis using equal area criteria & solve the given problem & verify the results of practical & theory.
10. Study basic instructions of PSAT software
11. Study basic instructions of POWERWORLD software
12. Study basic instructions of PSCAD software.

Note: Ten experiments are to be performed, out of which at least eight experiments should be performed from above list. Remaining three experiments may either be performed from above list or designed & set up by the department as per the scope of the syllabus.

MICROPROCESSOR & MICROCONTROLLER

Course Code: BT EE 603A **SEMESTER-VI**

L	T	P	Credits
3	1	-	4

Course Level Learning Outcomes:

Upon successful completion of the course, the students will be able

1. To be acquainted with the basic architecture of 8086 microprocessor and 8051 microcontroller.
2. To develop assembly language programming for variety of problems
3. To interface the peripherals like I/O, A/D, D/A, timer etc. with the microprocessors and microcontrollers
4. To develop and design various systems using different microcontrollers.
5. To develop an in-depth understanding of the operation of microprocessor and microcontrollers, machine language programming and interfacing techniques

UNIT-I

Introduction to 8086 microprocessor, RISC and SISC processors, architecture and pin diagram of 8086 and description of various signals. Register organization of 8086; Description of address computations & memory segmentation; Segment override, Instruction pipelining, Timing diagrams, Addressing modes.

UNIT-II

Instruction set of 8086, Instruction execution timing, Instruction format, Data transfer instructions, Arithmetic instructions, Branch instructions, Loop instructions, NOP & HLT instructions, Flag manipulation instructions, Logical instructions, Shift & Rotate instructions, Directives & operators, Interrupts of 8086, Assembly language Programs using 8086.

UNIT-III

The concept of microcontroller, comparison between Microcontrollers & Microprocessors. Architecture and Pin diagram of 8051 microcontroller, Memory organization. Special function registers. External memory, Reset operation. Instruction Set, Addressing modes, arithmetic, Logical. Data transfer. Boolean variable manipulation, program branching instructions etc. Programs based on various instructions. Timer operation, Timer Mode register, Timer Control register. Timer modes & overflow flag, Starting, Stopping & controlling the timers. Programs for generating square waves of various frequencies

UNIT-IV

Serial port operation, UART, Serial port control register, Modes of serial port operation. Serial port baud rate, Initialization & programming of serial port. Interrupts of 8051, SFRs related to interrupts, processing interrupts, program design using interrupts. Interfacing with LED, DC motors, stepper motors.

Suggested Readings:

1. Ayala K. J. *8051 Microcontroller.* Delmar Cengage Learning, 2004.
2. Hall D. V. *Microprocessors & Interfacing.* Tata McGraw Hill, 1991.
3. Mazidi M. A., Mazidi J. G. and McKinlay R. D. *The 8051 Microcontroller and Embedded Systems: Using Assembly and C.* Pearson Education, 2007.
4. Ram, Badri. *Adv Microprocessors Interfacing*. Tata McGraw-Hill, 2001.
5. Ray, Ajoy Kumar, and Kishor M. Bhurchandi. *Advanced Microprocessors and Peripherals*. Tata McGraw-Hill, 2006.

MICROPROCESSOR & MICROCONTROLLER LABORATORY

Course Code: BT EE 604A **SEMESTER-VI**

L	T	P	Credits
-	-	2	1

Course Level Learning Outcomes: On completion of this lab course the students will be able to: a. Understand and apply the fundamentals of assembly level programming of microprocessors and microcontroller. b. Work with standard microprocessor real time interfaces including GPIO, serial ports, digital-to-analog converters and analog-to-digital converters; c. Troubleshoot interactions between software and hardware; d. Analyze abstract problems and apply a combination of hardware and software to address the problem; e. Use standard test and measurement equipment to evaluate digital interfaces

LIST OF EXPERIMENTS:

(A) 8086 Microprocessor:

1. Write a well-documented program for copying 12 bytes from source to destination, on 8086 microprocessor kit.
2. Write a program for 8086 for division of a defined double word (stored in a data segment) by another double word and verify.
3. Write a well-documented program for finding the square root of a given number, on 8086, microprocessor kit.
4. Write a program using 8086 for finding the square of a given number and verify.
5. Write a program using 8086 and verify for:
   (i) Finding the largest number from an array and smallest number from array.
6. (i)WAP using 8086 for arranging an array of numbers in descending order and verify.
   (ii)WAP using 8086 for arranging an array of numbers in ascending order and verify.
7. WAP for 8086 for finding square of a number using look-up table and verify.
8. WAP to control the operation of stepper motor using 8086 microprocessor and 8255 chip.
9. WAP using 8086 to add a series of 16-bit numbers.

