CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY 2023-24

BE (Electrical and Electronics Engineering)

SEMESTER – III

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22MTC09	Applied Mathematics	3	1	-	3	40	60	4
2	22CSC29	C and Data Structures	3	-	-	3	40	60	3
3	22EEC03	Electrical Circuit Analysis	3	-	-	3	40	60	3
4	22EEC04	Electromagnetic Fields	3	-	-	3	40	60	3
5	22EEC05	Electrical Measurements and Instrumentation	3	-	-	3	40	60	3
6	22EEC06	Analog Electronic Circuits	3	-	-	3	40	60	3
7	22CEM01	Environmental Science	2	-	-	2	----	50	NC
PRACTICAL									
8	22EEC07	Electrical Circuits and Measurements Lab	-	-	3	3	50	50	1.5
9	22EEC08	Analog Electronic Circuits Lab	-	-	3	3	50	50	1.5
10	22CSC30	C and Data Structures Lab	-	-	2	3	50	50	1
11	22EEI01	MOOCs/Training/ Internship	2-3 weeks/90 hours				50	-	2
Total			**20**	**1**	**8**	**-**	**440**	**560**	**25**
Clock Hours Per Week: 29									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

22MTC09

APPLIED MATHEMATICS

(For EEE)

Instruction	3 L+1T Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	4

Prerequisite: The Student should be familiar with Knowledge on Calculus, Ordinary Differential equations, and permutation combinations.

Course Objectives:
This course aims to:
1. Learn the Laplace and Z- Transform concepts.
2. Explain the expansion of functions in sine and cosine series.
3. Solve Linear and Non-Linear partial differential equations and fitting the data in Linear and Non-Linear Models.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Find Laplace, Inverse Laplace and solution of engineering problems.
2. Find the solution of Difference Equation.
3. Calculate the Euler's coefficients for Fourier series expansion of a function.
4. Understand the methods to find solution of linear and non-linear PDE and solution of wave equation.
5. Analyze the coefficient of correlation, regression and fitting of the data by various methods.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	3	--	--	--	--	--	--	--	2	2	--	1
CO 2	3	3	2	3	--	--	--	--	--	--	--	2	2	--	1
CO 3	3	2	2	3	--	--	--	--	--	--	--	2	2	--	1
CO 4	2	3	3	2	--	--	--	--	--	--	--	2	2	--	1
CO 5	3	2	3	2	--	--	--	--	--	--	--	2	2	--	1

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I

Laplace Transforms: Laplace Transform of Elementary functions, Linearity property, First Shifting property, Change of scale property. Laplace Transform of Periodic functions, Transforms of derivatives, Transforms of integrals, Multiplication by t and division by t evaluation of Integrals by Laplace Transforms. Inverse Laplace transforms of elementary functions, Inverse Laplace Transform by method of partial fractions and Convolution theorem, Solutions of Ordinary Differential Equations by Laplace Transform method. Laplace transform of Unit step and Unit Impulse function.

UNIT -II

Z-Transforms: Z-transforms of standard functions, linearity property, damping rule, shifting theorems, multiplication by 'n', Initial and Final value theorems. Inverse Z-transforms of standard functions, Inverse Z-transform by Convolution theorem and partial fractions method, Z-transform applications to difference equations.

UNIT -III

Fourier Series: Periodic functions, Euler's formulae, Condition for a Fourier series expansion, Fourier series of Functions having points of discontinuity even and odd functions, Change of interval, Half range Sine & Cosine Series

UNIT -IV

Partial Differential Equations: Formation of Partial Differential Equations, Linear Equations of First Order (Lagrange's Linear Equations), Solution of First Order Non-linear Partial Differential Equation (Standard forms) and Charpit's method. Solutions by method of separation of variables, solution of One-dimensional wave equation and its applications.

UNIT -V:

Curve Fitting: Correlation, coefficient of Correlation, Linear Regression, Regression coefficients, Properties of Regression Coefficients. Curve fitting by the Method of Least Squares, Fitting of Straight lines, Second degree parabola and curve $y = ae^{bx}, y = ax^{b}.$ and $y = ab^{x}$.

Text Books:

1. B.S. Grewal, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2017.
2. S.C. Gupta, V.K. Kappoor, "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, 2014.

Suggested Reading:

3. Erwin Kreyszig, "Advanced Engineering Mathematics", 9th Edition, John Wiley & Sons, 2006.
4. Veerarajan T, "Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2008.
5. S.S. Sastry, "Introductory methods of numerical analysis", 4th Edition, PHI, 2005.

With effect from AY 2023-24

22CSC29

C AND DATA STRUCTURES

(Common for ECE and EEE)

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have Fundamental knowledge in Problem Solving and Programming

Course Objectives:
This course aims to:

1. Discuss the concepts of Functions, Arrays, Pointers and Structures.
2. Familiarize with Stack, Queue and Linked lists data structures.
3. Explain the concepts of non-linear data structures like graphs and trees.

Course Outcomes:
Upon completion of this course, students will be able to:

1. Analyze the basic concepts of C Programming language.
2. Design applications in C, using functions, arrays, pointers and structures.
3. Apply the concepts of Stacks and Queues in solving the problems.
4. Explore various operations on Linked lists.
5. Demonstrate various tree traversals and graph traversal techniques.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	3	1	-	1	-	-	-	-	-	-	-	2	-
CO 3	3	3	3	1	1	2	-	-	-	-	-	-	-	2	-
CO 4	3	3	3	1	-	1	-	-	-	-	-	-	-	1	-
CO 5	3	3	3	1	-	-	-	-	-	-	-	-	-	1	-

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I

Introduction to C Language: C language elements, variable declarations and data types, operators and expressions, decision statements – If and switch statements, loop control statements – while, for, do-while statements, arrays.

UNIT -II

Functions: Types of functions, Recursion and argument passing, pointers, storage allocation, pointers to functions, expressions involving pointers, Storage classes – auto, register, static, extern, Structures, Unions, and Command line arguments, File Operations.

UNIT -III

Data Structures: Overview of data structures, Types of Data Structures.
Stacks: Introduction, Operations on Stack, implementation of stack, Applications of Stacks- infix, prefix, and postfix notations, infix to postfix conversion, evaluation of arithmetic expressions, evaluation of postfix expression, recursion.
Queues: Introduction, Operations-representation of queue, insertion, deletion, searching operations, Applications of queues.

UNIT -IV

Linked Lists: Introduction, Types of linked list-Single linked list, Double linked lists, Circular linked lists, dynamic linked stacks and queues, Operations on all types of linked lists.

Application of Linked Lists: Polynomial representation.

UNIT -V

Trees: Tree terminology, representation, types of trees, Binary trees, representation, tree traversals, binary search tree and its operations.

Graphs: Graph terminology, representation, elementary graph operations, Graph traversals-Breadth First Search (BFS) and Depth First Search (DFS), spanning trees.

Text Books:

1. Pradip Dey and Manas Ghosh, “Programming in C”, 2nd Edition, Oxford University Press 2011.
2. E. Balaguruswamy, “C and Data Structures” , 4th Edition, Tata Mc Graw Hill.
3. A.K. Sharma, “Computer Fundamentals and Programming in C”, University Press, 2nd Edition.

Suggested Reading:

4. M.T. Somashekara, “Problem Solving Using C” , 2nd Edition, PHI 2009 Pearson, 2013.
5. Kamala Krithivasan, Rama R. “Introduction to Automata Theory, and Computation”, Pearson 2009.

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	Programming and Data Structure, https://nptel.ac.in/courses/106105085	Dr. P.P. Chakraborty	IIT Kharagpur
2	Programming, Data Structures and Algorithms using C https://archive.nptel.ac.in/courses/106/106/106106127	Prof. Shankar Balachandran	IIT, Madras

With effect from AY 2023-24

22EEC03

ELECTRICAL CIRCUIT ANALYSIS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have fundamental knowledge in Basic Electrical Engineering and concepts of Calculus in Mathematics.

