Syllabus for B.Tech Degree Programme in Instrumentation and Control Engineering

offered by

Department of Instrumentation under Faculty of Technology, Cochin University of Science and Technology.

(With effect from 2024 admissions onwards)

SEMESTER I

24-219-0101 CALCULUS

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of this course the student will be able to:

CO1:	Solve ordinary differential equations and linear differential equations of higher orders with constant coefficients and apply them to engineering problems.
CO2:	Estimate the maxima and minima of multi-variable functions.
CO3:	Evaluate area as double integrals and volume as triple integrals in engineering applications.
CO4:	Illustrate the application and physical meaning of gradient, divergence, and curl.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-		-	1

Module 1 (16 hours, End semester marks 25%)

Ordinary differential equations:
First-order differential equations - exact differential equations, Bernoulli's equations-- Methods of solution and Simple applications.

Linear differential equations of higher orders with constant co-efficient-Methods of solution of these equations. Cauchy's linear differential equations. Simultaneous linear differential equations- Simple applications of linear differential equations in engineering problems.

Module 2 (16 hours, End semester marks 25%)

Partial differentiation:
Partial differentiation-Concept of partial derivative - Chain rule, Total derivative- Euler's theorem for homogeneous functions, Differentials and their applications in errors and approximations, Jacobians - Maxima minima of functions of two variables (Proof of the result not required)-Simple applications.

Co-ordinate systems: Rectangular co-ordinates- Polar co-ordinates-In plane and in Space Cylindrical polar co-ordinates-Spherical polar co-ordinates.

Module 3 (16 hours, End semester marks 25%)

Integral calculus: Application of definite integrals: Area, Volume, Arc length, Surface area.
Multiple integrals: Evaluation of double integrals-Change of order of integration. Evaluation of triple integrals-Change of Variables in integrals.
Applications of multiple integrals. Plane Area, Surface area &Volumes of solids.

Module 4 (16 hours, End semester marks 25%)

Vector calculus: Scalar and vector point functions, gradient and directional derivative of a scalar point function, divergence and curl of vector point functions, their physical meaning. Evaluation of line integral, surface integral, and volume integrals, Gauss's divergence theorem, Stoke's theorem (No proofs), conservative force fields, scalar potential.

References:

1. Sastry, S.S. Engineering mathematics: Vol1. (Forty Fourth edition). PHI Learning, New Delhi. (2008).
2. Erwin Kreyzig. Advanced engineering mathematics (Tenth edition). John Wiley& Sons, Hoboken, NJ. (2020)
3. Veerarajan, T. Engineering mathematics. (third edition). Tata McGraw Hill Publishers, New Delhi. (2011)
4. Grewal, B.S. Higher Engineering Mathematics. (Forty Third Edition). Khanna Publishers, New Delhi. (2013).
5. Online courses from swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT Open Courseware (https://ocw.mit.edu/).

24-219-0102 ENGINEERING PHYSICS

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of the course, students will be able to demonstrate the ability to:

CO1: Explain wave phenomena and interpret optical phenomena involving interference and diffraction.

CO2: Explain the polarization of light and its applications.

CO3: Understand atomic phenomena based on the principles of quantum and statistical theories.

CO4: Explain the fundamentals of acoustics and ultrasonics.

CO5: Explain crystal structure and x-ray diffraction techniques.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	1	1	-	-	-	-	1
CO5	3	3	2	-	-	-	-	-	-	-	-	1

Module 1 (16 hours, End semester marks 25%)

Waves: One dimensional wave - differential equation and solution. Three dimensional waves - differential equation and solution (no derivation) - transverse and longitudinal waves- transverse vibrations of a stretched string.

Interference of light: Analytical treatment of interference- coherent sources -derivation of expression for fringe width in in double slit experiment - white light fringes - fringe shift with thin transparent plate - interference on thin films - Newton's rings - air wedge - planeness of surfaces - anti reflection coatings.

Module 2 (16 hours, End semester marks 25%)

Diffraction of light: - Fresnel and Fraunhofer diffraction - zone plates - plane diffraction grating - measurement of wavelength - dispersive power of grating - resolving power – Raleigh's criterion - resolving power of telescope and grating.

Polarization of light: polarization by reflection - refraction - Brewster's law - double refraction

- negative and positive crystals - Nicol prism - quarter and half wave plates - production and detection of circularly and elliptically polarized lights - rotatory polarization - half shade polarimeter - applications of polarized light.

Module 3 (16 hours, End semester marks 25%)

Quantum Mechanics: wave particle duality - de Broglie's concept of matter waves - Davison & Germer experiment - uncertainty principle - postulates of quantum mechanics- formulation of time independent and time dependent Schrodinger equation - energy and momentum operators - eigen values and functions - one dimensional infinite square well potential - tunnelling (qualitative ideas only).

Statistical mechanics: macrostates and microstates - phase space - basic postulates of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics and their distribution functions (no derivation) - Fermi level and its significance.

Module 4 (16 hours, End semester marks 25%)

Acoustics: Intensity of sound - loudness - absorption coefficient - reverberation - significance of reverberation time - Sabine's formula (no derivation) - acoustics of buildings.

Ultrasonics: production of ultrasonic waves - magnetostriction and piezoelectric oscillators - detection of ultrasonics - thermal and piezoelectric methods - applications of ultrasonics - NDT and medical applications.

Crystal structure: - space lattice – unit-cell - crystal systems - lattice planes - spacing between lattice planes - Miller indices - x-ray diffraction - Bragg's law - powder diffraction method - production of x-rays- continuous and characteristic x-rays.

References:

1. Aruldas, G., Engineering Physics, PHI Ltd.
2. Beiser, A., Concepts of Modern Physics, McGraw Hill India Ltd.
3. Bhattacharya and Tandon, Engineering Physics, Oxford India.
4. Raghuvanshi, G. S., Prentice Hall of India.
5. Brijlal and Subramanyam, A Textbook of Optics, S. Chand & Co.
6. Philip J., A Textbook of Engineering Physics, Educational Publishers.
7. Vasudeva A. S., A Textbook of Engineering Physics, S. Chand& Co.
8. Kittel C., Introduction to Solid State Physics; 8th edition, Wiley, 2018.

24-219-0103 BASIC ELECTRONICS

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of the course, students will be able to demonstrate the ability to:

CO1: Understand the basics of semiconductors and operation of p-n junction devices.

CO2: Understand the working of diode circuits and their applications.

CO3: Understand the basics of bipolar junction transistors and transistor biasing.

CO4: Understand different types of field effect transistors, their working principles, and applications.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module 1 (15 hours, End semester marks 25%)

P-N junction diode: Semiconductors - band structure of semiconductors - intrinsic and extrinsic semiconductors - doping. Law of mass action - P-N junction - V-I characteristics - Zener diode, LEDs, photodiodes, and solar cells.

Module 2 (15 hours, End semester marks 25%)

Diode circuits: Diode as a circuit element - piecewise linear model - clipping and clamping circuits - voltage multiplier - rectifiers -half wave, full wave, and bridge circuits- voltage equations - capacitive filters- Zener diode voltage regulator.

Module 3 (15 hours, End semester marks 25%)

Bipolar Junction Transistor: Construction and principle of operation - current components, CE, CB, and CC configurations - BJT characteristics - BJT as an amplifier.

Transistor Biasing: Operating point - fixed-bias and self-bias - bias stabilization - bias compensation - thermal runaway - thermal stability.

Module 4 (15 hours, End semester marks 25%)

Field effect transistors: The junction field effect transistor - pinch-off voltage - JFET V-I characteristics - FET small signal model - MOSFET-structure and characteristics - MOSFET gate protection and CMOS - low frequency common source and common drain amplifiers - biasing the FET - FET as a voltage variable resistor (VVR) - the common-source amplifier at high frequencies - the common drain amplifier at high frequencies.

References:

1. Jacob Millman, Christos C. Halkias, and Chetan D Parikh– Integrated Electronics 2/e– Tata McGraw Hill. (2017).
2. Jacob Millman and Arvin Grabel – Microelectronics 2/e– McGraw Hill Education (2017).
3. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar - Microelectronic Circuits: Theory and Applications 7E (Ia) (2017)
4. Sunipa Roy, Chandan Kumar Ghosh, Sayan Dey, Abhijit Kumar Pal - Solid State & Microelectronics Technology (2023)
5. Online courses from Swayam (https://swayam.gov.in/), Stanfrd online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0104 ELECTRICAL ENGINEERING I

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

CO1: Understand and apply the fundamental laws governing electric and magnetic fields, solve problems related to electrostatics and magnetic circuits, and explain the principles of electromagnetic induction.

CO2: Understand the fundamentals of ac voltage generation and the definition of various terms.

CO3: Define and apply various theorems for solving voltage and currents in DC circuits.

CO4: Analyze AC series and parallel circuits, as well as DC transients in R-L and R-C circuits.

CO5: Gain fundamental knowledge about three-phase power systems.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2
CO3	3	3	2	-	-	-	-	-	-	-	-	2
CO4	3	3	2	-		-	-	-	-		-	2
CO5	3	2	2	-	-	-	-	-	-	-	-	2

Module 1 (16 Hours, End semester marks 25%)

Electrostatics: Electric charge, Coulomb's law of electrostatics, Electric field, Electric potential, capacitor, and capacitance.