(B) 8051 Microcontroller:

10. To demonstrate the architecture of 8051 microcontroller.
11. Write a program in 8051 to add and subtract two 8 bit numbers.
12. Write an ALP to generate square wave of 10 kHz frequency using timer of 8051 microcontroller.
13. To find average of Ten 8-bit numbers.
14. Write an ALP to interface LED and switches with 8051 microcontroller.
15. Write a program to find (i) largest number and (ii) smallest number from an array using 8051 microcontroller.
16. Write a program to generate square wave of 50 Hz frequency using timer of 8051 microcontroller.
17. To control the operation of DC motor using 8051 microcontroller.
18. To interface LCD with 8051 microcontroller.
19. To control the operation of stepper motor using 8051 microcontroller

Note:-

1. Total ten experiments are to be performed in the semester.
2. At least eight experiments should be performed from the above list. Remaining three experiments should be performed as designed and set by the concerned institution as per the scope of the syllabus.

ELECTRONICS DESIGN LABORATORY

Course Code: BT EE 605A **SEMESTER-VI**

L	T	P	Credits
-	-	4	2

Course Level Learning Outcomes: At the end of the course, students will demonstrate the ability to

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

Experiments on:

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

Suggested Readings:

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

Note:-

1. Total ten experiments are to be performed in the semester.
2. At least eight experiments should be performed from the above list. Remaining three experiments should be performed as designed and set by the concerned institution as per the scope of the syllabus.

APPLICATIONS OF PSYCHOLOGY IN ENGINEERS LIFE

Course Code: BT EE 606A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

After going through this course, the students shall be able to:

1. Understand the different applications of psychology to everyday issues of life.
2. Understand the different social issues, workplace issues, and behavioural issues.
3. Understand how the knowledge gained from this course can be used in their personal and professional work life.
4. Understand the need of Psychology and Counselling.

Unit I

Introduction: Nature and fields.

Psychology in industries and organizations: Job analysis; fatigue and accidents in industries.

Unit II

Consumer behavior, Psychology and mental health: Abnormality, symptoms and causes psychological disorders.

Unit III

Psychology and Counseling: Need of Counseling, Counselor and the Counselee, Counseling Process, Areas of Counseling.

Unit IV

Psychology and social behavior: Group, group dynamics, teambuilding, Prejudice and stereotypes; Effective Communication, conflict and negotiation.

Suggested Readings:

1. Aronson, E., Wilson, T. D., and Akert, R. M. *Social Psychology.* Harlow: Pearson 2014.
2. Butcher, James N., Mineka, S., and Jill M. Hooley. *Abnormal Psychology.* Pearson Education India, 2017.
3. Gladding, Samuel T., and Batra P. *Counseling: A Comprehensive Profession.* Pearson Education India, 2007.
4. Schultz, Duane, and Sydney Ellen Schultz. *Psychology and Work Today. Pearson New International Edition Course Smart eTextbook*. Routledge, 2015.

ELECTROMAGNETIC WAVES

Course Code: BT EE 621A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, the students will be able to:

1. Analyse transmission lines and estimate voltage and current at any point on transmission line for different load conditions.
2. Provide solution to real life plane wave problems for various boundary conditions.
3. Analyse the field equations for the wave propagation in special cases such as lossy and low loss dielectric media.
4. Visualize TE and TM mode patterns of field distributions in a rectangular wave-guide.
5. Understand and analyse radiation by antennas.

UNIT- I

TRANSMISSION LINES: Introduction, Concept of distributed elements, Equations of voltage and current, Standing waves and impedance transformation, Lossless and low-loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.

UNIT- II

MAXWELL'S EQUATIONS & UNIFORM PLANE WAVE: Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface. Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.

UNIT- III

PLANE WAVES AT MEDIA INTERFACE: Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.

UNIT- IV

WAVEGUIDES & ANTENNAS: Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic(TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, Rectangular waveguides. Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, Near field, Far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.