Course Objectives:
This course aims to:
1. To study the nature of different circuit elements, laws and network theorems.
2. To study transient and steady state response of circuits with initial conditions & forcing functions
3. To learn the Laplace transforms and two-port networks.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Calculate the response of RLC networks with sinusoidal input at steady state & resonance conditions and to analyze three-phase circuits with different loads
2. Apply various network analysis techniques to find the responses in the circuits with dependent and independent sources.
3. Determine time constant, steady state and transient responses of RL, RC, RLC networks with initial conditions of network elements.
4. Evaluate the response of electrical circuits with Laplace transformation using initial & final value theorems and to obtain the pole-zero diagrams using network functions.
5. Find the impedance, admittance, ABCD, h and g- parameters of given two-port network and interconnected two-port networks.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	-	-	-	-	-	-	-	-	3	-	-
CO 2	3	3	1	2	-	-	-	-	-	-	-	-	3	-	-
CO 3	2	3	1	2	-	-	-	-	-	-	-	-	3	-	-
CO 4	3	3	1	2	-	-	-	-	-	-	-	-	3	-	-
CO 5	3	2	1	2	-	-	-	-	-	-	-	-	3	-	-

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I
Sinusoidal Steady State Analysis: Review of AC fundamentals, Steady state response of RLC networks with sinusoidal excitations, average power and complex power, series and parallel resonance, three phase circuits with balanced & unbalanced loads,

UNIT -II
Network Theorems: Node and Mesh Analysis, Analysis with dependent current and voltage sources, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem, Compensation and Milliman's theorems.

UNIT -III
Solution of First and Second Order Networks: Solution of first and second order differential equations for series and parallel RL, RC, RLC circuits, initial and final conditions in network elements, forced and force-free responses, time constant, steady state and transient state responses.

UNIT -IV
Electrical Circuit Analysis Using Laplace Transforms: Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, inverse Laplace Transform, transformed network with initial conditions. Transfer function representation, Poles and Zeros.

UNIT -V
Two Port Networks: Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two-port networks.

Text Books:

1. M. E. Van Valkenburg, "Network Analysis", 3rd Edition, Prentice Hall, 2015.
2. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", 6th Edition, McGraw Hill Education, 2019.
3. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", 8th Edition, McGraw Hill Education, 2013.
4. D. Roy Choudhury, "Networks and Systems", 2ndEdition, New Age International, 2010.

Suggested Reading:

1. Robert L. Boylestad, "Introductory Circuit Analysis", 13th Edition, Pearson Education, 2011.
2. Sudhakar and Shyam Mohan, "Circuits & Networks", 5th Edition, Tata McGraw Hill Education, 2017.
3. Asfaq Hussain, "Networks and Systems", 2nd Edition, Khanna Publishing House, 2021.

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	Basic Circuit Theory https://archive.nptel.ac.in/courses/108/104/108104139/	Prof. Ankush Sharma	IIT, Kanpur
2	Basic Electrical Circuits https://nptel.ac.in/courses/117106108	Dr. Gajendranath Chowdary, Dr. Nagendra Krishnapura	IIT, Madras
3	Network Analysis https://nptel.ac.in/courses/108105159	Dr. T. K. Bhattacharya	IIT, Kharagpur

With effect from AY 2023-24

22EEC04

ELECTROMAGNETIC FIELDS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have Fundamental knowledge in calculus and vector algebra.

Course Objectives:
This course aims to:
1. To understand coordinate systems, vector calculus and their applications to analyze electrostatic and magnetic fields.
2. To figure out Maxwell's equations, uniform plane wave and its propagation through different media.
3. To know the sources, effects & control techniques of EMI & EMC.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Understand the basic concepts of vector calculus, various coordinate systems and apply them appropriately for solving electromagnetic field problems.
2. Obtain the physical quantities like field intensity, flux density and potential due to various types of charge distributions in electric and magnetic fields using fundamental laws.
3. Differentiate between conduction & convections currents, and describe the behavior of static electric & magnetic fields in different media, boundary conditions and acquire the knowledge about energy storing elements.
4. Illustrate Maxwell's equations and their application to time-harmonic fields, wave propagation in different media and Poynting's power-balance theorem.
5. Recognize what is EMI & EMC, sources & effects of Electromagnetic Interferences in inter and intra systems and various methods to control EMI

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1
CO 2	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1
CO 3	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1
CO 4	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1
CO 5	3	3	2	1	-	-	-	-	-	-	-	-	3	-	1

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I
Orthogonal Coordinate Systems: Review of Vector Calculus, Rectangular, Cylindrical, Spherical Coordinate systems; Line, Surface and Volume integrals; Operator Del, Gradient, Divergence, Curl & Laplacian of a field; Divergence and Stoke's theorems.
Electrostatic fields: Various charge configurations, Coulomb's law, Electric field intensity and flux density of different charge distributions, Gauss's law, Integral and Point form of Maxwell's Electrostatic Equation.

UNIT -II
Electrostatic Field in Materials: Electrical Potential, Capacitance of Parallel plate capacitor, Equipotential lines, Properties of materials, convection and conduction currents, conductors, dielectric constant, continuity equation and relaxation time, boundary conditions, Poisson's and Laplace's equations, Uniqueness theorem.

UNIT -III
Magneto Static Fields: Biot-Savart's law, Ampere's law, Displacement current, Magnetic Scalar and Vector Potentials, boundary conditions, Forces in Magnetic fields, Lorentz force equation, Force between parallel conductors, Inductance Calculations (Solenoid, Toroid), Mutual Inductance, Coefficient of Coupling.

UNIT -IV
Time Varying Electromagnetic Fields: Faraday's laws of electromagnetic induction, Final forms of Maxwell's Equations, Power and Poynting theorem, Time-Harmonic Electromagnetic fields, Wave equations (One dimension), Plane Wave, Propagation in perfect and lossy-dielectrics.

UNIT -V
Electromagnetic Interference and Compatibility (Theoretical Aspects only): Introduction to Electromagnetic Interference and Electromagnetic Compatibility (EMI & EMC)- Sources and Characteristics of EMI, Control Techniques of EMI, Grounding, Shielding, Filtering. Introduction to numerical electromagnetics.

Text Books:
1. Hayt W.H and J.A Buck, "Engineering Electromagnetics", 8th Edition, Tata McGraw Hill, 2018.
2. Sadiku, M.N.O, S.V. Kulkarni, "Principles of Electromagnetics", 7th Edition, Oxford University press, 2018.

Suggested Readings:
1. S. P. Seth, "Elements of Electromagnetic Fields", Danpat Rai & Co, 2011.
2. David K. Cheng, "Field and Wave Electromagnetics", 2nd Edition, Pearson Education 2014.
3. Ashutosh Pramanik, "Electromagnetism Theory and Applications", 3rd Edition, PHI Pvt. Ltd., 2015.
4. R.L. Yadava, "Electromagnetic Fields & Waves", Khanna Publishing House,
5. Narayana Rao, "Engineering Electromagnetics", PHI Pvt. Ltd

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	Electromagnetic Theory https://nptel.ac.in/courses/115101005	Prof. D.K. Ghosh	IIT, Bombay
2	Electromagnetic Theory https://nptel.ac.in/courses/108104087	Dr. Pradeep Kumar K	IIT, Kanpur
3	Electromagnetic Fields https://archive.nptel.ac.in/courses/108/106/108106073/	Dr.Hari Sankar Ramachandran	IIT, Madras

With effect from AY 2023-24

22EEC05

ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have
1. Fundamental knowledge in calculus and complex algebra,
2. Electromagnetism and circuit theory concepts.

Course Objectives:
This course aims to:
1. To understand the principle of operation of various electrical Instruments
2. To measure electrical and magnetic parameters by demonstrating experimental setups
3. To introduce transducers and digital instruments with their working principle

Course Outcomes:
Upon completion of this course, students will be able to:
1. Identify a suitable instrument to measure a given electrical parameter.
2. Analyze the working principle by using suitable torque equations for DC and AC Instruments.
3. Design Bridge Circuits for measuring passive electrical parameters.
4. Distinguish between electrical and magnetic measurements and their instruments.
5. Select an Electrical transducer for a given physical quantity measurement.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	-	-	-	-	-	-	-	-	-	2	-	-
CO 2	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO 3	2	1	2	1	2	-	-	-	-	-	-	-	3	-	-
CO 4	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 5	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I

Introduction to Measurements: Objectives of measurement, static and dynamic characteristics, accuracy, precision, significant figures, errors and their classification, Standard Cell and Standard Resistance.
Instruments-1: Types of instruments, classification of instruments based on type of measurement and principle of working (PMMC, MI, Dynamometer, Induction and Electrostatic), types of torques (torque equations for MC, MI and dynamometer type instruments).