Electromagnetism: Magnetic field, Biot-Savart law, Magnetic field of an infinite linear conductor, field strength due to circular loop, field strength inside a solenoid, force on current carrying conductor in a magnetic field, hysteresis.

Magnetic Circuits: Magnetomotive force, magnetic field strength, reluctance, laws of magnetic circuits, ampere-turns of magnetic circuit.

Module 2 (16 Hours, End semester marks 25%)

Electromagnetic induction: Relation between magnetism and electricity, Faraday's laws of electromagnetic induction, direction and induced emf, magnitude of induced emf in a coil, dynamically induced emf, statically induced emf.

Fundamentals of AC: generation of alternating current and Voltage, emf equation, phase, and phase difference, rms value, average value form factor, peak factor and vector diagram.

Module 3 (16 Hours, End semester marks 25%)

DC circuit theory: Kirchoff's laws, source transformation, superposition theorem, Thevenin's theorem, Norton's theorem, reciprocity theorem, substitution theorem and maximum power transfer theorems

Single-phase series ac circuits: Purely resistive, capacitive, and inductive ac circuits. R-L, R-C and R-L-C series ac circuits. Resonance, Q-actor, power, and power factor in ac series circuits.

Single-phase parallel ac circuits: R-L, R-C, L-C, L-R-C parallel ac circuits, parallel resonance, Q factor and power factor improvement.

DC transients in R-L and R-C circuits: rise and fall of current, time constant and energy stored in R-L and R-C circuits.

Module 4 (16 Hours, End semester marks 25%)

Three phase system: generation of three phase voltage, star connection and delta connection, star to delta and delta to star conversion, power in 3 phase system, and measurement of 3 phase power in balanced and unbalanced systems.

Symmetrical components: Positive sequence components, negative sequence components and zero sequence components.

Power Transmission Methods and Devices: Introduction to Power Transmission, Belt, Rope, Chain and Gear Drive. Length of belt open and crossed. Ratio of belt tensions (Elementary problems only). Different types of gears (Elementary ideas only). Types and functioning of clutches.

References:

1. John Bird - Electrical Circuit Theory and Technology (Fourth Edition) - Routledge (2010)
2. DP Kothari, I J Nagrath - Basic Electrical Engineering (4th Edition) - McGraw-Hill (2019)
3. Abhijit Chakrabarti, Sudipta Nath, Chandan Chanda - McGraw Hill Education (2017)
4. U. A. Bakshi, A. V. Bakshi - Electromagnetic Field Theory - TECHNICAL PUBLICATIONS
5. David J. Griffiths - Introduction to Electrodynamics (Fourth Edition) - Cambridge University Press (2017)
6. https://onlinecourses.nptel.ac.in/noc22_ee113/preview Fundamentals of Electrical Engineering

24-219-0105 MECHANICAL ENGINEERING

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

CO1: Understand the basics of thermodynamics and the working of steam turbines.

CO2: Understand the basics of internal combustion engines, refrigeration and air conditioning.

CO3: Acquire an understanding of the operation and functioning of air compressors, power plants, and pumps.

CO4: Identify manufacturing methods encountered in engineering practice and understand the mechanism of power transmission.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	3	-	3	-	-	-	-	1	-	-

Module 1 (16 Hours, End semester marks 25%)

Thermodynamics: Thermodynamics systems – open, closed, and isolated systems, equilibrium state of a system, property and state, process, cycle, Zeroth law of thermodynamics – concept of temperature, temperature scales. First law – internal energy, enthalpy, work and heat, different processes (isobaric, isochoric, isothermal, adiabatic and polytropic processes). Second law – Kelvin-Planck and Clausius statements and their equivalence, Carnot Cycle (Elementary problems only).

Thermodynamic properties of Steam, Steam generator. Different types of boilers, boiler mountings, and accessories. Formation of steam at constant pressure, working of steam turbines, compounding of turbines.

Module 2 (16 Hours, End semester marks 25%)

Internal Combustion Engines: Air standard cycles – Otto and Diesel cycles, working of two stroke and four stroke Petrol and Diesel engines, carburetted and MPFI engines, fuel pump, fuel injector, ignition system, cooling system, lubricating system.

Refrigeration & Air-conditioning: Introduction to refrigeration and air-conditioning, rating of refrigeration machines, coefficient of performance, simple refrigeration vapour compression cycle (Elementary problems only), summer and winter air conditioning.

Module 3 (16 Hours, End semester marks 25%)

Air compressors: Reciprocating air compressors – Mechanical details – Shaft work – Multistage air compressors with intercooling – Introduction to condensers and cooling towers.

Power plants: Hydro-electric power plants, thermal power plants, nuclear power plants, diesel power plants, windmills, solar energy (working principles using schematic representations only)

Pumps: Centrifugal-Reciprocating-Classifications.

Module 4 (16 Hours, End semester marks 25%)

Introduction to Manufacturing Systems: Welding - different types of welding, resistance welding, arc welding, gas welding, brazing, and soldering, different welding defects. Casting - different casting processes, sand casting, casting defects, rolling - hot rolling and cold rolling, two high, three high, cluster rolling mills, wire drawing, forging, extrusion, heat treatment of steel, elementary ideas of annealing, hardening, normalizing, and surface hardening. Principle of CAD/CAM, Rapid and Additive manufacturing.

Power Transmission Methods and Devices: Introduction to Power Transmission, Belt, Rope, Chain and Gear Drive. Length of belt open and crossed. Ratio of belt tensions (Elementary problems only). Different types of gears (Elementary ideas only). Types and functioning of clutches.

References:

1. Nag, P.K. Engineering thermodynamics. (Fifth edition). McGraw Hill Education (India) Pvt. Ltd., New Delhi. (2015)
2. Stoecker, W.F. Refrigeration and air conditioning (Second edition). Tata McGraw Hill, New Delhi. (2014)
3. V Ganesan. Internal Combustion Engines. (4th Edition). McGraw-Hill Education. (2017)
4. Arora, C.P. Refrigeration and Air Conditioning. (Fourth edition). McGraw Hill Education (India) Pvt. Ltd. (2020)
5. Jagadish Lal. Hydraulic Machines Including Fluidics Metropolitan Book Co., New Delhi. (2016)
6. Rajendar Singh. Introduction to basic manufacturing processes and workshop technology (Third Edition), New Age International, New Delhi. (2022)
7. Radhakrishnan, P, Subramanyan S and Raju V. CAD/CAM/CIM. New Age International Pvt Ltd; Fourth edition (2018)
8. https://nptel.ac.in/courses/112105123
9. https://onlinecourses.nptel.ac.in/noc20_me42/preview

24-219-0106 SOFT SKILLS DEVELOPMENT

L	T	P	C
1	1	0	2

Pre-requisites: Nil

Total Hours: 32

Course Outcomes: After completion of this course, the student will be able to

CO1: Speak English at the formal and informal levels and use it for daily conversation, presentation, group discussion and debate.

CO2: Read, comprehend, and answer questions based on literary, scientific and technological texts.

CO3: Develop self-motivation, raised aspiration, belief in one's own abilities and commitment to achieving one's goal

CO4: Demonstrate emotional maturity and emotional health.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	2	1	-	-	3	2	-
CO2	-	-	-	-	-	2	1	-	-	3	2	-
CO3	-	-	-	-	-	2	1	-	-	3	2	3
CO4	-	-	-	-	-	2	1	-	-	3	2	2

Module 1

Role and importance of verbal communication, Everyday active vocabulary, Common words used in transitions, enhancing vocabulary, affixes and changes in pronunciation and grammatical functions, words often confused in pronunciation and usage. Passage comprehension- skimming, scanning techniques, note making, note taking and summarizing. Deciphering meaning from contexts. Two types of meaning- literal and contextual. Constructive criticism of speeches and explanations.

Module 2

Fundamental grammar, Simple structures, passivizing the active sentences, reported speech, the judicious use of tenses and moods of verbs, forming questions and conversion from questions to statements and vice versa, forming open–ended and close-ended questions. Words and style used for formal and informal communication. Practice converting informal language to formal, the diction, and the style of writing. Dealing with the nuances of ambiguous constructions in language. Learning authoritative writing skills, polite writing, and good netiquette. Writing for internships and scholarships.

Module 3

Kinesics, Proxemics, Haptics, and other areas of non-verbal communication, fighting communication barriers, positive grooming, and activities on the same. Different types of interviews, and presentations - oral, poster, PPT. Organizing ideas for group discussions, the difference between GD and debates. Effective listening and seeking to understand others' perspectives. Non-violent negotiation and persuasion, communicating across age groups, cultures, or identity groups. Higher-order thinking and evaluation, information-seeking, research, independent learning, synthesis, creativity, problem analysis, and problem-solving. Decision-making, Self-reflection, and learning from experience.

Module 4

Developing positive self: Understanding oneself, a realistic awareness of oneself and one's abilities, strengths and potential, Self-esteem, Self-efficacy, and steps for improvement. Intra-personal skills – Self-control, emotional regulation and self-discipline, conscientiousness, dutifulness, reliability, truthfulness, honesty, and trustworthiness. Goal orientation and initiative. Time management – prioritizing work. Interpersonal skills – cross-cultural competence and valuing diversity of perspectives, respecting and expressing concern for others. Empathy and ability to notice the effect of one's actions on others, tolerance for disagreement, conflict management, and resolution. Civic engagement and social responsibility – Global and local awareness (issues, challenges, priorities). Vision is the ability to imagine something new or improved. Social responsibility and willingness to take constructive action.