Suggested Readings:

1. Balanis C. A. *Advanced Engineering Electromagnetics.* John Wiley & Sons, 2012.
2. - - -. *Antenna Theory: Analysis and Design*. John Wiley & Sons, 2005.
3. Cheng D. K. *Field and Wave Electromagnetics*. Addison-Wesley, 1989.
4. Sadiku M. N.O. *Elements of Electromagnetics*. Oxford University Press, 2007.
5. Shevgaonkar R. K. *Electromagnetic Waves*. Tata McGraw Hill, 2005.

WIND AND SOLAR ENERGY SYSTEMS

Course Code: BT EE 622A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

COURSE LEVEL LEARNING OUTCOMES:

At the end of this course, 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.

UNIT-I

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.

Solar thermal power generation: Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis

UNIT-II

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.

UNIT-III

The Solar Resource: Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Solar photovoltaic: Technologies-Amorphous, monocrystalline, 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.

UNIT-IV

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 wind systems.

Suggested Readings:

1. Ackermann T. *Wind Power in Power Systems*. John Wiley and Sons Ltd., 2005.
2. Masters G. M. *Renewable and Efficient Electric Power Systems.* John Wiley and Sons, 2004.
3. Siegfried H. and Waddington R. *Grid Integration of Wind Energy Conversion Systems.* John Wiley and Sons Ltd., 2006.
4. Sukhatme S. P. *Solar Energy: Principles of Thermal Collection and Storage.* Tata McGraw-Hill, 1984.
5. Tiwari G. N. and Ghosal M. K. *Renewable Energy Applications.* Narosa Publications, 2004.

ELECTRICAL ENERGY CONSERVATION AND AUDITING

Course Code: BT EE 623A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the current energy scenario and importance of energy conservation.
2. Understand the concepts of energy audit.
3. Understand the methods of improving energy efficiency in different electrical systems.
4. Understand the concepts of improving energy efficiency in industrial systems.

UNIT-I

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features and the Energy Conservation Amendment Act, 2010, Schemes of BEE under Energy Conservation Act-2001, Electricity Act, 2003, Integrated Energy Policy.

UNIT-II

Energy Audit: Definition and objectives of energy audit, need, types of energy audit, Energy audit approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

UNIT-III

Energy Efficiency in Electrical Systems: Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, Assessment of Transmission and Distribution losses in power systems, estimation of technical losses in distribution system, Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

UNIT-IV

Energy Efficiency in Industrial Systems: HVAC: factors affecting the performance and savings opportunities in HVAC, performance assessment of window, split and package air conditioning units, Fans and blowers: performance evaluation and efficient system operation, flow control strategies and energy conservation opportunities, Pumps and Pumping System: Types, performance evaluation and energy conservation opportunities, Lighting System: Basic parameters and terms in lighting, methods of calculating illuminance, general energy saving opportunities, lighting case study.

Suggested Readings:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
3. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org)
4. Tripathy, S. C. *Utilization of Electrical Energy and Conservation.* Tata McGraw Hill, 1991.

DIGITAL CONTROL SYSTEMS

Course Code: BT EE 624A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, students will demonstrate the ability to:

1. Obtain discrete representation of LTI systems.
2. Analyse stability of open loop and closed loop discrete-time systems.
3. Design and analyse digital controllers.
4. Design digital compensator and discrete observer for LTI systems.

UNIT- I

INTRODUCTION: Terminology: continuous time, discrete-time & digital signals; Basic structure of digital control scheme and brief description of its blocks. Advantages & problems of digital control, General principles of signal conversion: operation by A/ D & D/A converters, A/D and D/A converter circuits; Sample and hold circuit: Mathematical analysis of sampling process, Ideal sampler, Choice of sampling frequency, Aliasing; Sampling theorem, The Hold operation, ZOH. Unit sample sequence, Unit step sequence & Unit sinusoidal sequence. Difference Equation models & Impulse response models for discrete time systems. State space models of discrete systems, state space analysis, Controllability, reachability, reconstructibility and observability analysis.