UNIT -II

Instruments-2: Single phase Induction type energy meter, concepts of driving torque & braking torque equations, (no derivation) ; Errors and their Compensation, Single phase Dynamometer type Power factor meter, Weston type frequency meter. Construction & theory of Instrument Transformers, Equations for ratio and phase angle error of C.T & P.T (Elementary treatment only).

UNIT -III

Resistance, Inductance and Capacitance parameters: Classification of resistance measuring methods Kelvin's double bridge, Wheatstone bridge and Meggar. Measurement of inductance using Maxwell's inductance bridge, Anderson's bridge, Measurement of capacitance using De-Sauty's bridge and Schering bridge, merits and demerits, Q-meter, measurement of relative permittivity, applications and related numerical problems.

UNIT -IV

Measurements of Magnetic and Electric Parameters: Ballistic galvanometer- Principle of operation, construction and applications of Ballistic galvanometer, flux meter its construction and principle of operation. Epstein square bridge for measuring Iron losses, Potentiometers, -Principle - Classification – Salient features related to Practical applicability.

UNIT -V

Introduction to Digital Instruments (DVM and Transducers): Introduction to digital Instruments, Digital Voltmeters (DVM), Range extension of DVM, display, resolution, related numerical problems on DVM. Digital Multimeters.

Transducers: Introduction, Role of Transducers in measurement system, Strain Gauge, Linear variable Differential transformer(LVDT), Piezoelectric transducer, Temperature transducers, bimetallic strip, Thermocouples, Resistance Temperature Detectors(RTD), Thermostats, Radiation pyrometers.

Text Books:

1. F.W. Golding and Widdis, "Electrical Measurements and measuring Instruments", A.H. Wheeler & Co., Jan-2011
2. A.K. Sawhney, "A Course in Electrical and Electronics Measurements and Instrumentation", 22ndEdition, Dhanapat Rai & Sons, New Delhi,2015.
3. CT. Baldwin, "Fundamentals of Electrical measurements", Kalyani publications, 2001.

Suggested Readings:

1. Helfrick, Albert D. Cooper, William D., "Modern Electronic Instrumentation and Measurement Techniques", PHI Publications, Jan-2015
2. Stanley Wold, Richard F.M. Smith, "Student reference manual for Electronic Instrumentation Laboratories", 2nd Edition, PHI. Alan.
3. S. Morris, "Essence of Measurement", PHI, Feb-1996

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	EMI	Dr. Avishek Chattergee	IITKGP
2	Industrial Instrumentation	Dr. Alok Barua	IITKGP

With effect from AY 2023-24

22EEC06

ANALOG ELECTRONIC CIRCUITS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have a prior knowledge of semiconductor Physics and basics of circuit theory.

Course Objectives:
This course aims to:
1. To understand the V-I characteristics of diodes, BJTs, MOSFETs and the biasing techniques of transistors and MOSFETs.
2. To understand the functioning, DC & AC characteristics of Operational Amplifiers (Op-Amps).
3. To Study the linear &non-linear applications of Op-Amps.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Comprehend the V-I characteristics of Diode and its applications.
2. Understand the V-I characteristics of BJT & MOSFET and to analyze the significance of operating point in the biasing techniques of BJT & MOSFET.
3. Apply the knowledge of differential amplifiers to understand the basic characteristics of Operational Amplifiers (Op-Amps) and their significance.
4. Design and analyze linear application circuits of Op-Amp like amplifiers, Integrator, differentiator, filters, and regulators.
5. Design and analyze non-linear application circuits of Op-Amps and design stable and mono-stable modes of 555 timer circuit.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	-	2	1	1	1	-	-	-	-	-	-	-	1	1
CO 2	2	-	2	2	1	2	-	-	-	-	-	-	-	2	2
CO 3	2	-	1	2	1	2	-	-	-	-	-	-	-	1	1
CO 4	3	-	3	2	1	2	-	-	-	-	-	-	-	1	1
CO 5	3	-	3	3	2	2	-	-	-	-	-	-	-	1	1

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I
Diode Characteristics and Applications: P-N junction diode- VI characteristics of a diode, Half-wave and Full-wave rectifiers, operation, performance characteristics, ripple factor calculations, C filter, Zener diode - VI characteristics, Regulator.

UNIT -II
BJT and MOSFET Circuits: BJTs: Structure and Operation of a BJT, Modes of transistor operation, Early effect, BJT input and output characteristics of CE, configuration, BJT as a switch, CE amplifier, small-signal model, significance of DC operating point, biasing circuits- Collector to base and voltage divider, numerical problems.
MOSFETs: Structure-Enhancement & Depletion mode MOSFETs and VI characteristics, MOSFET as a switch, MOSFET as an amplifier- common-source, biasing circuits- voltage divider numerical problems.

UNIT -III

Operational Amplifier (Op-Amp) Characteristics: Block diagram of an operational amplifier, ideal Op-Amp-characteristics, non-idealities in an Op-Amps - open loop voltage gain , output impedance, input impedance ,Output offset voltage, input bias current, input offset current, gain bandwidth product, common mode rejection ratio, slew rate, Frequency response, Stability.

Basic OP-Amp Applications: Inverting and non-inverting amplifier with ideal Op-Amps, voltage follower, current to voltage converter, voltage to current converter.

UNIT -IV

Linear Applications of Op-Amps: Summing amplifier, differential amplifier, instrumentation amplifier, ideal and practical integrator and differentiators, Active filters- First order RC, oscillators (Wein bridge).

UNIT -V

Applications of Op-Amps: Hysteretic Comparator, Zero Crossing Detector, Square-wave, and triangular-wave generators. Precision rectifier, Sample and Hold circuit, clamping and clipping circuits.

555 Timer: Functional diagram, Modes of operation- astable, mono stable.

Text Books:

1. Robert L. Boylestad, "Electronic Devices and Circuit Theory", 11th Edition, PHI, 2015.
2. Gayakwad R.A. “Op-Amps and Linear Integrated Circuits”, 4th Edition, PHI, 2015.
3. Roy Choudhury, Shail B. Jain, “Linear Integrated Circuits”, 4th Edition, New Age Intern. (P) Ltd., 2002.
4. Malvino Albert Paul, “Electronic Principles”, 7th Edition, Tata McGraw Hill, 2006.
5. J. V. Wait, L. P. Huelsman and G. A. Korn, “Introduction to Operational Amplifier theory and applications”, 2nd Edition, McGraw Hill U. S., 2013.

Suggested Readings:

1. Millman and Halkias, “Electronic Devices and Circuits”, 4th Edition, McGraw Hill Publication 2015.
2. David Bell, "Fundamentals of Electronic Devices and Circuits", 5th Edition, Oxford University Press 2008.
3. Coughlin and Driscoll, “Operational Amplifiers and Linear Integrated Circuits”, 6th Edition, PHI, 2003.

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Analog Circuits	Prof. Jayanta Mukherjee	IIT Bombay
2	Analog Electronic Circuits	Prof. Shouribrata	IIT Delhi

22CEM01

ENVIRONMENTAL SCIENCE

(Mandatory Course)

Instruction	2 L Hours per week
Duration of SEE	2 Hours
SEE	50 Marks
CIE	-
Credits	-

Prerequisite: None

Course Objectives:
This course aims to:
1. Identify environmental problems arising due to engineering and technological activities and become aware of the importance of eco system and biodiversity for maintaining ecological balance.
2. Identify the threats and solve the issues of biodiversity, learn about various attributes of pollution management and waste management practices.
3. Contribute for capacity building of nation for arresting and/or managing environmental disasters.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Identify the natural resources and realize the importance of water, food, forest, mineral, energy, land resources and effects of over utilization.
2. Understand the concept of ecosystems and realize the importance of interlinking food chains.
3. Contribute for the conservation of bio-diversity.
4. Suggest suitable remedial measure for the problems of environmental pollution and contribute for the framing of legislation for protection of environment.
5. Follow the environmental ethics and contribute to the mitigation and management of environmental disasters.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	1	-	-	-	-	-	3	-	-	-	-	1	--	--	--
CO 2	1	-	-	-	-	-	2	1	-	-	-	1	--	--	--
CO 3	1	-	-	-	-	-	2	1	-	-	-	1	1	--	--
CO 4	1	-	-	-	-	1	2	1	-	-	-	1	1	--	--
CO 5	1	-	-	-	-	1	2	1	-	-	-	1	--	--	--

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I

Environmental Studies: Definition, Scope and importance, need for public awareness.