Assessment:

1. 'Soft Skills Development' is a practical and activity-oriented course which has a continuous assessment for 50 marks based on classroom interaction, activities, and assignments. The activities may include 'Just a Minute' (JAM) sessions, group discussion, role-play, debate, and extempore speech.

   The Marks for the different components shall be as follows:
   Classroom interaction – 10 marks
   Activities – 30 marks
   Assignments (mainly from Modules I and II) – 10 marks

2. Semester End Examination is not envisaged.
3. A student should secure a minimum of 50% marks in continuous assessment for a pass in the course.

24-219-0107 LANGUAGE LAB

L	T	P	C
1	1	0	2

Pre-requisites: Nil

Total Hours: 32

Course Outcomes: After completion of this course, the student will be able to

CO1: Test pronunciation skills through stress on word accent, intonation, and rhythm.

CO2: Use the English language effectively for writing business letters, resumes, minutes of meetings, and reports.

CO3: Use the English language effectively to face interviews, group discussions, and public speaking.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	-	-	-	-	-	1	-	3	-	3
CO2	3	-	-	-	-	-	-	1	2	3	3	2
CO3	-	-	-	-	-	-	-	1	2	3	3	3

The following course content is prescribed for the Language Laboratory sessions:

1. Introduction to the Sounds of English- Vowels, Diphthongs & Consonants.
2. Introduction to Stress and Intonation.
3. Preparing business letters
4. Preparing a resume
5. Conducting a meeting and writing the minutes
6. Writing a report
7. Situational Dialogues / Role Play.
8. Oral Presentations- Prepared and Extempore.
9. 'Just A Minute' Sessions (JAM).
10. Describing Objects / Situations / People.
11. Debate
12. Group discussion

24-219-0108 ENGINEERING GRAPHICS

L	T	P	C
1	0	3	2

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

CO1: Sketch orthographic projection of points and lines as per BIS code of practice for general engineering drawing.

CO2: Draw (a) orthographic projection of solids & sectioned solids (b) development of surfaces of solid and truncated solids.

CO3: Draw (a) curves of intersection of solids, and perspective drawings of objects. (b) Construct isometric scale and isometric projections.

CO4: Draw (a) orthographic views from isometric view of a solid (b) 2D and 3D models of simple solids in modelling software.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	3	-	-	-	-	-	-	-	-	2
CO2	3	2	3	-	-	-	-	-	-	-	-	2
CO3	3	2	3	-	-	-	-	-	-	-	-	2
CO4	3	2	3	-	3	-	-	-	-		-	2

Module 1 (16 Hours, End semester marks 25%)

Relevance of technical drawing in the engineering field, Drawing instruments, Types of lines, Dimensioning, and BIS code of practice for technical drawing.

Orthographic projection of points and lines: Projection of points in different quadrants, projection of straight lines inclined to either one or both reference planes.

True length and inclination of lines with reference planes; Traces of lines. Application problems of lines.

Module 2 (16 Hours, End semester marks 25%)

Orthographic projection of solids in simple position, axis inclined to either one of the reference planes and axis inclined to both reference planes. Section of solids with section plane inclined to any of the reference planes.

The true shape of the section. Development of surfaces of the solid, truncated solids, Application-based problems.

Module 3 (16 Hours, End semester marks 25%)

Intersection of surfaces: Intersection of prism in prism and cylinder in cylinder - axis bisecting at right angles only.

Perspective projections: Perspective projections of simple solids- Visual ray and vanishing point methods.

Isometric projections: Isometric projections and views of plane figures of simple and truncated solids in simple positions including sphere and hemisphere and their combinations.

Module 4 (16 Hours, End semester marks 25%)

Multi-view projection: Conversion of isometric view of objects to orthographic views.

Introduction to Computer Aided Drawing: Role of CAD in design and development of new products, Advantages of CAD. Creating two-dimensional drawings with dimensions using suitable software. Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software.

References:

1. N.D. Bhatt - Engineering Drawing - Charotar Publishing House
2. P.I. Varghese - Engineering Graphics with AutoCAD - VIP Publishers
3. N.D. Bhat and V.M. Panchal - Machine Drawing Charotar Publishing House
4. John, K.C. Engineering Graphics, Prentice Hall India Publishers
5. Agrawal, B. and Agrawal, C.M., Engineering Drawing, Tata McGraw Hill Publishers."

24-219-0109 ELECTRICAL AND MECHANICAL WORKSHOP

L	T	P	C
0	0	3	1

Pre-requisites: Nil

Total Hours: 48

Course Outcomes: After completion of this course, the student will be able to

CO1: understand the safety precautions to be taken in a mechanical workshop.

CO2: understand different tools and equipment used in a mechanical workshop.

CO3: acquire skills for the preparation of different fitting and welding models

CO4: understand different operating of different machining tools used in a mechanical workshop.

CO5: understand the safety precautions to be taken while dealing with electric circuits.

CO6: understand and analyse different types of wiring circuits, both domestic and industrial.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	-	-	-	-	-	-	-	-	-	-	1
CO2	3	-	2	-	2	-	-	-	-	-	-	1
CO3	3	2	2	2	-	-	-	-	-	-	-	1
CO4	3	-	2	2	2	-	-	-	-	-	-	1
CO5	3	-	-	-	-	-	-	-	-	-	-	1
CO6	3	2	2	2	-	-	-	-	-	-	-	1

List of Exercises/ Experiments for Mechanical Engineering Workshop (24 hours, End semester marks 50%)

Safety rules: Understand the safety rules in mechanical engineering workshops.

General: Study of mechanical tools such as screwdrivers, spanners, Allen keys, cutting pliers etc.

Sheet metal works: Make cylindrical, conical, and prismatic shaped jobs from sheet metals**.**

Welding: Make joints using electric arc welding - butt joint, comer joint, T-joint and lap joint.

Fitting: Exercise on one simple fitting job involving practice of chipping, filing, drilling, tapping, cutting etc.

Machines: Demonstration and application of drilling machine, grinding machine, shaping machine, milling machine and lathe.

List of Exercises/ Experiments for Electrical Workshop (24 hours, End semester marks 50%)

Safety rules: Understand the safety rules in electrical engineering labs.

Component identification: Identify different electric wiring components such as different types of wires/cables, fuses, and fuse carriers, MCB, ELCB, MCCB and their uses**.**

Wiring exercises:

1. Simple light controlling circuit, PVC conduit wiring.
2. Light control circuit using the two-way switch.
3. Godown wiring, PVC conduit wiring.
4. Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, main switch, and energy meter.
5. Measurement of voltage, current, and power in a single-phase circuit using voltmeter, ammeter, and Wattmeter. Calculation of the power factor of the circuit.

References:

1. Lab manual provided by the concerned faculty in charge.
2. Virtual labs (http://www.vlab.eo.in/)

SEMESTER II

24-219-0201 LINEAR ALGEBRA AND TRANSFORM TECHNIQUES

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: On completion of this course the student will be able to:

CO1: Solve linear system of equations and to determine Eigen values and vectors of a matrix.

CO2: Evaluation of limits and continuity, Talyor and Maclaurin series.

CO3: Determine Fourier series expansion of functions and transform.

CO4: Solve linear differential equation and integral equation using Laplace transform.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	-	1	-	2	-	-	-	-	-	1
CO2	3	3	-	1	-	2	-	-	-	-	-	1
CO3	3	3	-	2	-	2	-	-	-	-	-	1
CO4	3	3	-	2	-	2	-	-	-		-	1

Module 1 (16 Hours, End semester marks 25%)

Linear Algebra 1:

Rank of a matrix, solution of linear system of equations- existence, uniqueness, general form- Eigen values, and Eigen vectors- properties of Eigen values –Diagonalization of a matrix- Cayley Hamilton theorem (without proof) Verification-Finding inverse and power of a matrix using it-Quadratic form-orthogonal reduction of quadratic form to Canonical form.

Module 2 (16 Hours, End semester marks 25%)

Limits and continuity: Definition, mean value theorem, L'Hospitals rule for the evaluation of limits of indeterminate forms.

Series: Definition, Taylor series and Maclaurin series, its applications.

Module 3 (16 Hours, End semester marks 25%)

Fourier Analysis:

Periodic function, Fourier series, Functions of arbitrary period, Even and odd functions, Half Range Expansion, Harmonic analysis, Complex Fourier Series, Fourier Integrals, Fourier

Cosine and Sine Transform, Fourier Transform. Isometric projections: Isometric projections and views of plane figures of simple and truncated solids in simple positions including sphere and hemisphere and their combinations.

Module 4 (16 Hours, End semester marks 25%)

Laplace Transforms: Gamma functions and Beta Function-Definition and properties, Laplace transforms. Inverse Laplace Transform, shifting theorem, Transform of Derivative and Integrals, Solution of differential equation and integral equation using Laplace transform, Convolution, Unit step function, Second Shifting theorem, Laplace transform of periodic function.

References:

1. Erwin Kreyzig, Advanced Engineering Mathematics, 10th Edition, Wiley, 2011.
2. Grewal, B. S., Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, 2013.
3. Linear Algebra and Group Representations: Linear algebra and introduction to group representations, Academic Press, 2022.
4. Hsiung, C.Y. and Mao, G.Y.- Linear Algebra, World Scientfic, 1998.
5. Hoffman, K. and Kunze, R., Linear Algebra, Prentice Hall of India, New Delhi 1971.
6. Exercises in algebra: a collection of exercises, in algebra, linear algebra and geometry, CRC Press, 1996.
7. Venkataraman, M. K., Linear Algebra, The National Co., 1999.
8. Online courses from swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT Open Courseware (https://ocw.mit.edu/).