UNIT- II

TRANSFORM DOMAIN PROCESSING:; Definition of Z-transform; The Z-transforms of typical functions such as Unit sample sequence, Unit step sequence, sampled ramp function, sampled exponential function, sampled sinusoids; Operations with Z transform such as shifting (forward & backward); Z transform Inversion; Final value & Initial value theorems; Transfer function models; Unit delayer Transfer function; Dynamic response; Stability in z-plane; Jury Stability test; Z-plane poles v/ s stability (& the nature of response functions); Mapping s-plane to z-plane, Bilinear transformation.

UNIT- III

MODELS OF DIGITAL CONTROL DEVICES & SYSTEMS: z-domain description of sampled continuous-time plants, model of ADC & DAC, Interconnection of discrete-time & continuous time systems & their equivalent transfer functions; Implementation of digital controllers, Recursive realizations: direct, cascade & parallel realizations, Non-recursive realization; Digital

PID controller: Positional & velocity forms; Tuning rules for digital PID. Design of digital control system with dead beat response. Practical issues with dead beat response design.

UNIT- IV

DESIGN OF DIGITAL CONTROL ALGORITHMS: Basic structure of digital control system; Routes to the design of digital Controller, z-plane specifications of control system design: steady state accuracy, Steady state errors & error constants for type -0,-1,-2 systems, Transient accuracy, dominant poles, Effect of extra zero & pole on discrete time 2nd order system; Digital compensator design using frequency response plot; Digital compensator design using root locus plot. Design of discrete observer for LTI System. Design of set point tracker.

Suggested Readings:

1. Franklin G. F., Powell J. D. and Workman M. L. *Digital Control of Dynamic Systems*. Addison-Wesley, 1998.
2. Gopal, M. Digital Control & State Variable Methods (Conventional and Intelligent Control System). Tata McGraw-Hill Education Pvt. Ltd., 2012.
3. - - -. *Digital control engineering.* New Age International, 1988.
4. Hopis, C.H. and Lemont, G. B. *Digital Control System: Theory, Hardware & Software*. Tata McGraw-Hill Publications.
5. Kuo, Benjamin C. *Discrete-data control systems*. Englewood Cliffs. NJ: Prentice-Hall, 1970.
6. Ogata, Katsuhiko, and Yanjuan Yang. *Modern control engineering*. Vol. 5. Upper Saddle River, NJ: Prentice hall, 2010.
7. Phillips, C. L. & H. T. Nagle, Jr. *Digital Control System Analysis.* Pearson Education, New Jersey.

LINE-COMMUTATED AND ACTIVE PWM RECTIFIERS

Course Code: BT EE 631A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, students will demonstrate

1. the ability to Analyse controlled rectifier circuits.
2. Understand the operation of line-commutated rectifiers – 6 pulse and multi-pulse configurations.
3. Understand the operation of PWM rectifiers – operation in rectification and regeneration modes.
4. Understand the lagging, leading and unity power factor mode.

UNIT-I

Thyristor rectifiers with passive filtering: Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

UNIT-II

Multi-Pulse converter: Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6- pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

UNIT-III

Single-phase ac-dc single-switch boost converter: Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.

Ac-dc bidirectional boost converter: Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors.

UNIT-IV

Rectification and regenerating modes: Phasor diagrams, closed-loop control structure.

Isolated single-phase ac-dc flyback converter: Dc-dc flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc flyback converter, steady state analysis, unity power factor operation, closed loop control structure.

Suggested Readings:

1. De G. *Principles of Thyristorised Converters.* Oxford & IBH Publishing Co, 1988.
2. Erickson R. W. and Maksimovic D. *Fundamentals of Power Electronics.* Springer Science & Business Media, 2001.
3. Kassakian J. G., Schlecht M. F. and Verghese G. C. *Principles of Power Electronics.* Addison Wesley, 1991.
4. Mohan N. and Undeland T. M. *Power Electronics: Converters, Applications and Design.* John Wiley & Sons, 2007.
5. Umanand L. *Power Electronics: Essentials and Applications.* Wiley India, 2009.

HVDC TRANSMISSION SYSTEMS

Course Code: BT EE 632A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

COURSE LEVEL LEARNING OUTCOMES:

At the end of this course, the students will be able 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

UNIT- I

DC TRANSMISSION TECHNOLOGY& ANALYSIS OF CONVERTERS: 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. 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. Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter.

UNIT- II

CONTROL OF HVDC CONVERTERS: Principles of Link Control in LCC HVdc 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, dc Voltage Control. Reactive Power Control/AC voltage regulation.

