B.Tech (Electrical Engineering)

SEMESTER-IV

Sl. No.	Course Code	Course Title	Hours Per Week			Total Credits	ESE	IA
			Lecture	Tutorial	Practical			
1.	103401	Digital Electronics	3	1	0	4	70	30
2.	103402	Signals and Systems	3	1	0	4	70	30
3.	103403	Electrical Machine-II	3	1	0	4	70	30
4.	103404	Electromagnetic Field Theory	3	1	0	4	70	30
5.	103405	Control System	3	1	0	4	70	30
6.	103406	Environmental Science	3	0	0	0	-	-
7.	103401P	Digital Electronics Lab	0	0	2	1	30	20
8.	103403P	Electrical Machine-II Lab	0	0	2	1	30	20
9.	103405P	Control System Lab	0	0	2	1	30	20
10.	103407	NPTEL-I (Open Course)	12 weeks			3	75	25
					TOTAL	26	750	

Course Code-103401 **Digital Electronics** **3 1 0 4**

Unit-1.0: Fundamentals of Digital Systems and logic families **6 hrs**

Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive OR operations, Boolean algebra, number systems-binary, signed binary, octal, hexadecimal number, binary arithmetic, one's and two's complements arithmetic, codes, error detecting and correcting codes, characteristics of digital lCs, , examples of IC gates, digital logic families, TTL, Schottky TTL and CMOS logic, interfacing CMOS and TTL, Tri-state logic.

Unit-2.0: Combinational Digital Circuits **8 hrs**

Standard representation for logic functions, K-map representation, simplification of logic functions using K-map, minimization of logical functions. Don't care conditions, Multiplexer, De-Multiplexer/Decoders, Adders, Sub tractors, BCD arithmetic, carry look ahead adder, serial adder, ALU, elementary ALU design, popular MSI chips, digital comparator, parity checker/generator, code converters, priority encoders, decoders/drivers for display devices, Quine-Mc cluskey method of function realization.

Unit-3.0: Sequential circuits and systems **8 hrs**

A 1-bit memory, the circuit properties of Bistable latch, the clocked SR flip flop, J- K, T and D types flip flops, applications of flip flops, shift registers, applications of shift registers, serial to parallel converter, parallel to serial converter, ring counter, sequence generator, ripple (Asynchronous) counters, synchronous counters, counters design using flip flops, special counter ICs, asynchronous sequential counters, applications of counters.

Unit-4.0: A/D and D/A Converters **8 hrs**

Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, examples of D/A converter ICs, sample and hold circuit, analog to digital converters: quantization and encoding, parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion, specifications of A/D converters, example of A/D converter ICs.

Unit-5.0: Semiconductor memories and Programmable logic devices **8 hrs**

Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory(RAM), content addressable memory (CAM), charge de coupled device memory (CCD), commonly used memory chips, ROM as a PLD.

Unit-6.0: **4 hrs**

Programmable logic array, Programmable array logic, complex Programmable logic devices (CPLDS), Field Programmable Gate Array (FPGA).

Text/ Reference:-

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education,2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India,2016.
3. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India,2016.

Course Code-103402 Signals and Systems 3 0 0 3

Unit- 1.0: Introduction to Signals and Systems 7 hrs

Signals and systems as seen in everyday life, and in various branches of engineering and science. Signal properties: periodicity, absolute integrability, determinism and stochastic character. Some special signals of importance: the unit step, the unit impulse, the sinusoid, the complex exponential, some special time-limited signals; continuous and discrete time signals, continuous and discrete amplitude signals. System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, realizability. Examples.

Unit- 2.0: Behavior of continuous and discrete-time LTI systems 6 hrs

Impulse response and step response, convolution, input-output behavior with aperiodic convergent inputs, cascade interconnections. Characterization of causality and stability of LTI systems. System representation through differential equations and difference equations. State space representation of systems. State-Space analysis, Multi-input multi-output representation. State Transition Matrix and its Role. Periodic inputs to an LTI system, the notion of a frequency response and its relation to the impulse response.