Natural resources: Use and over utilization of Natural Resources - Water resources, Food resources, Forest resources, Mineral resources, Energy resources, Land resources.

UNIT -II

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, role of producers, consumers and decomposers, energy flow in an ecosystem, food chains, food webs, ecological pyramids, Nutrient cycling, Bio-geo chemical cycles, Terrestrial and Aquatic ecosystems.

UNIT -III

Biodiversity: Genetic, species and ecosystem biodiversity, Bio-geographical classification of India, India as a Mega diversity nation. Values of biodiversity, hot-spots of biodiversity, threats to biodiversity, endangered and endemic species of India, methods of conservation of biodiversity.

UNIT -IV

Environmental Pollution: Cause, effects and control measures of air pollution, water pollution, marine pollution, soil pollution, noise pollution and Solid waste management, nuclear hazards

Environmental Legislations: Environment protection Act, Air, Water, Forest & Wild life Acts, issues involved in enforcement of environmental legislation, responsibilities of state and central pollution control boards

UNIT -V

Social issues and the environment: Water conservation methods: Rain water harvesting and watershed management, Environmental ethics, Sustainable development and Climate change: Global warming, Ozone layer depletion, forest fires, and Contemporary issues.

Text Books:

1. Y. Anjaneyulu, “Introduction to Environmental Science”, B S Publications, 2004.
2. Suresh K. Dhameja, “Environmental Studies”, S. K. Kataria & Sons, 2009.

Suggested Reading:

1. C. S. Rao,” Environmental Pollution Control Engineering”, Wiley, 1991.
2. S. S. Dara, “A Text Book of Environmental Chemistry &Pollution Control”, S. Chand Limited, 2006

22EEC07

ELECTRICAL CIRCUITS AND MEASUREMENTS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Students should have.

1. Fundamental Knowledge in Calculus and Complex Algebra,
2. Electromagnetism and Circuit Theory Concepts.

Course Objectives:
This course aims to:

1. To plot the frequency response & locus diagrams of first and second-order circuits
2. To verify various circuit theorems and to determine different parameters of a two-port network.
3. To measure the unknown values of different electrical elements and to become familiar with different transducers.

Course Outcomes:
Upon completion of this course, students will be able to:

1. Obtain and plot the frequency response and locus diagrams of RLC circuits.
2. Verify various circuit theorems.
3. Determine various two-port network parameters.
4. Validate DC and AC bridges for measuring unknown electrical parameters and demonstrate the principles of magnetic measurements.
5. Demonstrate the measurement of non-electrical quantity with an appropriate transducer, to study the operation of megger, CT & PT and to calibrate energy meter.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1
CO 2	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1
CO 3	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1
CO 4	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1
CO 5	3	2	1	1	-	-	-	-	-	-	-	-	3	-	1

1 - Slightly; 2 - Moderately; 3 – Substantially

List of Experiments:

Part-A

1. Frequency response of RLC series circuit.
2. Frequency response of RLC parallel circuit.
3. Locus diagrams of RL & RC circuits.
4. Verification of Maximum power transfer theorem.
5. Verification of Milliman’s & Compensation theorems.
6. Determination of Z, Y, ABCD & h-parameters of two-port network.
7. Determination of parameters of two 2-port networks connected in Series, parallel and cascade.

Part-B

1. Determination of unknown low resistance using Kelvin's double bridge. Measurement of unknown Inductance using Maxwell’s bridge and validating with an LCR meter.
2. Determination of unknown inductance using Anderson's bridge and validating with an LCR meter.
3. Determination of unknown capacitance using Schering bridge and validating with LCR meter.
4. Measurement of iron losses using Epstein's square bridge.
5. Measurement of strain using a strain gauge.
6. Measurement of Displacement using LVDT.
7. Measurement of unknown voltage using D.C Crompton's potentiometer.
8. Study of analog hand-driven electrical Megger
9. Study of measurements with digital current and potential transformers.
10. Calibration of three phase energy meter.

Note: Five experiments from Part-A and Part-B should be conducted in the semester**.**

22EEC08

ANALOG ELECTRONIC CIRCUITS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Students should have a prior knowledge of semiconductor Physics and basics of circuit theory.

Course Objectives:
This course aims to:
1. To understand the V-I Characteristics of diode, transistor and MOSFET.
2. To understand the frequency response of BJT, FET amplifiers.
3. To design linear and non-linear applications of Op-Amp.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Demonstrate the working principle of PN junction diode, transistor and MOSFET from their V-I characteristics.
2. Realize half wave and Full wave rectifiers for C filter combinations.
3. Analyze the significance of choosing a DC operating point for a transistor/MOSFET and to analyze the frequency response of CE amplifier.
4. Design of linear and non-applications of Op-Amps.
5. Design a 555 Timer in A stable mode to produce pulses for Pulse Width Modulation (PWM) Schemes.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	2	1	2	-	-	-	-	-	-	-	2	2	2
CO 2	2	2	2	2	2	-	-	-	-	-	-	-	2	2	2
CO 3	1	2	2	1	2	-	-	-	-	-	-	-	1	2	2
CO 4	3	3	2	1	2	-	-	-	-	-	-	-	2	3	2
CO 5	1	2	2	1	2	-	-	-	-	-	-	-	1	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

List of Experiments:

Part A
1. V-I characteristics of (Silicon and Germanium) diodes and measurement of static and dynamic resistance.
2. Zener diode characteristics and its application as a voltage regulator.
3. Rectifier Circuits-
   a. Design, realization, and performance evaluation of half wave rectifier - without and with C-filter.
   b. Design, realization, and performance evaluation of Full wave rectifier- without and with C- filter.
4. Plotting the characteristics of BJT and MOSFET.
5. Design of Biasing circuits for BJT
6. Design of Biasing Circuits for MOSFET
7. Design and Frequency response of Common Emitter BJT amplifier and measurement of Gain, Bandwidth, Input and Output impedances.

Part B

1. Measurements of Op-Amp parameters
2. Design of integrator and differentiator using Op-Amp.
3. Design of Active filters –LPF & HPF
4. Generation of triangular, sine and square wave using IC's.
5. Design of Clampers using Op-Amps.
6. Design of Clippers using Op-Amps.
7. Analysis of Hysteric comparator using Schmitt Trigger circuit.
8. Design of 555 Timer in A stable mode

Note: At least FOUR experiments from Part-A and SIX from Part-B should be conducted in the semester

22CSC30

C AND DATA STRUCTURES LAB

Instruction	2P Hours for week
Duration of SEE	3 Hours
SEE	50Marks
CIE	50Marks
Credits	1

Prerequisite: None

Course Objectives:
This course aims to:
1. Master the concepts of Functions, Arrays, Pointers and Structures.
2. Learn data structures such as Stack, Queue and Linked lists.
3. Write C programs to implement Trees and Graphs

Course Outcomes:
Upon completion of this course, students will be able to:
1. Understand and trace the execution of programs written in C language
2. Apply the concepts of looping and decision-making statements for a given problem.
3. Solve problems using functions, arrays, structures and pointers.
4. Implementation various operations on stack, queue, tree and graph.
5. Apply the knowledge of data structure in problem solving

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-
CO 3	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-
CO 4	2	3	3	1	-	-	-	-	-	-	-	-	-	1	-
CO 5	3	3	3	1	-	-	-	-	-	-	-	-	-	1	-

1 - Slightly; 2 - Moderately; 3 - Substantially

List of Experiments:
1. Using if and Switch Constructs Programs.
2. Demonstration of Looping Statements Problems.
3. Demonstration of Functions and Recursive Programs.
4. Demonstration of Structures and Union Programs.
5. Demonstration of Command line arguments.
6. Demonstration of Pointers and Arrays Programs.
7. Implementation of Stacks and Queues.
8. Implementation of Linked List Programs: Single , Double and Circular Linked List
9. Implementation of Trees: Tree operations and its traversals.
10. Implementation of Graph traversals- DFS and BFS.