UNIT- III

COMPONENTS OF HVDC SYSTEMS: 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.

UNIT- IV

STABILITY ENHANCEMENT USING HVDC CONTROL&MTDC LINKS: Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems. 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.

Suggested Readings:

1. Arrillaga J. *High Voltage Direct Current Transmission.* Peter Peregrinus Ltd., 1983.
2. Arrillaga, Jos, and Jos Arrillaga. *High voltage direct current transmission*. IET, 1998.
3. Jovcic, Dragan. *High voltage direct current transmission: converters, systems and DC grids*. John Wiley & Sons, 2019.
4. Kimbark E. W. *Direct Current Transmission.* Vol.1, Wiley-Interscience, 1971.
5. Padiyar K. R. *HVDC Power Transmission Systems.* New Age International Publishers, 2011.

UTILIZATION OF ELECTRIC POWER AND TRACTION

Course Code: BT EE 633A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

At the end of this course, the students will be able to:

1. Understand the construction and applications of electrical components.
2. Understand the various electrical heating and welding machines
3. Understand the principles and performances of different batteries.
4. Understand the principles and performances of traction motors and design calculations.

UNIT-I

Selection of Electrical Components: Sizing of a transformer, main dimensions, kVA output for single- and three-phase, sizing and selection of motors (ac as well dc) cables sizing. SENSORS AND TRANSDUCERS: Temperature, pressure, displacement, velocity, acceleration, strain and torque type.

Medical equipment's: X-ray machine - Radio graphic and fluoroscopic techniques – Computer tomography – MRI – Ultrasonography – Endoscopy – Thermography – Different types of biotelemetry systems and patient monitoring – Electrical safety. Biological effects of X-rays and precautions.

UNIT-II

ELECTRIC HEATING & WELDING: Principle and application of resistance, induction and dielectric heating., Resistance welding, arc welding, welding generator and welding transformer, properties of arcing electrode.

UNIT-III

ELECTROLYTIC PROCESS: Principles and applications of electrolysis. Faraday's law of electrolysis, electroplating, charging and discharging. Different types of battery, Capacity and efficiency of battery, defects in battery, maintenance of battery.

UNIT-IV

ELECTRIC TRACTION: Systems of electric traction, traction motors, traction motor control, multi-unit control, braking of electric motors, thyristor control of electric traction., Types of services, speed time and speed distance curves, average and schedule speed, Estimation of power and energy requirements: specific energy consumption. Mechanics of train movement coefficient of adhesion, Adhesive weight, effective weight.

Suggested Readings:

1. Gupta, J. B. *Utilization of Electric Power and Electric Traction*. S. K. Kataria & Sons, 2009.
2. Pratab H. *Art and Science of Utilization of Electrical Energy.* Dhanpat Rai & Sons, Delhi, 2014
3. Pratab H. *Electric Traction*. Vijay publisher, 2017.
4. Sivanagaraju, S., M. Balasubba Reddy, and D. Srilatha. *Generation and utilization of electrical energy*. Pearson Education India, 2010.
5. Taylor, Eric Openshaw. *Utilisation of Electric Energy.* Orient Blackswan, 1971.
6. Wadhwa, C. L. *Electrical Power Systems*. New Age International, 2006.

SIGNAL PROCESSING

Course Code: BT EE 634A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

COURSE LEVEL LEARNING OUTCOMES

At the end of this course, students will demonstrate the ability to

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

UNIT - I

Discrete-time signals and systems: Classification of signals, Analog to digital conversion, sampling theorem, Nyquist rate, Digital to analog conversion of signal, Elementary discrete time signals, Classification of discrete time signals, Simple manipulations of discrete time signals, Discrete time systems and their classification, Response of LTI systems to arbitrary inputs by convolution, Properties of convolution, Stability of LTI systems, Discrete-time systems described by difference equations, Correlation of discrete-time signals.

UNIT - II

Z-transform: z-transform, Properties of z-transform, Poles and zeros of z-transform, Pole location and time-domain behaviour for causal signals, System function of LTI system, Inverse z-transform, Analysis of LTI systems in z-domain, One-sided z-transform.