Unit- 3.0: Fourier series and Fourier Transform 8 hrs

Fourier series representation of periodic signals, Waveform Symmetries, Calculation of Fourier Coefficients. Fourier Transform, convolution/multiplication and their effect in the frequency domain, magnitude and phase response, Fourier domain duality. The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT). Parseval's Theorem.

Unit- 4.0: Laplace Transform 6 hrs

Review of the Laplace Transform for continuous time signals and systems, system functions, poles and zeros of system functions and signals, Laplace domain analysis, solution to differential equations and system behavior.

Unit- 5.0: Sampling and Reconstruction 8 hrs

The Sampling theorem and its implications. Spectra of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold. Aliasing and its effects. Relation between continuous and discrete time systems. Introduction to the applications of signal and system theory: modulation for communication, filtering, feedback control systems.

Unit- 6.0: Z-Transform 7 hrs

The Z-Transform for discrete time signals and systems, system functions, poles and zeros of systems and sequences, region of convergence, Z-domain analysis**;** Unilateral Laplace transform, difference equations, system representations: direct, cascade, parallel forms

Text/ Reference:-

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and systems”, Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 2006.
3. H. P. Hsu, “Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
4. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.
5. A. V. Oppenheim and R. W. Schafer, “Discrete-Time Signal Processing”, Prentice Hall, 2009.
6. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
7. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2009.

Course Code-103403 Electrical Machines – II 3 1 0 4

Unit- 1.0: Fundamentals of AC machine windings 6 hrs

Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding-concentrated and distributed, Sinusoidally distributed winding, winding distribution factor.

Unit- 2.0: Pulsating and revolving magnetic fields 7 hrs

Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.

Unit- 3.0: Induction Machines 8 hrs

Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines; Linear Induction Machine

Unit- 4.0: Single-phase AC motors 4 hrs

Single-phase induction motor: Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications; Universal Series Motor

Unit-5.0: Synchronous machines 11 hrs

Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division; starting and speed control of synchronous motors.

Unit-6.0: Special Electric Machines 6 hrs

Reluctance Machines: Synchronous reluctance, stepper motors, and switched reluctance machines, principles of operation and models for operating characteristics. Steady-state and dynamic performance. **PM machines**: Basic analysis of magnetic circuit with permanent magnets, Steady-state and dynamic performance of PM synchronous machines, and Brushless DC machines. Servo Motors: Working principle and applications

Text/ Reference:-

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
3. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
4. I.J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
5. A.S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
6. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley &Sons, 2007.

Course Code-103404 Electromagnetic Field Theory 3 1 0 4

Unit-1.0: Review of Vector Calculus 6 hrs

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.

Unit-2.0: Static Electric Field 6 hrs

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-3.0: Conductors, Dielectrics, and Capacitance 6 hrs

Current and current density, Ohm's 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.

Unit-4.0: Static Magnetic Fields & Time Varying Fields 12 hrs

Static Magnetic Field: Biot-Savart Law, Ampere Law, Magnetic flux and magnetic flux density, Scalar and Vector Magnetic potentials. Steady magnetic fields produced by current-carrying conductors *Time Varying Field:* 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-5.0: Magnetic Forces, Materials, and Inductance 6 hrs

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.

Unit-6.0: Electromagnetic Waves 6 hrs

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

Text/ Reference:-

1. W. Hayt, & J. A. Buck, Engineering Electromagnetics, 6th Edition, Tata McGraw-Hill, 2015
2. M. N. O. Sadiku, Principles of Electromagnetics, 6th edition, Oxford University Press, 2015
3. David K. Cheng (1989), Fields and Waves Electromagnetics, 2nd edition, Pearson Education
4. A. Pramanik, "Electromagnetism - Theory and applications", PHI Learning Pvt. Ltd, New Delhi, 2009.
5. E.G. Cullwick, "The Fundamentals of Electromagnetism", Cambridge University Press, 1966

Course Code-103405 **Control System** **3 1 0 4**

Unit- 1.0: Introduction to control problem **4 hrs**

Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time-invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.