24-219-0202 ENGINEERING CHEMISTRY

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: On completion of this course the student will be able to:

CO1:	Get an understanding of the theoretical principles understanding atomic orbitals and electron distribution, molecular structure, bonding, and properties.
CO2:	Discover the importance of electrical energy originating from chemical reactions articulate and utilize corrosion prevention strategies and estimate the corrosion behavior of materials and components.
CO3:	Acquire knowledge of various organic reaction mechanisms.
CO4:	Develop an ability to design and construct engineering products like fuel cells, batteries, composites, and antistatic materials.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	3	-	-	-	2	-	-	-	-	3
CO2	3	3	3	-	-	-	2	-	-	-	-	3
CO3	3	3	3	-	-	-	2	-	-	-	-	3
CO4	3	3	3	-	-	-	2	-	-	-	-	3

Module 1 (16 Hours, End semester marks 25%)

Atomic Orbitals: Quantum mechanical model of atom and probability distribution function of hydrogen atom – quantum numbers and atomic orbital filling – LCAO approximation for diatomic molecules like N2 and CO – hybridization and molecular shapes.

Module 2 (16 Hours, End semester marks 25%)

Electrochemistry: Galvanic cells – EMF measurement, classification of electrodes – Nernst equation – Electrode potential cell reaction relation between cell potential and thermodynamic quantities, Ni-Cd cell, Hydrogen – Oxygen fuel cell, electro-chemical corrosion.

Corrosion: Theories of corrosion – Factors influencing corrosion – Corrosion Control – Cathode protection – Protective coatings – Metallic coatings – Hot dipping – electroplating, metal spraying, cladding, Non-metallic coatings – properties and functions of ingredients used in paints, varnishes, Enamels and Lacquers – special paints.

Module 3 (16 Hours, End semester marks 25%)

Organic Chemistry: Aliphatic nucleophilic substitution: S N 1 & S N 2 mechanism, structure, reactivity, kinetics and stereochemistry, applications.

Elimination reactions: E1, E2 & E1cb mechanism, structure, reactivity, kinetics and stereochemistry, applications.

Addition reactions: Additions at carbon-carbon multiple bonds, cis-trans addition, structure and reactivity, applications; additions at carbon-oxygen double bonds, structure and reactivity, applications.

Rearrangement reactions: Allylic rearrangement, pinacol-pinacolone rearrangement, Hofmann rearrangement, Beckman rearrangement.

Module 4 (16 Hours, End semester marks 25%)

Fuels: Classification – Calorific value determination of solids, liquids, and Gaseous fuels – solid fuels, wood, peut, lignite, coal and coke proximate analysis of coal – liquid fuels – petroleum and its refining – fractions and their uses – cracking and reforming – petrol knock and octane number – Diesel knock and octane number – Synthetic petrol – Gaseous fuels – Natural cases – Acetylene Combustion calculation

Lubrication: Classification and properties of lubricants – Production of lubricating oils – Synthetic lubricants.

References:

1. K S Tewari & N K Vishnoi – A textbook of organic chemistry – 3 rd edition
2. F A Carey & R J Sundberg - Advanced organic chemistry
3. James E House – Inorganic chemistry
4. Castallan – Physical chemistry – Addison Wesley.
5. Galsitone and Leivis – Elementary Physical Chemistry.
6. G.S. Munku – Theoretical principles of inorganic chemistry.
7. Hendrickson, Cram and Hammond – Organic Chemistry – McGraw Hill.
8. Morrison and Boyd – Organic chemistry – Prentice Hall India.
9. J.C. Kuriakose and Rajaram – Chemistry in Engineering & Technology, Vol.II
10. P.C. Jain and Monika – Engineering Chemistry
11. L. Munree – Chemistry of Engineering Materials.
12. Online courses from Swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0203 ANALOG ELECTRONICS

L	T	P	C
3	1	0	3

Pre-requisites: Basic Electronics

Total Hours: 64

Course Outcomes: After completion of the course, students will be able to demonstrate the ability to:

CO1: Explain the basic MOS physics.

CO2: Analyze transistor amplifiers.

CO3: Explain the concept of feedback and the working of oscillators.

CO4: Understand the operation of power amplifiers and their classification.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module 1 (16 Hours, End semester marks 25%)

Energy bands in intrinsic and extrinsic silicon, Fermi levels, PN junction formation-Energy band diagram-barrier formation-changes in band diagram with forward and reverse bias.

Metal Insulator semiconductor devices: The ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, effects of real surfaces, work function difference, interface charge, threshold voltage.

Module 2 (16 Hours, End semester marks 25%)

Two port networks-transistor hybrid model-conversion formulas-transistor amplifier analysis using h-parameters-CE and CC-comparison of configurations-Miller's theorem and its dual cascading-simplified CE, CC configurations-CE amplifier with emitter resistance.

Transistors at high frequencies: hybrid pi CE transistor model-CE short circuit current gain single stage CE amplifier response, Gain-BW product – emitter follower at high frequencies.

Module 3 (16 Hours, End semester marks 25%)

Feedback amplifiers: Concept of feedback-positive and negative feedback-Voltage series, current series, voltage shunt, current shunt-effect of feedback on amplifiers-expressions and derivations- practical circuits.

Oscillators: Basic concepts- Barkhausen criteria, RC and LC oscillators-principle, analysis, and design.

Module 4 (16 Hours, End semester marks 25%)

Power amplifiers: - Classification of power amplifiers - Class A, Class B, Class AB and Class C- push-pull power amplifier - transformer less class AB - complementary symmetry power amplifier -harmonic distortion.

References:

1. Ben G Streetman, Solid State Devices,7th edition, Pearson.
2. V. Suresh Babu, Solid State Devices and Technology,3rd edition, Pearson.
3. Jacob Milman and Christos C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, E/2, Tata McGraw-Hill Publishing Co. Ltd.
4. Pulse and Digital Switching Circuits, J. B. Gupta, S. K. Kataria & Sons.
5. Microelectronic Circuits and Devices, Mark A. Horenstein, PHI Learning.
6. Online courses from Swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0204 ELECTRICAL ENGINEERING II

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of the course, students will be able to

CO1: Understand the working principles of transformers, including testing methods and applications.

CO2: Comprehend the working principles of rotating DC machines, their basic characteristics, and applications.

CO3: Explain the working principles of alternators, including starting methods.

CO4: Analyse the working principles of different types of induction motors and their performance.

CO5: Describe the basic methods of electric power generation, distribution, and protection circuits.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	2	-	-	-	-	-	-	-	-	1
CO2	3	2	1	-	-	-	-	-	-	-	-	1
CO3	3	2	1	-	-	-	-	-	-	-	-	1
CO4	3	2	2	-		-	-	-	-		-	1
CO5	3	2	-	-	-	-	-	-	-	-	-	1

Module 1 (16 Hours, End semester marks 25%)

Transformer: Working principles of ideal transformer – constructional features – emf equation – vector diagram – equivalent circuit – impedance transformation – transformer losses – flux leakage – efficiency – open circuit and short circuit tests – auto transformer – working principle and saving of copper – Basic idea of current transformer and potential transformer.

Module 2 (16 Hours, End semester marks 25%)

Rotating DC Machines: Types of rotating D.C. machines, emf generated in the armature, Torque in DC machine, method of excitation, mmf and flux density wave forms in D.C. machines, commutation process, compensating windings, magnetisation curve. Effect of armature mmf on DC machine calculations. Operating characteristics of DC generators and motors. DC motor starting, speed control of DC machines and DC machine applications.

Module 3 (16 Hours, End semester marks 25%)

Alternator: rotating field, speed, and frequency – effect of distribution of winding – emf equation – losses and efficiency regulation – emf and mmf methods. Synchronous motor – torque equation – starting methods – effect of over/under excitation.

Induction motor: Three phase induction motor – constructional features – principle of operation – Vector Diagram and equivalent circuits – performance calculation using circle diagram – starting and speed control of squirrel cage and wound rotor induction motor.

Principle of operation of single-phase induction motor, stepper motor, universal motor, and Hysteresis motor.

Module 4 (16 Hours, End semester marks 25%)

Generation and distribution of electric power: Introduction to hydroelectric, thermal, nuclear, diesel and gas power stations. Elements of transmission and distribution of electric power – Practical working voltages – underground systems and overhead systems – Typical power scheme – Different systems of transmission and circuits – Different types of line insulators used.

Switchgear and protection: Requirement of circuit breaker, basic principle of operation of circuit breakers and types of circuit breakers.

References:

1. P.S. Bimbhara – Electrical Machinery (Edition seven) – Khanna Publishers (1977)
2. S.L. Uppal – Electrical Power Systems (Generation, Transmission, Distribution, Protection and Utilization of Electrical Energy) (Fifteenth Edition) – Khanna Publishers (1987)
3. I. J. Nagrath and D. P. Kothari - Electrical Machines (Fifth Edition), Tata McGraw Hill Publishers (2017).
4. J.B Gupta - Course in Power Systems - S K Kataria and Sons (2013).
5. B L Theraja, AK Theraja - Textbook Of Electrical Technology: Ac And Dc Machines (volume - 2) (Twenty third Edition)- S Chand (1959)
6. Online courses from Swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0205 ENGINEERING MECHANICS

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of the course, students will be able to

CO1: Understand the principles of mechanics (statics and dynamics), the concept of free body diagrams and resolution of forces.