Discrete Fourier Transform: Frequency domain sampling and reconstruction of discrete-time signals, Discrete Fourier transform, DFT as linear transformation, Properties of DFT, Fast Fourier transform algorithms: Radix-2 algorithms (Decimation in Frequency and Decimation in Time), Application of DFT in computation of linear and circular convolution.

UNIT - III

Design of digital filters: Implementation of discrete-time systems (FIR&IIR systems), Structures for FIR systems: direct-form, cascade-form and lattice, Structures for IIR systems: direct-form, cascade-form, parallel form and lattice-ladder.Design of FIR filters using windows method, Fourier series method and frequency-sampling methods. Design of IIR filters by approximation of derivatives, impulse invarianceand bilinear transformation methods. Commonly used analog filters (Butterworth, Chebyshev, Elliptic and Bessel).

UNIT - IV

Multirate digital signal processing: Introduction to multirate digital signal processing, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Interchange of downsamplers/ upsamplers.

Applications of digital signal processing: Power Spectrum Estimation: Energy spectral density, Estimation of auto-correlation and power spectrum of random signals, Power spectrum estimation using non parametric methods (Barlett method, Welch and Blackman and Tukey method) and parametric methods (AR, MA, ARMA). Optimum filtering: Wiener filter, Kalman filter.

Suggested Readings:

1. Johnson J. R. *Introduction to Digital Signal Processing.* Prentice-Hall International, 1989.
2. Kumar A. *Digital Signal Processing.* PHI Learning Pvt. Ltd., 2015.
3. Oppenheim A. V., Schafer R. W. and Buck J. R. *Digital Signal Processing*, Pearson, 2007.
4. Proakis J. G. and Manolakis D. G. *Digital Signal Processing: Principles, Algorithms and Applications*. Pearson Prentice Hall, 2007.
5. Salivahanan S. *Digital Signal Processing*. Tata McGraw Hill, 2010.
6. Somanathan Nair B. *Digital Signal Processing: Theory, Analysis & Digital Filter Design.* PHI Learning Pvt. Ltd., 2004.

SENSORS & TRANSDUCERS

Course Code: BT EE 641A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

After going through this course, the students shall be able to:

1. Familiarize with the construction and working principle of different types of sensors and transducers
2. Explain various measurement techniques for industrial applications based on transducers.
3. Choose proper sensors and transducers to make measurements of non-electrical quantities
4. Have an understanding of smart sensors and their application areas

UNIT-I

Introduction: Basic concepts of sensors and transducers and their classification, performance characteristics and choice of transducers, factors influencing the choice of transducers. **Resistive transducers:** Types of resistive transducers Potentiometers, loading effect, construction of potentiometers, materials used for potentiometers; Strain gauges, theory of strain gauges, types of strain gauges, semiconductor strain gauges, Rossetts, Load cells. Thermistors, thermometers, thermocouples and their applications.

Inductive Transducers: Basic principle, Variable inductance transducers, Linear Variable Differential Transformer(LVDT),Rotary Variable Differential Transformer(RVDT), Synchros, control type synchro systems, synchros as torque transmitters.

UNIT-II

Capacitive Transducers: Transducers using change in area of plates, transducers using change in distance between plates, differential arrangement, variation of dielectric constant for measurement of displacement and liquid level, frequency response of capacitive transducers.

Piezoelectric Transducers: Principle of working, modes of operation of piezoelectric crystals, properties of piezoelectric crystals, equivalent circuit of piezoelectric transducers, loading effects and frequency response, impulse response of piezoelectric crystals.

OtherTransducers: Hall Effect transducers, photovoltaic cells, photoconductive cells, semiconductor photodiode, phototransistors. Transducers for measurement of angular velocity, Electrical tachometers, Electromagnetic tachometer generators, Digital methods, photoelectric tachometers, stroboscope and stroboscopic methods.

UNIT-III

Measurement of Non–Electrical Quantities: Pressure measurement, temperature measurement, flow measurement, Electromagnetic Flow meters, Ultrasonic Flow Meters, Thermal Meters, and Wire Anemometers. Measurement of Displacement, Measurement of Velocity/ Speed, Measurement of Acceleration, Measurement of Force, Measurement of Torque, Measurement of Shaft Power, Measurement of Liquid Level, Measurement of Viscosity. Measurement of low pressure using various methods, Measurement of acceleration, flow, liquid level and humidity employing different transducers. Chemical sensors, measurement of pH values, measurement of thermal conductivity.