Text Books:
1. Pradip Dey and Manas Ghosh, "Programming in C", 2nd Edition, Oxford University Press 2011.
2. E. Bala Guruswamy, "C and Data Structures", 4th Edition, Tata Mc Graw Hill.
3. A.K. Sharma, "Computer Fundamentals and Programming in C", University Press, 2nd Edition.

Suggested Reading:
4. M.T. Somashekara, "Problem Solving Using C", 2nd Edition, PHI 2009 Pearson, 2013.
5. Kamala Krithivasan, Rama R. "Introduction to Automata Theory, and Computation", Pearson 2009.

NPTEL Courses:

S.No.	NPTEL Course Name	Instructor	Host Institute
1	Programming and Data Structure, https://nptel.ac.in/courses/106105085	Dr. P.P. Chakraborty	IIT Kharagpur
2	Programming, Data Structures and Algorithms using C https://archive.nptel.ac.in/courses/106/106/106106127	Prof. Shankar Balachandran	IIT, Madras

22EEI01

MOOCs/Training/Internship

CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY

In line with AICTE Model Curriculum with effect from AY 2023-24

BE (Electrical and Electronics Engineering)

SEMESTER – IV

S. No	Course Code	Title of the Course	Scheme of Instruction			Scheme of Examination			Credits
			Hours per Week			Duration of SEE in Hours	Maximum Marks		
			L	T	P/D		CIE	SEE	
THEORY									
1	22E C09	Electrical Machines-I	3	-	-	3	40	60	3
2	22EEC10	Power Systems I	3	-	-	3	40	60	3
3	22EEC11	Control Systems	3	-	-	3	40	60	3
4	22EEC12	Digital Electronics	3	-	-	3	40	60	3
5	22EEC13	Signals and Systems	3	-	-	3	40	60	3
6	22EEM01	Universal Human Values-II: Understanding Harmony	1	-	-	-	50	-	1
PRACTICAL									
7	22EEC14	Electrical Machines-I Lab	-	-	3	3	50	50	1.5
8	22EEC15	Control Systems Lab	-	-	3	3	50	50	1.5
9	22EEC16	Digital Electronics Lab	-	-	3	3	50	50	1.5
Total			**16**	**-**	**9**	**-**	**400**	**450**	**20.5**
Clock Hours Per Week: 25									

L: Lecture **D: Drawing** **CIE: Continuous Internal Evaluation**

T: Tutorial **P: Practical/Project Seminar/Dissertation** **SEE: Semester End Examination**

With effect from AY 2023-24

22EEC09

ELECTRICAL MACHINES-I

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have prior knowledge of Basic Electrical Engineering.

Course Objectives:
This course aims to:

1. To inculcate the principles of Electromechanical Energy Conversions.
2. To determine the performance of DC Machines by conducting various tests.
3. To impart the knowledge of transformers and evaluate its performance.

Course Outcomes:
Upon completion of this course, students will be able to:

1. Comprehend the nomenclature and principles related to the concepts of energy balance and various excited systems
2. Elucidate the principle of operation , characteristics and parallel operation of DC Generators
3. Analyze the starting methods , speed control and testing methods under different conditions of a given DC motor
4. Explain the principle of operation, performance ,testing methods and parallel operation aspects of 1-ph transformer
5. Explore the performance and other aspects of various 3-ph transformer

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	3	2	2	2	-	-	-	-	-	-	-	1	2	2
CO 2	3	3	2	2	2	-	-	--	-	-	-	-	1	2	2
CO 3	3	3	3	3	2	-	-	-	-	-	-	-	1	2	2
CO 4	3	3	3	2	2	-	-	-	-	-	-	-	1	2	2
CO 5	3	3	3	2	2	-	-	-	-	-	-	-	1	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I
Electromechanical energy conversion: Introduction to Magnetic circuits, forces and torques in magnetic field system, energy balance, singly excited and multiple excited magnetic systems, co-energy.

UNIT -II
DC Generators: Review of Constructional features and Principle of operation of a DC machine, armature windings diagram (Lap and Wave winding), analysis of EMF equation of a DC generator, Armature reaction and its effects, process of commutation, methods of improving commutation, methods of excitation and classification of DC generators, voltage build-up in a shunt generator, critical field resistance and critical speed, generator characteristics, losses and efficiency, parallel operation and applications of DC generators.

UNIT -III
DC Motors: Review of Principle of operation, back EMF and significance of back EMF, electromagnetic torque, types of DC motors, characteristics, analysis of speed control methods, necessity of starter, three-point starter and four-point starter, soft starters (elementary treatment only) losses and efficiency, applications of DC motors.
Testing of DC machines: Swinburne's test, brake test, Hopkinson's test, fields test, retardation test and separation of losses.

UNIT -IV

Single Phase Transformer:

Review of Constructional features, principle of operation, EMF equation and ideal transformer, transformer on no-load and on-load and its phasor diagrams. Detailed study of equivalent circuits, voltage regulation and efficiency. All day efficiency, parallel operation of transformer.

Testing of transformer: Polarity test, analysis of open circuit and short circuit test, Sumpner's test, separation of losses.

Auto transformer: Construction, principle, applications, and comparison with two-winding transformers.

UNIT -V

Three-Phase Transformers: Construction, types of connection and their comparative features, Scott connection. Tap-changing transformers: No-load and on-load tap-changing of transformers, Three-winding transformers, cooling of transformers.

Text Books:

1. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
2. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
3. H. Cotton, "Advanced Electrical Technology", 7th Edition, Wheeler & Co, CBS publishers, 2005.
4. J.B Gupta, "Theory and performance of electrical machines", 14th Edition, S.K. Kataria & Sons, 2014.

Suggested Readings:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
4. Ashfaq Hussain "Electrical Machines", 3rd Edition, Danpat Rai and sons, 2012.

22EEC10

POWER SYSTEMS-I

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have knowledge in Electrical Circuit Analysis

Course Objectives:
This course aims to:
1. To introduce Generation of power through conventional sources such as: Thermal, Hydro, Nuclear and Renewable energy sources
2. To familiarize mechanical design of transmission lines and cables.
3. To familiarize present practices in tariff calculations and understand the classification and Connection schemes of distribution systems.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Discuss the construction and operation of conventional and non-conventional sources of energy along with financial management.
2. Determine the line parameters such as inductance and capacitance for different configurations of transmission line.
3. Calculate the sag and tension for given transmission line under different weather conditions.
4. Discuss the operation of underground cables, insulators and calculate the capacitance of cables and string efficiency of insulators.
5. Discuss the different tariff structures, types of costs and general aspects of distribution systems.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	-	1	-	-	2	-	-	-	-	-	1	-	2
CO 2	3	3	-	-	-	-	-	-	-	-	-	-	1	-	2
CO 3	3	3	-	-	-	-	-	-	-	-	-	-	1	-	2
CO 4	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I
Basic Concepts: Evolution of Power Systems and Present-Day Scenario. Structure of a power system: Bulk Power Grids and Micro-grids.
Generation: Thermal- Hydro -Power Plants: Principles, Choice of site, layout and various parts of generating stations, Brief description of Hydro Power Plant Dam, Spillways, Head works, Surge tank, Penstocks, Line diagram of Thermal Power Station (TPS) showing paths of coal, steam, water, air, ash and flue gasses, Brief description of TPS components: Economizers, Boilers, Super heaters, Turbines, Condensers, Chimney and Cooling towers.
Nuclear Station: Schematic Arrangement of Nuclear Power Station, Advantages and disadvantages, Types of Nuclear reactors.