CO2: Understand the concept of moment of inertia, stress and strain.

CO3: Understand the concept of virtual work, dynamics, kinematics and kinetics.

CO4: Analyse the problems under curvilinear translation motion and rotation of rigid bodies.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	2	1	-	-	-	-	-	-	-	-	1
CO2	2	3	1	-	-	-	-	-	-	-	-	1
CO3	2	3	2	-	-	-	-	-	-	-	-	1
CO4	2	2	3	-	-	-	-	-	-	-	-	1

Module 1 (16 Hours, End semester marks 25%)

Introduction to Mechanics: Definition and classification of mechanics – rigid body (statics and dynamics) and deformable body mechanics.

Forces and Force systems: Force and its characteristics, principles of statics – concept of resultant and equilibrant, composition, and resolution of forces force systems.

Coplanar concurrent force system: Equilibrium of two, three and more than three forces, moment of a force, Varignon's theorem of moments, equations of equilibrium, friction and its effects on bodies, engineering applications.

Coplanar parallel force system: Two parallel forces, general case of parallel forces in a plane, centre of parallel forces, centre of gravity, centre of mass, centroids of curves, areas and volumes– regular and composite. Pappu's theorems, equilibrium of distributed forces in a plane, applications of the concept of centroid in engineering practice.

Module 2 (16 Hours, End semester marks 25%)

Moment of Inertia: Concept of moment of inertia and second moment of area, moment of inertia of regular and composite solids, second moment of area of regular and irregular surfaces, Polar moment of inertia / second moment of area, product of inertia, principal moments of inertia and principal axes, applications of the concepts in engineering practice.

Concepts of stress and strain - Hooke's law, elastic constants - thermal strain - shear stress and strain.

Module 3 (16 Hours, End semester marks 25%)

Principle of virtual work: Concept of virtual work and the principle of virtual work, applications in engineering, equilibrium of ideal systems, stable and unstable equilibrium.

Introduction to Dynamics: Definitions, units, divisions – kinematics, kinetics.

Rectilinear translation: Kinematics of rectilinear motion – displacement, velocity, acceleration, kinetics – differential equations of motion, D'Alembert's principle in rectilinear translation and its applications, motion of a particle due to a constant force, motion of a particle due to a force proportional to displacement – simple harmonic motion, momentum and impulse, work and energy, conservation of energy, collision of two bodies – direct central impact.

Module 4 (16 Hours, End semester marks 25%)

Curvilinear translation: Kinematics of curvilinear translation – components of displacement, velocity and acceleration, normal and tangential acceleration, kinetics – differential equations of motion, motion of projectile – projection on horizontal and inclined surfaces, D'Alembert's principle in curvilinear motion and its applications, moment of momentum, work, and energy in curvilinear motion.

Rotation of a rigid body: Kinematics of rotation – angular displacement, velocity and acceleration, RPM, relations of kinematic parameters of linear and angular motions, kinetics – differential equations of motion of a rigid rotating about a fixed axis, rotation under the action of a constant moment, rotation proportional to angular displacement – compound pendulum, D'Alembert's principle in rotation, resultant inertia force in rotation, principle of angular momentum in rotation, energy equation for rotating bodies.

References:

1. S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati, "Engineering Mechanics" 5th Edition 2017, McGraw Hill Education ISBN-10: 9781259062667, ISBN-13: 978-1259062667.
2. Dr. Biju N "Engineering Mechanics Statics & Dynamics" 2nd Edition, Educational Publishers and Distributors, ISBN-10: 8187198214, ISBN-13: 978-8187198215.
3. Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Philip J. Cornwell, "Mechanics for Engineers, Volume 1: Statics", 10th Edition 2023, McGraw-Hill Education, ISBN-10: 1337925230, ISBN-13: 978-1337925231.
4. Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Philip J. Cornwell, "Mechanics for Engineers, Volume 2: Dynamics", 10th Edition 2023, McGraw-Hill Education, IISBN-10: 1337925206, ISBN-13: 978-1337925200.
5. J. L. Meriam, L. G. Kraige, James L. Meriam "Engineering Mechanics, Volume 1: Statics" 7th Edition 2017, John Wiley & Sons, ISBN-10: 1118597228, ISBN-13: 978-1118597222.
6. J. L. Meriam, L. G. Kraige, James L. Meriam "Engineering Mechanics, Volume 2: Dynamics" 7th Edition 2017, John Wiley & Sons, ISBN-10: 111859718X, ISBN-13: 978-1118597180.

7. S. Rajasekaran and G. Sankarasubramanian, "Fundamentals of Engineering Mechanics", 3rd Edition, 2017, Vikas Publishing House Pvt. Ltd., New Delhi, ISBN-10: 8125918655, ISBN-13: 978-8125918653.
8. R.C. Hibbeler, "Engineering Mechanics, Volume 1: Statics", 15th Edition 2023, Pearson Education Asia Pvt. Ltd., New Delhi, ISBN-10: 9789355540255, ISBN-13: 9789355540255.
9. R.C. Hibbeler, "Engineering Mechanics, Volume 2: Dynamics", 15th Edition 2023, Pearson Education Asia Pvt. Ltd., New Delhi, ISBN-10: 9789355540262, ISBN-13: 9789355540262.
10. Online courses from swayam (https://swayam.gov.in/), Stanford online (https://online.stanford.edu/) and MIT OpenCourseware (https://ocw.mit.edu/).

24-219-0206 NETWORK THEORY

L	T	P	C
3	1	0	3

Pre-requisites: Nil

Total Hours: 64

Course Outcomes: After completion of the course, students will be able to

CO1: Analyze linear time-invariant electrical networks.

CO2: Apply time-domain, phasor, and Laplace transform methods for linear circuit analysis.

CO3: Investigate the transient response of networks under test signals.

CO4: Understand the principles of resonance, coupled circuits, and two-port networks.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	3	3	-	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	2	2	-	-	-	-	-		-	1

Module 1 (16 Hours, End semester marks 25%)

Introduction to circuit variables and circuit elements, Kirchhoff's Laws, Independent and dependent Sources, Network topology, Network graphs, Trees, Incidence matrix, Tie-set matrix, and Cut-set matrix.

Solution methods applied to dc and phasor circuits: Mesh and node, analysis of network containing independent and dependent sources.

Module 2 (16 Hours, End semester marks 25%)

Network theorems applied to dc and phasor circuits: Thevenin's theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Millman's theorem, Maximum power transfer theorem.

Laplace transform, properties, Laplace Transforms and inverse Laplace transform of common functions, Important theorems: Time shifting theorem, Frequency shifting theorem, Time differentiation theorem, Time integration theorem, s domain differentiation theorem, s domain integration theorem, Initial value theorem, Final value theorem.

Module 3 (16 Hours, End semester marks 25%)

Partial Fraction expansions for inverse Laplace transforms, Solution of differential equations using Laplace transforms Transformation of basic signals and circuits into s-domain.

Transient analysis of RL, RC, and RLC networks with impulse, step, pulse, exponential and sinusoidal inputs, Analysis of networks with transformed impedance and dependent sources.

Module 4 (16 Hours, End semester marks 25%)

Network functions for the single port and two ports, properties of driving point and transfer functions, Poles and Zeros of network functions, Significance of Poles and Zeros, Time domain response from pole zero plot, Impulse Response Network functions in the sinusoidal steady state, Magnitude and Phase response.

Parameters of two port network: impedance, admittance, transmission and hybrid parameters, Interrelationship among parameter sets Series and parallel connections of two port networks Reciprocal and Symmetrical two port network Characteristic impedance, Image impedance and propagation constant (derivation not required)

References:

1. Ravish R., Network Analysis and Synthesis, 2/e, McGraw-Hill, 2015.
2. Valkenburg V., Network Analysis, 3/e, PHI, 2011.
3. Sudhakar A.S. P. Shyam Mohan, Circuits and Networks- Analysis and Synthesis, 5/e, McGraw-Hill, 2015.
4. Choudhary R., Networks and Systems, 2/e, New Age International, 2013.
5. Franklin F. Kuo, Network Analysis and Synthesis, 2/e, Wiley India, 2012.
6. Pandey S. K., Fundamentals of Network Analysis and Synthesis, 1/e, S. Chand, 2012.

24-219-0207 COMPUTER PROGRAMMING

L	T	P	C
1	1	1	2

Pre-requisites: Nil

Total Hours: 48

Course Outcomes: After completion of the course, students will be able to

CO1: Solve problems efficiently by choosing loops and decision-making statements programming.

CO2: Implement different operations on arrays.

CO3: Solve problems using functions and recursion.

CO4: Design and implement C programs using the concepts of structure, pointers, and files.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	2	1	-	-	-	-	-	-	2	1	-	-
CO2	1	2	-	-	-	-	-	-	1	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	3	1	-	-	-	-	-	1	3	3

Cycle I

C Programming Basics:

1. To write a program to calculate and display areas of rectangle and triangle.

Decision Making:

2. To write a program for electricity bill preparation.
3. To write a program to find the roots of a quadratic equation.
4. To write a simple menu driven calculator program using switch statement.
5. To write a program to find the sum of digits of a given number.