Unit- 2.0: Time Response Analysis **9 hrs**

Standard test signals. Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time- response. Concept of Stability. Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

Unit- 3.0: Frequency-response analysis **7 hrs**

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Unit- 4.0: Introduction to Controller Design **9 hrs**

Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency-domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controllers.

Unit-5.0: State variable Analysis **7 hrs**

Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.

Unit- 6.0: Introduction to Optimal Control and Nonlinear Control **5 hrs**

Performance Indices. Regulator problem, Tracking Problem. Nonlinear system–Basic concepts and analysis.

Text/ Reference:-

1. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.
2. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.
3. K.Ogata, “Modern Control Engineering”, Prentice Hall, 1991.
4. I.J Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009.

Course Code-103406 Environmental Science 3 0 0 0

Unit-1.0: Ecosystem 6 hrs

• Structure of ecosystem, Biotic & Abiotic components.
• Food chain and food web.
• Aquatic (Lentic and Lotic) and terrestrial ecosystem.
• Carbon, Nitrogen, Sulphur, Phosphorus cycle.
• Global warming -Causes, effects, process, Green House Effect, Ozone depletion.

Unit–2.0: Air Pollution 7 hrs

• Definition of pollution and pollutant, Natural and manmade sources of air pollution (Refrigerants, I.C., Boiler).
• Air Pollutants: Types, Particulate Pollutants: Effects and control (Bag filter, Cyclone separator, Electrostatic Precipitator).
• Gaseous Pollution Control: Absorber, Catalytic Converter, Effects of air pollution due to Refrigerants, I.C., Boiler.

Unit-3.0: Noise Pollution 6 hrs

• Noise pollution: sources of pollution, measurement of pollution level, Effects of Noise pollution, Noise pollution (Regulation and Control) Rules, 2000.

Unit-4.0: Water and Soil Pollution 7 hrs

• Sources of water pollution, Types of water pollutants, Characteristics of water pollutants Turbidity, pH, total suspended solids, total solids BOD and COD: Definition, calculation.
• Waste Water Treatment: Primary methods: sedimentation, froth floatation, Secondary methods: Activated sludge treatment, Trickling filter, Bioreactor, Tertiary Method: Membrane separation technology, RO (reverse osmosis).
• Causes, Effects and Preventive measures of Soil Pollution: Causes-Excessive use of Fertilisers, Pesticides and Insecticides, Irrigation, E-Waste.

Unit– 5.0: Renewable sources of Energy 8 hrs

• Solar Energy: Basics of Solar energy. Flat plate collector (Liquid & Air). Theory of flat plate collector. Importance of coating. Advanced collector. Solar pond. Solar water heater, solar dryer. Solar stills.
• Biomass: Overview of biomass as energy source. Thermal characteristics of biomass as fuel. Anaerobic digestion. Biogas production mechanism. Utilisation and storage of biogas.
• Wind energy: Current status and future prospects of wind energy. Wind energy in India. Environmental benefits and problem of wind energy.
• New Energy Sources: Need of new sources. Different types new energy sources. Applications of (Hydrogen energy, Ocean energy resources, Tidal energy conversion.) Concept, origin and power plants of geothermal energy.

Unit-6.0: Solid Waste Management, ISO 14000 & Environmental Management 6 hrs

• Solid waste generation- Sources and characteristics of: Municipal solid waste, E- waste, biomedical waste.
• Metallic wastes and Non-Metallic wastes (lubricants, plastics, rubber) from industries. Collection and disposal: MSW (3R, principles, energy recovery, sanitary landfill), Hazardous waste.
• Air quality act 2004, air pollution control act 1981 and water pollution and control act1996. Structure and role of Central and state pollution control board.
• Concept of Carbon Credit, Carbon Footprint.
• Environmental management in fabrication industry.
• ISO14000: Implementation in industries, Benefits.