UNIT -II

Solar and Wind Generation: Solar cell fundamentals, Solar Cell characteristics, solar cell classification, solar cell, Module, Panel and Array Construction, Maximizing the solar PV output and load matching, Solar PV Systems, Basic Principles of Wind Energy Conversion, The Nature of the Wind, The Power in the Wind, Forces on the Blades, Wind Energy Conversion, Wind Data and Energy Estimation, Site Selection Considerations.

UNIT -III

Line Parameter Calculations: Inductance & Capacitance calculations of Transmission Line, single-phase and three-phase symmetrical composite conductors, GMD, GMR, Transposition of conductors, bundled conductors, effect of earth capacitance.

UNIT -IV

Over-head Transmission Lines and Cables: Over-head line materials, supports, types, Ground wires, Sag/Tension calculations, Equal / Unequal supports, Effects of wind, ice/Erection Conditions stringing. charts, Insulators, Types, Material for construction, potential distribution over string of insulators, equalizing of potential, Methods.

Underground Cables: Construction of Cables, Insulating Materials for Cables, Classification of Cables, Insulation Resistance of a Single-Core Cable, Capacitance of a Single-Core Cable, Dielectric Stress in a Single-Core Cable, Most Economical Conductor Size in a Cable, Grading of Cables, Capacitance Grading, Intersheath grading, Capacitance of 3-Core Cables, Measurements of Ce and Cc.

UNIT -V

Economics of Power Generation: Load curve, Load demand and diversified factors, Base load operation, Types of costs and depreciation calculations; Tariffs, different types of tariffs; Methods of power factor improvement.

General Aspects of Distribution Systems-Types of Distribution, Ring main & Radial Distribution system, Calculations for Distributor fed at one end, distributor fed at both ends **(AC & DC).**

Text Books:

1. J. Giangrande'd. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. C.L. Wadhwa, "Electric Power Systems Theory", New Academic Science Limited, 2012.
3. B.H. Khan, "Non-Conventional Energy Resources" McGraw Hill Education, 2015

Suggested Reading:

1. A.R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc.,1999.
2. D.P. Kothari and I.J. Nagrath, "Modern Power System Analysis", McGraw Hill, 2003.
3. B.M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012

22EEC11

CONTROL SYSTEMS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have a prior knowledge of Newton's laws of Motion, Circuit theory, Vector Calculus & Differential Equations, Laplace transform and linear algebra.

Course Objectives:
This course aims to:
1. To understand different types of linear control systems and their mathematical modeling.
2. To study the stability analysis both in time and frequency domains.
3. To study the concepts of State space representation of Linear Time invariant systems (LTI).

Course Outcomes:
Upon completion of this course, students will be able to:
1. Demonstrate the characteristics of DC, AC Servo motors and Synchro Pair.
2. Analyze the performance parameters of a given second order plant in the time domain.
3. Analyze the performance of different compensators through its frequency response.
4. Design P, PI, PID and ON/OFF controller of a given system and to distinguish the merits and demerits of these controllers.
5. Demonstrate the effect of damping on the plant using the DC position control system.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	1	1	1	-	-	-	-	-	-	-	-	-	-	1
CO 2	3	3	2	2	2	-	-	-	-	-	-	-	1	-	1
CO 3	3	2	3	2	2	-	-	-	-	-	-	-	2	-	2
CO 4	3	3	2	3	2	-	-	-	-	-	-	-	3	-	2
CO 5	3	2	2	1	-	-	-	-	-	-	-	-	-	-	1

UNIT -I
Introduction to Control Systems: Open loop, closed loop System with illustrations and other classification of control systems, Impulse response and Transfer Function, Mathematical modeling of Mechanical and Electrical Systems, Analogous Systems, Feedback control characteristics - effects of feedback.

UNIT -II
Mathematical Models of Physical Systems: Introduction of servo motors & Synchro pair, Modeling of armature and field-controlled D.C motors, Block diagram algebra, Signal flow graphs and problems on conversion from block diagram to signal flow graph.

UNIT -III
Time Response Analysis: Standard test signals, Time response of first and second order systems for standard test inputs, Application of initial and final value theorem, Static error coefficients and steady state error (for standard test input signals), Performance parameters of a second-order systems based on the time-response. Concept of Stability, Routh-Hurwitz Criteria, Relative Stability analysis, root locus technique, Typical systems analyzed by root locus technique, Response with P, PI & PID controllers.

UNIT -IV

Frequency Response Analysis: Introduction, Frequency domain specifications for a second order system, Relationship between time and frequency response, bode plots, Polar plots, Nyquist stability criterion, Relative stability using Nyquist criterion. Stability analysis of plots based on gain and phase margin, Introduction to Lag and Lead networks and their Transfer functions.

UNIT -V

State Variable Analysis and Introduction to Discrete Control Systems: Concepts of state, state variable, State models of linear time invariant systems, Derivation for state models from transfer functions and differential equations, State transition matrix and its properties, Solution of state equations in time & Laplace domain, Eigenvalues and Stability Analysis, Concept of Controllability and Observability. Introduction to discrete control systems.

Text Books:

1. I.J. Nagrath, M. Gopal, "Control System Engineering", 5thEdition, New Age International(P) Limited Publishers, 2008.
2. B.C. Kuo, "Automatic Control Systems", 9th edition, John Wiley, and son's Publishers, 2009.
3. K. Ogata, "Modern Control Systems", 5thEdition, PHI publication, 2010.
4. A. Anand Kumar, "Control Systems", 2ndEdition, PHI publications, 2014.

Suggested Readings:

1. M. Gopal, "Control Systems Principles and Design", 2nd Edition Tata McGraw Hill, 2003.
2. N.C Jagan "Control Systems", 2nd Edition, BS Publications, 2008.
3. N. Nise, "Control Systems Engineering", 6th Edition, Wiley Publications, 2011.

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Control Engineering	Prof. Ramakrishna Pasumarthi	IITM

22EEC12

DIGITAL ELECTRONICS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Basics of number systems, basics of transistors and MOSFETs

Course Objectives:
This course aims to:
1. To demonstrate the working of logic families and logic gates
2. To present design and implementation of combinational and sequential logic circuits.
3. To illustrate the process of A/D and D/A conversions and PLD's in implementing the given logical problems.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Understand the fundamental concepts and techniques used in logical operations.
2. Analyze and design various combination circuits using k Maps and Q-M method.
3. Design and implement Sequential logic circuits like counters shift register sand sequence generators
4. Understand the process of Analog to Digital conversion and Digital to Analog conversion.
5. Implement PLD's to solve the given logical problems.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO 2	2	3	3	2	1	-	-	-	-	-	-	-	1	2	-
CO 3	2	3	3	2	1	-	-	-	-	-	-	-	1	3	1
CO 4	2	2	2	2	1	-	-	-	-	-	-	-	1	1	1
CO 5	1	2	2	1	1	-	-	-	-	-	-	-	1	1	1

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I
Fundamentals of Digital Systems and Logic Families: Digital signals, digital circuits, AND, OR, NOT, NAND, NOR and Exclusive-OR operations, Boolean algebra, examples of IC gates, 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 ICs, digital logic families, TTL, and CMOS logic.

UNIT -II
Combinational Digital Circuits: 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, Subtractors, BCD arithmetic, carry look ahead adder, serial adder, digital comparator, parity checker/generator, code converters, priority encoders, decoders/Seven segment display device, Q-M method of function realization.

UNIT –III
Sequential Circuits and Systems: A 1-bit memory, the circuit properties of bi-stable latch, the clocked SR flipflop, 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, sequence detector, ripple(Asynchronous) counters, synchronous counters, counters design using flip flops, applications of counters.

UNIT -IV
A/D and D/A Converters: Digital to analog converters: weighted resistor/converter, R-2R Ladder D/A converter, specifications for D/A converters, analog to digital converters: parallel comparator A/D converter, successive approximation A/D converter, counting A/D converter, dual slope A/D converter, specifications of A/D converters. **-** Significance of size of data on the accuracy of conversion.

UNIT -V

Semiconductor memories and Programmable Logic Devices: Introduction to state diagram- Moore and Mealy machine Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memory, read only memory (ROM), read and write memory (RAM), commonly used memory chips, ROM as a PLD, Programmable logic array, Programmable array logic.