Cycle II

Looping:

6. To write a program to print all the prime numbers of a given range.
7. To write a program to print the sine and cosine series.
8. To write a program to print Pascal's triangle.

Arrays:

9. To write a program to print the sum and average of elements in an array.

10. To write a program to sort the given numbers using bubble sort.

11. To write a program to perform Matrix addition and matrix multiplication.

String:

12. To write a program to perform string manipulation functions like string concatenations, comparison, find the length and string copy without using library functions.

13. To write a program to arrange names in alphabetical order.

Cycle III

Functions:

14. To write a C program to calculate the mean, variance and standard deviation using functions.

15. To write a C program to perform sequential and binary search using functions.

Recursion:

16. To write a program to print the Fibonacci series using recursive function.

17. To write a program to print the factorial of the given number using recursive function.

Structure:

18. To print the mark sheet of n students using structures.

Pointers:

19. To write a program using pointers to access the elements of an array and count the number of occurrences of the given number in the array.

Files:

20. To write a program to count the number of characters and lines in a file.

References:

1. Pradip Dey and Manas Ghosh, Computer Fundamentals and Programming in C, Second Edition, Oxford University Press, (2013).
2. Smarajit Ghosh, All of C, PHI Learning Pvt. Ltd, (2009).
3. Byron Gottfried, Programming with C, 2 nd edition, Tata McGraw-Hill, (2006).
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Second Edition, Pearson Education, (2001).
5. Sukhendu Dey, Debobrata Dutta, Complete Knowledge in C, Narosa Publishing House, New Delhi, (2009).
6. Virtual labs (http://www.vlab.co.in/)

24-219-0208 BASIC ELECTRONICS LAB

L	T	P	C
0	0	3	1

Pre-requisites: 24-219-0103 Basic Electronics

Total Hours: 48

Course Outcomes: After completion of the course, students will be able to

CO1: Remember how to identify different electronic components and read its specification.

CO2: Read electronic circuits drawn using IEEE standard symbols

CO3: Understand testing of various electronic components.

CO4: Properly use electronic testing and measurement instruments in the laboratories.

CO5: Understand the characteristics of electronic components such as diodes, BJTs and FETs.

Mapping of course outcomes with PO's: **Level - Low (1), medium (2) and high (3)**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO1	-	-	2	2	-	2	-	-	-	-	-	-
CO2	-	-	-	2	-	2	-	-	-	-	-	-
CO3	3	3	-	-	-	3	-	-	-	-	-	-
CO4	-	3	3	-	-	3	-	-	-	-	-	-
CO5	-	-	2	2	-	2	-	-	-	-	-	-

List of exercises (18 hours, End semester marks 40%)

1. Familiarization/ identification of electronic components with specification: functionality, type, size/ value, colour coding, package etc. of components such as resistors, capacitors, inductors, ICs, switches, relays, crystals, displays, heat sinks etc.

2. Understanding IEEE symbols for electronic components in drawings.

3. Familiarization of electronic test and measurement instruments such as multi-meter, function generator, power supply, oscilloscope etc.

4. Testing of electronic components such as resistor, capacitor, diode, transistor, UJT and FET

5. Soldering practice: assemble a full wave rectifier using transformer, diodes, capacitor, and Zener diode on a general-purpose PCB.

List of experiments (30 hours, End semester marks 60%)

1. Characteristics of diode

2. Characteristics of Zener diode

3. Transistor characteristics in CB configuration

4. Transistor characteristics in CE configuration

5. Bias and bias stabilization

6. FET characteristics

7. Design of FET amplifiers – frequency response

References:

1. The faculty in charge will provide lab manual

2. Virtual labs (http://www.vlab.co.in/)

SEMESTER III

24-219-0301 COMPLEX ANALYSIS AND PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

(The cognitive levels are given in bracket)

On completion of the course, students will be able to:

CO1: Transform a region to another region using conformal mapping. (Understand)

CO2: Evaluate real integrals using residue theorem.(Apply)

CO3: Formation and solution of partial differential equation.(Apply)

CO4: Determine solution of partial differential equation for vibrating string and heat conduction.(Apply)

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	1
CO2	2	2	-	-	-	-	-	-	-	-	-	1
CO3	2	2	1	-	-	-	-	-	-	-	-	1
CO4	2	2	1	-	-	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)

Analytic functions - Cauchy-Riemann equation (Cartesian and polar) -Harmonic function construction of analytic function given real or imaginary parts- Conformal mapping of standard elementary function and bilinear transformation.

Module II (16 hours, End semester marks 25%)

Cauchy's integral theorem, Cauchy's integral formula and for derivatives-Taylor's and Laurent's expansion (without proof) - Singularities-Residues-Cauchy's Residues theorem- Contour integration involving unit circle.

Module III (16 hours, End semester marks 25%)

Formation of partial differential equation eliminating arbitrary constants and function—Solution of first order equation-four standard types- Lagrange's equation—Linear homogeneous partial differential equation with constant coefficient.

Module IV (16 hours, End semester marks 25%)
One dimensional wave equation, D'Alembert's solution and one dimensional heat flow equation - solution by the method of separation of variables - application of Fourier series solution. Solution of Laplace's equation over a rectangular region by the method of separation of variables.

References:

1. Erwin Kreyzig, Advanced Engineering Mathematics, 10th ed.,Wiley,2011.
2. Grewal, B. S.,Higher Engineering Mathematics, 43rd ed., Khanna Publishers,2013.

NPTEL course links that align with the syllabus:

1. **Ordinary and Partial differential equations:**
   https://nptel.ac.in/courses/111/107/111107111/

Experimental learning modules:
Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

24-219-0302 ELECTRICAL MEASUREMENTS AND INSTRUMENTATION

L	T	P	C
3	1	0	3

Pre-requisites: Nil
Total hours: 64
Course Outcomes:
(The cognitive levels are given in bracket)
On completion of the course, students will be able to:

CO1: Comprehend the principle of measuring instruments. (Understand). **CO2:** Identify the describe various methods of power and energy measurement(Understand).
CO3: Identify and evaluate bridges for measurement of R, L and C (Apply).
CO4: Summarize the characteristics of instruments for magnetic measurements (Understand).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2

Module I (16 Hours. End semester marks: 25%)
Electrical instruments:– Moving coil, moving iron, dynamometer, induction, thermal and rectifier type instruments, - principles and operation - conversion of PMMC type instruments to voltmeter and ammeter. D' Arsonval galvanometer-constructional details.
Cathode ray oscilloscopes: - Principles, block diagram, construction, Lissajous patterns.

Module II (16 Hours. End semester marks: 25%)
Measurement of power: Wattmeters- Electrodynamometer type, induction type, single phase and three phase wattmeter, compensation, Errors in power measurements. Measurement of Energy: Induction type single phase and three phase energy meter, Errors and Compensation in energy meters. Current transformer and potential transformer: Construction, theory, operation, and application.

Module III (16 hours, End semester marks 25%)
Potentiometers: DC potentiometer-use of DC potentiometer in the measurement of voltage, current, resistance and power – calibration of ammeter, voltmeter, wattmeter – AC potentiometers – use of AC potentiometers in magnetic measurements

DC bridges: General equation for bridge at balance, Types of bridges –Wheatstone, Kelvin, Carey Foster slide wire bridge.
AC bridges: General equation for bridge at balance, Maxwell's inductance, Maxwell's inductance – capacitance bridge, Hay's bridge, Anderson's bridge, Schering bridge, Wien's bridge.

Module IV (16 hours, End semester marks 25%)
Magnetic measurements : Classification of magnetic measurements – Ballistic Galvanometer, Flux Meter, measurement of flux density and magnetizing force – magnetic potentiometers – determination of B.H. curve – hysteresis loop – testing of bar and ring specimens– measurement of air gap flux – testing of permanent magnets.

References:

1. A K Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpath Rai & Co, 19th Edition, 2023.
2. David A Bell, Electronic instrumentation and Measurements, 3rd Edition, Oxford, 2013.
3. Kalsi H S, Electronic Instrumentation and Measurements, Mc Graw hill, 4th ed., 2019.

NPTEL course links that align with the syllabus:

1. **Electrical and electronic measurements**
   https://nptel.ac.in/courses/108/105/108105153

Experimental learning modules:
1. http://vlab.amrita.edu/index.php?sub=1&brch=192

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

24-219-0303 DIGITAL ELECTRONICS

L	T	P	C
3	1	0	3

Pre-requisites: Nil
Total Hours: 64
Course Outcomes: After completion of this course, the student will be able to,

CO1: Demonstrate the ability to convert between different number systems and perform arithmetic operations while identifying and classifying various binary codes, and simplify complex logic expressions using Boolean algebra,
CO2: Design and implement combinational circuits and understanding different logic families.
CO3: Design and implement sequential logic circuits and demonstrating an understanding of their functional operation and applications.
CO4: Classify different types of semiconductor memories and utilize Verilog to model, simulate, and implement both combinational and sequential circuits effectively.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO	PO5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11	PO 12
CO1	3	2	-	-	-	-	-	-	-	-	-	2
CO2	2	1	3	-	2	-	-	-	-	-	-	2
CO3	2	3	3	2	-	-	-	-	-	-	-	2
CO4	2	1	-	-	3	-	-	-	-	-	-	2

Module 1 (16 Hours, End semester marks 25%)
Number Systems: Decimal, binary, octal, hexadecimal number systems and conversions – basic arithmetic operations in various number systems.
Binary Codes: Classification of binary codes – 8421 BCD codes, excess – 3 code, gray code, error detecting and correcting codes.
Logic Gates: AND, OR, NOT, NAND, NOR, EXOR, EXNOR.
Boolean Postulates and Laws: – De-Morgan's theorems, principle of duality, minimization of boolean expressions, Sum of Products (SOP), Product of Sums (POS), Canonical forms, Karnaugh map minimisation.