Text / References:

1. S.C. Sharma & M.P. Poonia, Environmental Studies, Khanna Publishing House.
2. S.C. Sharma & M.P. Poonia, Environmental Engineering, Khanna Publishing House, New Delhi.
3. C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd., 2011.
4. Arceivala, Soli Asolekar, Shyam, Waste Water Treatment for Pollution Control and
5. Reuse, Mc-Graw Hill Education India Pvt. Ltd., New York, 2007, ISBN:978-07- 062099-
6. Nazaroff, William, Cohen, Lisa, Environmental Engineering Science, Willy, New York, 2000, ISBN 10: 0471144940.
7. O.P. Gupta, Elements of Environmental Pollution Control, Khanna Publishing House, New Delhi
8. Rao, C. S., Environmental Pollution Control and Engineering, New Age International Publication, 2007, ISBN: 81-224-1835-X.
9. Rao, M. N.Rao, H.V.N, Air Pollution, Tata Mc-Graw Hill Publication, New delhi, 1988, ISBN: 0-07- 451871-8.
10. Frank Kreith, Jan F Kreider, Principles of Solar Engineering, McGraw-Hill, New York; 1978, ISBN: 9780070354760.
11. Aldo Vieira, Da Rosa, Fundamentals of renewable energy processes, Academic Press Oxford, UK; 2013. ISBN: 9780123978257.
12. Patvardhan, A.D, Industrial Solid Waste, Teri Press, New Delhi, 2013, ISBN:978- 81-7993-502-6
13. Metcalf & Eddy, Waste Water Engineering, Mc-Graw Hill, New York,2013,ISBN:077441206.
14. Keshav Kant, Air Pollution & Control, Khanna Publishing House, New Delhi

Course Code-103401P **Digital Electronics Lab** **0 0 2 1**

Perform any 10 Experiments

List of Experiments

1. Study and verify the operation of all logic gates.
2. Design and verify NAND & NOR Gate as a Universalgates.
3. Design and Verify DE Morgan's Theorem.
4. Design and verity Binary to Gray & Gray to Binary Conversion.
5. Design and verify Half adder circuit & Half Subtractor circuit.
6. Design and Verity Full adder circuit & Full Subtractor Circuit.
7. Study and verify multiplexer and De-multiplexer Circuit.
8. Design and Verity BCD to 7-segment display.
9. Study of Encoder and Decoder circuit
10. Study of characteristics of SR, JK, T & Master-Slave Flip-Flop.
11. Design and Verify shift, register circuit
12. Study and Verity weighted Binary DAC R-2R ladder DAC & Flash ADC
13. Study of Johnson counter & Binary counter.
14. Study of 4-bit Synchronous Up/Down mod-n counter.

Course Code-103403P **Electrical Machine – II Lab** **0 0 2 1**

Perform the following Experiments

List of Experiments

1. Study of the three-phase Induction motor starting methods
2. Determination of equivalent circuit parameters of a three-phase induction Motor
3. To perform a load test on a single-phase squirrel-cage Induction motor
4. To perform a load test on a three-phase squirrel-cage Induction motor
5. To perform a load test on a three-phase slip ring induction motor
6. To perform the speed control on a three-phase squirrel cage Induction motor
7. To perform the operation of a three-phase synchronous motor by varying the field excitation at different mechanical loading
8. Determination of OCC, SCC, and ZPF characteristics of a 3-phase Synchronous Machine
9. Determining the V-curve of a Synchronous Machine
10. To study the operation of a synchronous generator at NO load and Full load

Course Code-103405P **Control System Lab** **0 0 2 1**

Perform the following Experiments

List of Experiments:

1. To study the potentiometer as an error detector.
2. To study the PID controller for an oven.
3. To study the synchro transmission-receiver & output v/s input characteristics.
4. To study the characteristics of a small A.C. servomotor.
5. Determine the transient response of a 2^{nd} order system.
6. To study the performance of an Analog PID controller using a simulated system.
7. To study the behavior of DC-separated excited motors at open-loop and closed-loop control systems.

B.Tech in Electrical Engineering

Course Code-103407 NPTEL (Open Course) 12 Weeks (3 Credits)

NPTEL (Open Course) Guidelines:

NPTEL (Open Course) should be taken from the course other than core subjects of the branch.