Text Books:

1. R. P. Jain, "Modern Digital Electronics", McGraw Hill Education, 2009.
2. M. M. Mano, "Digital logic and Computer design", Pearson Education India, 2016.

Suggested Readings:

1. A. Kumar, "Fundamentals of Digital Circuits", Prentice Hall India, 2016.
2. S. Salivahanan "Digital circuits and design", 4th edition, Vikas Publishing house, 2010.

NPTEL Courses:

S. No.	NPTEL Course Name	Instructor	Host Institute
1	Digital Electronic Circuits https://onlinecourses.nptel.ac.in/noc20_ee32/preview	Prof. Goutam Saha	IIT Kharagpur

22EEC13

SIGNALS AND SYSTEMS

Instruction	3L Hours per week
Duration of SEE	3 Hours
SEE	60 Marks
CIE	40 Marks
Credits	3

Prerequisite: Students should have prior knowledge on calculus, ordinary differential equations, Laplace & Z-transforms.

Course Objectives:
This course aims to:
1. To know about signal properties and their characteristics for LTI systems in time & frequency domain
2. To elucidate the techniques of Laplace & Z- transforms and their applications on various systems.
3. To study about sampling theorem and different methods to reconstruct the signal.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Understand the classification & properties of signals & systems.
2. Analyze the behavior of LTI systems in continuous and discrete time domain.
3. Representation of continuous & discrete time signals in complex frequency domain
4. Apply Laplace & Z-transforms to analyze the continuous & discrete signals
5. Analyze the concept of sampling theorem and to know about the process of reconstruction.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	1	-	-
CO 2	3	2	1	1	1	-	-	-	-	-	-	-	1	-	1
CO 3	3	3	2	2	3	-	-	-	-	-	-	-	3	-	1
CO 4	3	3	2	1	2	-	-	-	-	-	-	-	3	-	2
CO 5	2	1	1	3	2	-	-	-	-	-	-	-	2	-	2

1 - Slightly; 2 - Moderately; 3 - Substantially

UNIT -I

Introduction to Signals and Systems: Signals & systems with their examples in various fields-Continuous and Discrete time systems – Representation of Discrete time signals – Unit step -Impulse-Sinusoidal -Complex exponential signals in CT & DT domains-Special time limited signals - Signal properties: Even & Odd signals - Periodic & Aperiodic signals - Energy & Power signals in CT & DT domain- Basic operations on signals-Sketching of signals –System properties : Linearity (Additivity & Homogeneity)-Time invariance -Causality - Stability with examples.

UNIT -II

Behavior of Continuous and Discrete Time LTI Systems: Response of LTI system to arbitrary input signal-Convolution in CT & DT domain-Impulse response –step response – Characterization of stability & causality of an LTI system -System of Interconnections: Cascade & Parallel – System representation through differential and difference equations.

UNIT -III

Fourier series & Fourier Transforms:

Fourier Series: Fourier series representation of periodic signals-Dirichlet's condition – Trigonometric & Exponential Fourier Series-Waveform symmetries – Fourier coefficients –Complex Fourier spectrum-

Fourier Transforms: Introduction- Fourier transform of arbitrary, periodic and standard signals – Properties of Fourier transform – Parseval's theorem.

UNIT -IV

Laplace Transforms & Z-Transforms:

Review of Laplace transforms- Relation between Laplace transform & Fourier transform of a signal-Concept of R.O.C for Laplace transform - Poles and Zeros of rational function of s and their R.OC -Properties of R.O.C - Stability in 's' domain -Laplace transform for LTI systems - Inverse Laplace transforms.

Z-Transforms: Concept of Z-Transform for discrete sequences -Distinction between Laplace -Fourier & Z-Transforms-R.O.C in Z-Transforms -Poles and Zeros of rational function of z and their ROC -Properties of R.O.C - Stability in Z-domain-Z-transforms for discrete time LTI systems -Inverse Z- Transforms - Properties of Z-Transforms.

UNIT -V

Sampling & Reconstruction: Sampling theorem & its implications - Spectra of sampled signals -Aliasing and its effects -Nyquist rate-Reconstruction: Ideal interpolator -Zero order & First order hold circuits.

Text Books:

1. A.V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and Systems", Prentice Hall India, 1997.
2. G. Proakis and D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson, 2006.
3. Anand Kumar. A, "Signals & Systems", 3rd Edition, Prentice Hall India, 2017.
4. A Nagoor Kani, "Signals & Systems", Tata McGraw Hill Education Private Limited 2010.

Suggested Readings:

1. H. P. Hsu, "Signals and systems", Schaum's series, McGraw Hill Education, 2010.
2. S. Haykin and B. V. Veen, "Signals and Systems", John Wileyand Sons, 2007.
3. Michel J. Robert, "Fundamentals of Signals & Systems", MGH International Edition, 2008.

22EEM01

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY

(Common to all Branches)

Instruction	1 T Hours per week
Duration of SEE	-
SEE	-
CIE	50 Mark
Credits	1

Introduction

This course discusses the role of human values in one's family, in society and in nature. During the Induction Program, students would get an initial exposure to human values through Universal Human Values–I. This exposure is to be augmented by this compulsory full semester foundation course.

Course Objectives:

This course aims to:

1. Understand the concept of universal human values.
2. Cultivate empathy and respect for diversity.
3. Inspire social responsibility and global citizenship.

Course Outcomes:

Upon completion of this course, students will be able to:

1. Become familiar with themselves, and their surroundings (family, society, nature).
2. Develop empathy and respect for diversity by gaining an appreciation for different cultures, perspectives, and identities.
3. Exhibit responsible and ethical behavior by adhering to principles of integrity, honesty, compassion, and justice.
4. Recognize their role as global citizens.
5. Exhibit a sense of social responsibility.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	-	-	1	-	-	1	-	-	1	-	-	1	-	1	1
CO 2	-	-	1	-	-	1	1	-	1	-	1	1	-	1	1
CO 3	-	-	-	-	-	1	-	-	-	1	-	-	-	1	1
CO 4	-	-	-	-	-	1	1	1	-	-	-	-	-	1	1
CO 5	-	-	-	-	-	1	1	1	-	-	-	-	-	1	1

1 - Slightly; 2 - Moderately; 3 - Substantially

MODULE -1

Course Introduction - Need, Basic Guidelines, Content and Process for Value Education:

- Purpose and motivation for the course, recapitulation from Universal Human Values-I
- Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and
- Experiential Validation- as the process for self-exploration.
- Natural acceptance of human values.
- Definitiveness of Ethical Human Conduct.
- Continuous Happiness and Prosperity- A look at basic Human Aspirations.
- Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority.
- Understanding Happiness and Prosperity correctly- A critical appraisal of the current Scenario.
- Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Include practice sessions to discuss natural acceptance in human beings as the innate acceptance for living with responsibility (living in relationship, harmony, and co-existence) rather than as arbitrariness in choice based on liking-disliking.

MODULE- 2

Understanding Harmony in the Human Being - Harmony in Myself:

- Understanding human being as a co-existence of the sentient 'I' and the material 'Body'
- Understanding the needs of Self ('I') and 'Body' - happiness and physical facility
- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer)
- Understanding the characteristics and activities of 'I' and harmony in 'I'
- Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail.
- Programs to ensure Sanyam and Health.

Include practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.

MODULE-3

Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship:

- Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
- Understanding the meaning of Trust; Difference between intention and competence.
- Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship.
- Understanding the harmony in society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co -existence as comprehensive Human Goals.
- Strategy for transition from the present state to Universal Human Order:
  a. At the level of individual: as socially and ecologically responsible engineers, technologists, and managers.
  b. At the level of society: as mutually enriching institutions and organizations.

Include practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss scenarios. Elicit examples from students' lives.

MODULE -4

Understanding Harmony in Nature and Existence - Whole existence as Coexistence:

- Understanding the harmony in Nature.
- Interconnectedness and mutual fulfilment among the four orders of nature - recyclability and self-regulation in nature.
- Understanding Existence as Co-existence of mutually interacting units in all - pervasive space.
- Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.
- Holistic perception of harmony at all levels of existence.
- Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
- Case studies of typical holistic technologies, management models and production systems.