Module 2 (16 Hours, End semester marks 25%)

Introduction to Logic Families: –RTL, DTL and TTL characteristics –TTL inverter - circuit description and operation, CMOS inverter - circuit description and operation, structure and operations of TTL and CMOS gates; NAND in TTL and CMOS, NAND and NOR in CMOS, comparison of RTL, DTL, TTL, I2L, CMOS and ECL logic families.

Combinational Logic Circuits:- Comparators, multiplexers, de-multiplexers, encoder, decoder. Half and full adders, subtractors, serial and parallel adders, BCD adder.

Module 3 (16 Hours, End semester marks 25%)

Programmable Logic Devices – Design of combinational logic using PAL and PLA.

Sequential Logic Circuits: Building blocks like S-R, JK and master-slave JK FF, edge triggered FF, conversion of flip-flops, excitation table and characteristic equation. shift registers-SIPO, SISO, PISO, PIPO. shift Registers with parallel Load/Shift, ring counter and Johnson's counter. Asynchronous and synchronous counter design, mod N counter.

Module 4 (16 Hours, End semester marks 25%)

Semiconductor Memories: – Classification-RAM, ROM, PROM, EEPROM.

Basics of Verilog: -- basic language elements: identifiers, data objects, scalar data types, operators, modeling in Verilog, implementation of gates with simple Verilog codes. Modeling and simulation of combinational circuits with Verilog codes at the gate level. Modeling and simulation of flip-flops and counters in Verilog.

References:

1. "Digital Design" by M. Morris Mano and Michael D. Ciletti,5th Edition, Pearson 2017.
2. "Digital Fundamentals" by Thomas L. Floyd, Pearson, 11th Edition, 2020.
3. "Digital Logic Design" by Brian Holdsworth and Clive Woods, 3rd Edition, Pearson, 2018.
4. "Contemporary Logic Design" by Randy H. Katz and Gang Wei, 3rd Edition, Pearson, 2019.
5. "Digital Electronics: A Practical Approach with VHDL" by William Kleitz, 4th Edition, Pearson, 2016.
6. Mano M.M., Ciletti M.D., Digital Design, Pearson India, 4th Edition, 2006.
7. S. Brown, Z. Vranesic, Fundamentals of Digital Logic with Verilog Design, McGraw Hill.
8. D.V. Hall, Digital Circuits and Systems, Tata McGraw Hill, 1989

NPTEL Suggestions:

1. **Introduction to Digital System Design:**
   http://nptel.ac.in/courses/117105080/
2. **Digital Circuits and Systems:**
   https://nptel.ac.in/courses/117/106/117106114

Experimental learning modules:

1. http://vlabs.iitkgp.ernet.in/dec/
2. http://vlabs.iitkgp.ernet.in/coa/

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

24-219-0304 LINEAR INTEGRATED CIRCUITS

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

After completion of the course, students will be able to demonstrate the ability to:

CO1: Explain the basic principles and characteristics of operational amplifiers.
CO2: Explain and design various op-amp circuits for linear applications.
CO3: Explain and design various op-amp circuits for non-linear applications.
CO4: Design circuits for various applications using 555 timer IC, voltage regulator ICs and phase locked loops.

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)

Differential amplifiers: – Structure and principle of operation– input and output impedance, voltage gain - CMRR - transfer characteristics.

Operational Amplifiers:-Block diagram –ideal characteristics- Op Amp parameters –open-loop configurations- voltage-transfer curve- frequency response –Gain-BW product-slew rate.

Module II (16 hours, End semester marks 25%)

Op-amps with negative feedback: Virtual ground concept-inverting amplifier-non-inverting amplifier - voltage follower - summing amplifier - difference amplifier - instrumentation amplifier - voltage to current and current to voltage converters - integrator - differentiator - analog computation.**Active filters:** First and second order low pass, high pass, band pass and band reject filters - narrow band pass and notch filters - design of low pass filters using Butterworth approximations.

Module III (16 hours, End semester marks 25%)
Non-linear applications: Precision rectifiers –sample and hold circuits - logarithmic and anti-logarithmic amplifiers - analog multipliers - comparator - Schmitt trigger - waveform generators - Pulse, square and triangular wave forms - RC Phase shift and Wien bridge oscillators.

Module IV (16 hours, End semester marks 25%)
Timer IC 555: Astable and monostable operations - applications.

Monolithic regulators: –Series regulator, - fixed voltage regulators - 78XX and 79XX series - adjustable voltage regulators - IC 723 - Switched mode power supplies - Principles and applications – switching regulators.

Phase locked loops and applications: Operating principles - Building blocks-Lock and capture – classification - phase sensitive detection using PLL.

References:

1. Jacob Milman and Christos C. Halkias, Integrated Electronics 2/E ,2017,McGraw Hill Education.
2. Gayakwad R. A., Op-Amps and Linear Integrated Circuits, Prentice Hall, 4/e, 2010
3. Salivahanan S. ,V. S. K. Bhaaskaran, Linear Integrated Circuits, Tata McGraw Hill, 2008
4. Roy D. C. and S. B. Jain, Linear Integrated Circuits, New Age International, 3/e, 2010
5. Operational Amplifiers and Linear Integrated Circuits 4th Ed 2007 – William D. Stanley, Pearson

NPTEL course links that align with the syllabus:
1. Analog circuits.
https://archive.nptel.ac.in/courses/108101094/

2. Op-Amp Practical Applications: Design, Simulation And Implementation.
https://archive.nptel.ac.in/courses/108108114/

24-219-0305 TRANSDUCERS - I

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

After completion of the course, students will be able to demonstrate the ability to:

- **CO1**: Describe working principles of various transducers/sensors (Understand).
- **CO2**: Interpret the characteristics of the transducers/sensors (Understand).
- **CO3**: List various standards used for selection of transducers/sensors (Remember)
- **CO4**: Select transducers/sensors for specific applications (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)

Introduction: Definition of transducer, classification, basic requirements, sensitivity, Specification of a transducer.

Level measurement: Float type level indicator, displacer level indicator, air purge systems, diaphragm box type, manometer type - Electrical methods of level measurement, resistive, capacitive, ultrasonic, radiation type, laser level sensors - Solid level measurement, gamma ray absorption method, weighing method, capacitive type, diaphragm method, rotating paddle, stack detector - Level switches.

Module II (16 hours, End semester marks 25%)

Temperature measurement:- Temperature scales, classification of temperature sensors, standards - different types of filled system thermometers, installation maintenance, source of errors – Bimetallic thermometer - Thermocouples, basic principles, various types of thermocouples, materials, construction - RTD, materials, construction, characteristics, measuring circuits, three wire and four wire methods - Thermistor, materials, construction, characteristics, measuring circuits – Radiation methods of temperature measurement, radiation pyrometer, optical pyrometer - Semiconductor and IC sensors.

Module III (16 hours, End semester marks 25%)

Pressure measurement:- Definition, pressure scale, standards - Elastic type pressure gauges, material, construction, calibration - Elastic pressure sensors - Pressure gauges using strain gauge, capacitive, inductive and piezoelectric materials - Measurement of low pressure, McLeod gauge, thermal conductivity gauge, thermocouple gauges, ionisation gauges - Pressure calibration using dead weight tester.

Module IV (16 hours, End semester marks 25%)

Measurement of speed:- Mechanical tachometers, revolution counter type, resonance type, centrifugal force type tachometers – Electrical tachometers, Eddy current, electric generator, contactless type, frequency type tachometers - Stroboscopic tachometers - magnetic pickups, encoders, photoelectric pickups.

Measurement of acceleration:- Potentiometric accelerometer, LVDT accelerometer, piezo- electric accelerometer, strain gauge accelerometer.

References:

1. D.V.S. Murthi, "Instrumentation and Measurement Principles", PHI, New Delhi, 2nd ed. 2012.
2. D. Patranabis, "Instrumentation and Control", Tata McGraw Hill, 2nd ed. 2011.
3. Rangan, C. S., Sarma, G. R., & Mani, V. S. "Instrumentation: Devices and Systems" Tata McGraw Hill, 2nd ed.1983.
4. B. C. Nakra and K. K. Choudhari, "Instrumentation Measurements and Analysis" McGraw Hill Education, 4th ed. 2016.
5. R. K. Jain, "Mechanical and industrial measurements" Khanna Publishers 11th ed. 1995.
6. E.O. Doebelin, "Measurement Systems", McGraw Hill, 6th ed. 2011.
7. A.K. Sawhney , "A Course in Electrical and Electronic Measurements and Instrumentation" Dhanpat rai, 19th ed. 2023

NPTEL course links that align with the syllabus:

1. **Sensors and actuators**
   https://nptel.ac.in/courses/108/108/108108147/
2. **Industrial Instrumentation**
   https://nptel.ac.in/courses/108/105/108105064/

24-219-0306 PRINCIPLES OF MEASUREMENT AND INSTRUMENTATION

L	T	P	C
3	1	0	3

Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

> **CO1:** Analyze and evaluate the performance characteristics of various instruments, identifying sources of measurement errors and applying techniques to minimize those errors. (Understand)
> **CO2**: Apply statistical concepts and techniques to analyze and interpret measurement data, including graphical representation, curve fitting, and understanding of frequency distributions. (Apply)
> **CO3**: Describe the components and functioning of analog and digital data acquisition systems, including A/D and D/A conversion techniques, and assess their accuracy and resolution. (Understand)
> **CO4:** Understand the appropriate data presentation elements and digital instruments, demonstrating an understanding of their resolution and sensitivity (Understand)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	1
CO2	2	3	-	2	-	-	-	-	-	-	-	1
CO3	3	2	-	-	2	-	-	-	-	-	-	1
CO4	1	2	3	-	-	-	-	-	-	2	-	1

Module 1 (16 Hours, End semester marks 25%)

Generalised Performance characteristics of Instruments: Functional elements of an Instrument, Performance characteristics : static characteristics, dynamic characteristics, mathematical model,zero order, first order, second order Instruments – impulse, step and ramp response.