UNIT-IV

Smart Sensors: Introduction to smart sensors, components of smart sensors, General architecture of smart sensors, Evolution of Smart Sensors, Advantages, standards for smart

Data Acquisition Systems and Conversion: Introduction, Objectives and Configuration of Data Acquisition System, various types of Data Acquisition Systems, Data Conversion. Data acquisition in instrumentation systems.

Data Transmission and Telemetry: Introduction, Methods of Data/Signal Transmission, characteristics of Telemetry systems, Landline telemetry and Radio Frequency telemetry. sensor interface, Industrial applications Microelectromechanical Systems.

Suggested Readings:

1. Bell, David A. *Electronic Instrumentation and Measurements.* Englewood Cliffs, NJ: Regents/Prentice Hall, 2011.
2. Helfrick, Albert D., and William David Cooper. *Modern electronic instrumentation and measurement techniques.* NJ.: Prentice Hall, 1990.
3. Kirianaki, Nikolay V., et al. *Data Acquisition and Signal Processing for Smart Sensors.* Chichester, England, Wiley, 2002.
4. Murty, D. V. S. *Transducers and Instrumentation*. PHI Learning Pvt. Ltd., 2010.
5. Patranabi, D. *Sensors and Tranducers.* PHI Learning Pvt. Ltd., 2003.
6. Saini, J. S. *Textbook of Measurements and Instrumentation (With Laboratory Experiments).* New Age International, New Delhi, 2019.
7. Sawhney. A. K. *A Course in Electrical Instrumentation*. Dhanpat Rai & Co, 1995.

FUZZY SYSTEMS

Course Code: BT EE 642A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

After going through this course, the students shall be able to:

1. understand the nuances of the fuzzy set, distinct from crisp set.
2. understand the operations on Fuzzy sets.
3. understand the concepts of fuzzy inferencing.
4. apply the learnt concepts to further decipher the non-linearities in FLCs & to apply fuzzy systems theory to a practical problem.

UNIT-I

Introduction: Fuzzy sets; Key Distinctions from classical sets. Properties & operations on fuzzy sets. Membership Functions, their shapes and Elicitation methods. Fuzzy control from an industrial perspective, knowledge-based Systems (KBS), Early & key events in fuzzy systems development; knowledge representation in KBS's. Differentiating b/n Fuzzy Logic & Probability Theory**;** Vagueness.

UNIT-II

Fuzzy Mathematics: Classical or crisp relation; Fuzzy relations & operations on fuzzy relations, the Extension Principle, Classical Inference Rules, Classical Implication, N-valued Logic & Fuzzy Logic; Fuzzy propositions, Max-min, Max-product & Max-av Compositions; The Compositional Rule of Inference; Two types of Inference engine or rule firing: Composition based Inferencing & Individual rule based Inferencing. Different implications, Representing a set of rules.

UNIT-III

Fuzzy System Design Parameters: The Fuzzy System architecture (Mamdani Type & TSK Type), Rationale for Normalization, Choice of scaling factors, & Rationale for Denormalization; Choice of variables & content of rules, Derivation of rules, choice of membership functions, Choice of fuzzification procedure, choice of defuzzification procedure, comparison and evaluation of defuzzification methods.

UNIT-IV

Nonlinear Fuzzy System: The Fuzzy System as a Non-Linear Transfer Element, Types of Fuzzy System such as PID-like Fuzzy System, Sugeno FKBC; Distinctions between Mamdani & Sugeno Type Fuzzy Systems. One typical application of Fuzzy System.

Suggested Readings:

1. Driankov, D., Hans H., and Michael R. *An Introduction to Fuzzy Control.* Springer Science & Business Media, 2013.
2. Kandel, A., and Gideon L.*Fuzzy Control Systems.* CRC press, 1993.
3. Klir, George, and Bo Y.*Fuzzy Sets and Fuzzy Logic.* Vol. 4. New Jersey: Prentice hall, 1995.
4. Kosko, Bart. *Fuzzy Engineering.* Prentice-Hall, Inc., 1996.
5. Ross, Timothy J. *Fuzzy Logic With Engineering Applications*. John Wiley & Sons, 2005.
6. Ying, Hao. *Fuzzy Control and Modeling: Analytical Foundations and Applications.* Wiley- IEEE Press, 2000.