Include practice sessions to discuss human beings as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc. Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

Mode of Conduct (L-T-P-C 0-1-0-0)

- While analyzing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.
- In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self-observation, self-reflection, and self- exploration.
- Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations. Such observations and their analyses are shared and discussed with other students and faculty mentors, in a group sitting.

- **Tutorials (experiments or practical) are important for this course**. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignments and/or activities are included.
- The practice sessions would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to the development of commitment, namely behaving and working based on basic human values.
- **It is advised to share the experience of the Faculty to the class in a capsule form.**
- **Involve more in evaluating the student by different activities with proper RUBRCCS**

Assessment:
This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self- assessment, peer assessment etc. will be used in evaluation.

Example:

Module-1:	10 M
Module -2:	10 M
Module- 3:	10 M
Module-4:	10 M
Attendance & Attitude:	10 M

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

Text Books:

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2022.
2. R R Gaur, R Asthana, G P Bagaria, "Teacher's Manual for A Foundation Course in Human Values and Professional Ethics", 2nd Revised Edition, Excel Books, New Delhi, 2022.

Suggested Readings:

1. A Nagaraj, "Jeevan Vidya: Ek Parichaya", Jeevan Vidya Prakashan, Amarkantak, 1999.
2. A.N. Tripathi, "Human Values", New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. Mohandas Karamchand Gandhi, "The Story of My Experiments with Truth"

22EEC14

ELECTRICAL MACHINES - I LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Students should have the prior knowledge of Basic Electrical Engineering.

Course Objectives:
This course aims to:
1. Draw the characteristics of different types of DC generators.
2. Test the DC machines under different loading conditions.
3. Understand the performance of single-phase transformer.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Understand how to perform experiments to measure and analyze the performance of different types of electrical machines.
2. Realize the performance parameters through experimentation.
3. Understand the Practical aspects of electrical machines and control
4. Obtain the performance characteristics of the given Machine
5. Interpret the experimental data and drawing conclusions.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	2	1	-	-	-	-	-	-	-	1	2	2
CO 2	3	3	2	2	1	-	-	-	-	-	-	-	1	2	2
CO 3	3	3	2	2	1	-	-	-	-	-	-	-	1	2	2
CO 4	3	3	2	2	1	-	-	-	-	-	-	-	1	2	2
CO 5	3	3	2	2	1	-	-	-	-	-	-	-	1	2	2

1 - Slightly; 2 - Moderately; 3 - Substantially

List of Experiments:
1. OCC and load characteristics of separately excited DC generator.
2. OCC and load characteristics of DC shunt generator.
3. Load characteristics of DC compound generator.
4. Swinburne’s test on DC shunt machine to predetermine the efficiency at any given load.
5. Brake test on DC series motor.
6. Hopkinson’s test on two identical DC shunt machines.
7. Separation of stray losses of DC shunt machine.
8. Load test on single phase transformers.
9. Sumpner’s test on two identical single-phase transformers.
10. Separation of Magnetic losses of transformer.
11. Study of three-phase transformer connections.
12. Demonstration of three-point starter and four-point starter.
13. Study of excitation phenomenon of three-phase transformer.
14. Parallel operation of two single-phase transformers.

Note: At least TEN experiments should be conducted in the semester.

Suggested Reading:

1. S.G. Tarnekar, P.K. Kharbanda, “Laboratory course in Electrical engineering”, S. Chand & Co 1990

22EEC15

CONTROL SYSTEMS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Students should have a prior knowledge of Newton's laws, Circuit theory, Vector Calculus & Differential Equations, Laplace transform and their properties and linear algebra.

Course Objectives:
This course aims to:
1. To understand different types of linear control systems and their mathematical modeling.
2. To study the stability analysis both in time and frequency domains.
3. To study the concepts of State space representation of Linear Time invariant systems (LTI).

Course Outcomes:
Upon completion of this course, students will be able to:
1. Obtain mathematical models and transfer functions for any electromechanical LTI system.
2. Determine the Transfer function of an LTI system using block diagram & signal flow graph approach.
3. Analyze the given first and second order systems based on their performance parameters & PID controllers.
4. Analyze the absolute and relative stabilities of an LTI system using time and frequency domain techniques and demonstrate the design of compensators.
5. Develop the state space models for various LTI systems and check their Controllability and Observability.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	2	2	-	-	-	-	-	-	-	2	-	-
CO 2	3	2	2	1	1	-	-	-	-	-	-	-	1	-	-
CO 3	3	2	1	3	2	-	-	-	-	-	-	-	2	-	1
CO 4	3	3	2	3	3	-	-	-	-	-	-	-	2	-	-
CO 5	3	3	3	3	3	-	-	-	-	-	-	-	2	-	1

1 - Slightly; 2 - Moderately; 3 - Substantially

List of Experiments:
1. Characteristics of D.C Servomotor.
2. Characteristics of A.C. Servomotor.
3. Characteristics of Synchro Pair.
4. Performance parameters of a second order system excited with step input for different damping ratios.
5. Frequency response of lag and lead compensating networks.
6. Performance of a temperature control system using P, PI and PID Controllers.
7. Temperature control of a system using relay (ON/OFF Control).
8. Characteristics of magnetic amplifier for series and parallel connections with different values of resistive load.
9. Measurement of step angle for stepper motor.
10. Response of different components of a control system using Linear System Simulator.
11. Demonstration of damping effect on the plant using DC position control system.
12. Study of closed loop speed control of BLDC motor with the effect of PI controller

Note: At least TEN Experiments should be conducted in the semester from the above list of experiments

22EEC16

DIGITAL ELECTRONICS LAB

Instruction	3P Hours per week
Duration of SEE	3 Hours
SEE	50 Marks
CIE	50 Marks
Credits	1.5

Prerequisite: Basic knowledge on logical operations, basics of logic gates, basics of flip-flops.

Course Objectives:
This course aims to:
1. To explain Demorgan's Theorem, SOP, POS forms.
2. To demonstrate implementation of Full/Parallel Adders, Subtractors and Magnitude Comparators, multiplexers, de-multiplexers and decoders using logic gates.
3. To illustrate various flip-flops, shift registers and design different counters.

Course Outcomes:
Upon completion of this course, students will be able to:
1. Demonstrate the truth table of various expressions and combinational circuits using logic gates.
2. Design, test and implement various combinational circuits such as adders, sub tractors, comparators.
3. Apply knowledge of logic gates to design complex logic circuits like multiplexers and demultiplexers.
4. Design, test and implement various sequential circuits using flip-flops
5. Design various logic circuits using shift registers.

CO-PO Articulation Matrix

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	2	2	1	1	1	-	-	-	-	-	-	-	1	1	-
CO 2	2	3	3	2	1	-	-	-	-	-	-	-	1	2	-
CO 3	2	3	3	2	1	-	-	-	-	-	-	-	1	3	1
CO 4	2	2	2	2	1	-	-	-	-	-	-	-	1	1	1
CO 5	1	2	2	1	1	-	-	-	-	-	-	-	1	1	1

1 - Slightly; 2 - Moderately; 3 - Substantially

List of Experiments:
1. 1. Verify Demorgan's Theorem for 2 variables.
2. The sum-of product and product-of-sum expressions using gates.
3. Design and implement
   (a) Full Adder using basic logic gates.
   (b) Full subtractor using basic logic gates
4. Design and implement 4-bit Parallel Adder/ subtractor using IC 7483.
5. Design and Implementation of 4-bit Magnitude Comparator using IC 7485.
6. Realize (a) 4:1 Multiplexer using gates. (b) 3-variable function using IC 74151(8:1MUX).
7. Realize 1:8 Demux and 3:8 Decoder using IC74138.
8. Realize the following flip-flops using NAND Gates.
   (a) Clocked SR Flip-Flop (b) JK Flip-Flop
9. Realize the following shift registers using IC7474
   (a) SISO (b) SIPO (c) PISO (d) PIPO.
10. Realize the Ring Counter and Johnson Counter using IC7476.
11. Realize the Mod-N Counter using IC7490.
12. Design of synchronous counters using flip-flops.
13. Design of Asynchronous counters using flip-flops.

Note: At least TEN experiments should be conducted in the Semester