ANALOG AND DIGITAL COMMUNICATION

Course Code: BT EE 643A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

After going through this course, the students shall be able to:

1. Analyze and compare different analog modulation schemes for their efficiency and bandwidth
2. Analyze the behavior of a communication system in presence of noise
3. Investigate pulsed modulation system and analyze their system performance
4. Analyze different digital modulation schemes and can compute the bit error performance

UNIT-I

Review of signals and systems, Frequency domain representation of signals, Principles of Amplitude Modulation Systems- DSB, SSB and VSB modulations. Angle Modulation, Representation of FM and PM signals, Spectral characteristics of angle modulated signals.

UNIT-II

Review of probability and random process. Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and Deemphasis, Threshold effect in angle modulation.

UNIT-III

Pulse modulation. Sampling process. Pulse Amplitude and Pulse code modulation (PCM), Differential pulse code modulation. Delta modulation, Noise considerations in PCM, Time Division multiplexing, Digital Multiplexers.

UNIT-IV

Elements of Detection Theory, Optimum detection of signals in noise, Coherent communication with waveforms- Probability of Error evaluations. Base band Pulse Transmission- Inter symbol Interference and Nyquist criterion. Pass band Digital Modulation schemes- Phase Shift Keying, Frequency Shift Keying, Quadrature Amplitude Modulation, Continuous Phase Modulation and Minimum Shift Keying.

Suggested Readings:

1. Barry J. R., Lee E. A. and Messerschmitt D. G. *Digital Communication*. Kluwer Academic Publishers, 2004.
2. Haykin S. *Communications Systems*. John Wiley and Sons, 2001.
3. Proakis J. G. & Salehi M. *Communication Systems Engineering*. Pearson Education, 2002.
4. Proakis J. G. *Digital Communications*. 4th Edition, McGraw Hill, 2000.
5. Taub H. &Schilling D. L. *Principles of Communication Systems*. Tata McGraw Hill, 2001.
6. Wozencraft J.M. & Jacobs I.M., *Principles of Communication Engineering.* John Wiley, 1965.

OPTIMIZATION TECHNIQUES

Course Code: BT EE 644A **SEMESTER-VI**

L	T	P	Credits
3	-	-	3

Course Level Learning Outcomes:

After going through this course, the students shall be able to:

1. Understand the concepts of classical optimization techniques.
2. Understand the concepts of linear and nonlinear programming.
3. Understand the concepts of nonlinear constrained unconstrained optimization techniques.
4. Understand the concepts of Dynamic Programming.

Unit I

Introduction and Classical Optimization Techniques: Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems. Classical Optimization Techniques: Single variable Optimization – multivariable Optimization without constraints – necessary and sufficient conditions for minimum / maximum – multivariable Optimization with equality constraints. Solution by method of Lagrange multipliers – multivariable Optimization with inequality constraint – Kuhn – Tucker conditions.

Unit II

Linear Programming: Standard form of a linear programming problem – geometry of linear programming problems – definitions and theorems, linear simultaneous equations: Elimination method, Gauss and Gauss-Jordan method, Jacobi's method, Gauss-Seidal method, simplex method. Transportation problem finding initial basic feasible solution by north - west corner rule, least cost method and Vogel's approximation method.

Unit III

Unconstrained Nonlinear Programming: One – dimensional minimization methods: Classification, Fibonacci method and Quadratic interpolation method Unconstrained Optimization Techniques: Univariate method, Powell's method and steepest descent method.

Unit IV

Constrained Nonlinear Programming: Characteristics of a constrained problem, Classification, Basic approach of Penalty Function method, Introduction to convex Programming Problem, Dynamic Programming

Suggested Readings:

1. Hadley G. *Linear Programming*. Narosa, 2002
2. Mital, K. V. *Optimization Methods in Operations Research and Systems Analysis.* New Age International, 1996.
3. Rao, Singiresu S. *Engineering Optimization: Theory and Practice.* John Wiley & Sons, 2019.
4. Sharma, S. D., and Himanshu Sharma. *Operations Research: Theory, Methods and Applications*", Kedar Nath Ram Nath, 2010.
5. Taha, Hamdy A. *Operations Research: An Introduction*. Pearson Education India, 2013.