Errors in measurement: Sources of error - Limiting errors, Types of errors – Gross, systematic, Random and sources of errors, error reduction techniques, Loading effect of Instrument.

Module 2 (16 Hours, End semester marks 25%)

Measurement Data Analytics: Graphical representation of data, curve fitting, statistical concepts, mean and median values, standard deviation, variance, frequency distribution, normal and Gaussian distribution, confidence level, Analysis of linear systems.

Module 3 (16 Hours, End semester marks 25%)

Data acquisition systems: Objectives of DAS, elements of analog data acquisition system – elements of digital DAS –Elementary treatment of A/D and D/A conversion, D/A converters –Binary weighted and R-2R ladder type – D/A accuracy and resolution – A/D converters counter ramp, successive approximation, Simultaneous, dual – slope A/D converters – A/D accuracy and resolution – sample and hold circuit. – Data loggers – elements of microprocessor and PC based DAS.

Module 4 (16 Hours, End semester marks 25%)

Data presentation elements: – Review and choice of data presentation elements, pointer – scale indicators, Analog chart recorders –Oscillographic recorders, magnetic tape recorders, : , LCD and LED devices, and displays. Digital meters – resolution, sensitivity – Digital Voltmeter- Digital Frequency meter, Digital Multimeter, RMS meter, Q meter. Digital storage oscilloscope – Principles and instrumentation – Spectrum analyzer.

References:

1. “Electrical and Electronic Measurements and Instrumentation”,A K Shawney, Dhanpath Rai&Co., 2021.
2. “Digital Principles and Applications”, Leach, Malvino, Saha, McGraw Hill Education, 8th Edition, 2014.
3. "Measurement and Instrumentation: Theory and Application" by Alan S. Morris and Reza Malekian, Elsevier,2020.
4. "Instrumentation and Control Systems" by William Bolton, Newnes, 2015.
5. "Principles of Measurement and Instrumentation" by D.V. Dhanasekaran, Cengage Learning, 2018.
6. "Electronic Instrumentation and Measurements" by David A. Bell, Oxford University Press, 2020.
7. "Fundamentals of Measurement and Instrumentation" by R. P. Singh and V. K. Jain, Wiley, 2021.
8. A.D. Helfrick and W.D. Cooper, “Modern electronic instrumentation and measurement techniques”, Prentice Hall India.
9. “Measurement Systems”, by Ernest O Doebelin & Dhanesh N Manik, McGrawHill Publications, 7th Edition, 2020

NPTEL course links that align with the syllabus:

1. Electrical Measurement and Electronic Instruments:
   https://nptel.ac.in/courses/108/105/108105153/
2. Industrial Instrumentation:
   https://archive.nptel.ac.in/courses/108/105/108105064/

24-219-0307 SCIENTIFIC COMPUTING LAB

L	T	P	C
0	0	3	1

Total hours: 48

Course Outcomes:

On completion of the course the students will be able:

> **CO1: Demonstrate** proficiency in basic programming constructs using MATLAB/Python/Scilab, including data types, control structures, and small script execution.
>
> **CO2: Apply** scientific computing functions to solve mathematical problems and **perform** basic data analysis using built-in functions in the programming language.
>
> **CO3: Implement** array and matrix operations, and **perform** numerical differentiation and integration for solving engineering problems.
>
> **CO4: Visualize and analyze** data using plots and spreadsheets, demonstrating the ability to generate histograms, stem plots, and scatter plots with random data.

Mapping of course outcomes with Program outcomes.

	PO1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3	3	-	-	-	-	-	-	3
CO 2	3	3	3	3	3	-	-	-	-	-	-	3
CO 3	3	3	3	3	3	-	-	-	-	-	-	3
CO 4	3	3	3	3	3	-	-	-	-	-	-	3

1. Familiarization of the Computing Tool
   a. Familiarization of a programming language – MATLAB/ Python/ Scilab
   b. Familiarization of data types in the language used.
   c. Familiarization of the syntax of different conditional statements.
   d. Basic syntax and execution of small scripts
      i. Write a program to compute the sum of the digits of an integer.
      ii. Write a program to compute the factorial of an integer.
      iii. Write a program to find the Sum of Two Numbers
      iv. Write a program to Check Prime Number
2. Familiarization of Scientific Computing
   a. Basic arithmetic functions such as abs, sine, real, imag, complex, sinc etc. using bulit

in modules.

b. Functions with examples

  i. *Write a function to print the first N Fibonacci numbers and its sum*
  ii. *Write a function to print the first N even numbers and their sum.*
  iii. *Write a function to print the first N odd numbers and its sum.*
  iv. *Write a function to compute the factorial of an integer.*
  v. *Write a function for Celsius to Fahrenheit conversion*
  vi. *Write a function to Sort the elements of an array in ascending order.*
  vii. *Write a function to calculate the area of a circle given its radius.*
  viii. *Write a function for Palindrome Check*

3. Realization of Arrays and Matrices
4. Numerical Differentiation and Integration
5. Simple Data Visualization (Draw stem plots, line plots, box plots, bar plots and scatter plots with random data, Plot the histogram of a random data etc.)
6. Simple Data Analysis with Spreadsheets (Compute the mean and standard deviation of the signal. Plot its histogram with an appropriate bin size.)

Implementation Examples

(Any two from the following list, The Faculty in charge may add more similar experiments)

1. Convergence of Fourier Series
2. Convolution
3. Output of LTI systems
4. Checking Energy signal or power signal
5. Plot heatmap of correlation in IRIS dataset
6. Employee management system
7. Object detection
8. Classification
9. Digit Recognition

References:

1. E. Balaguruswamy, *Introduction to Computing and Problem Solving Using Python*, McGraw Hill Education, 1st Edition, 2016.
2. Martin C. Brown, *Python: The Complete Reference*, McGraw Hill Education, 1st Edition, 2018.
3. Richard L. Halterman, *Learning To Program With Python*, Latest Edition, 2017, Available Online.
4. Eric Matthes, *Python Crash Course, 3rd Edition, A Hands-On, Project-Based Introduction to Programming*, No Starch Press, 3rd Edition, 2023, ISBN: 978-1718502703.

5. Aurelien Geron, *Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, O'Reilly Media Inc, 2nd Edition, 2022, ISBN: 978-9355421982.
6. Adrian Rosebrock, *Practical Python and OpenCV - An Introductory Example-Driven Guide to Image Processing and Computer Vision*, PyImageSearch, 3rd Edition, 2021.
7. Andreas C. Muller and Sarah Guido, *Introduction to Machine Learning with Python: A Guide for Data Scientists*, O'Reilly Media Inc, 1st Edition, 2016, ISBN: 978-1449369415.

Experiential learning modules:

1. https://python-iitk.vlabs.ac.in/http://vlab.co.in/
2. https://cse02-iiith.vlabs.ac.in/List%20of%20experiments.html
3. https://ps-iiith.vlabs.ac.in/List%20of%20experiments.html

NPTEL course links that align with the syllabus:

1. https://onlinecourses.nptel.ac.in/noc22_cs26/preview
2. https://onlinecourses.nptel.ac.in/noc20_ge05/preview
3. https://onlinecourses.swayam2.ac.in/aic20_sp38/preview
4. https://onlinecourses.nptel.ac.in/noc23_ph46/preview
5. https://onlinecourses.nptel.ac.in/noc23_cs18/preview

(Any other relevant Experiential learning module from Virtual Lab and courses from NPTEL may also be included as and when it is made available by the Ministry of Education).

24-219-0308 ELECTRICAL MACHINES LAB

L	T	P	C
0	0	3	1

Pre-requisites: Electrical Engineering
Total hours: 64
Course Outcomes:
After completion of the course, students will be able to demonstrate the ability to:

CO1: Analyse the performance of DC motors and DC generators by performing suitable tests (Analyse).
CO2: Evaluate the performance characteristics of AC generators & AC motors by conducting appropriate experiments (Apply).
CO3: Interpret the performance characteristics of transformers by conducting OC, SC & load test (Apply).
CO4: Implement the concept of calibration and understand the limitations of the measuring instruments (Understand).
CO5: Demonstrate methods of measurement of self-inductance, capacitance and resistance using AC and DC bridges (Understand).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	-	-	-	-	-	1	1
CO2	3	3	2	1	1	-	-	-	-	-	1	1
CO3	3	3	2	2	2	-	-	-	-	-	2	1
CO4	3	3	2	2	2	-	-	-	-	-	2	1
CO5	3	3	2	2	2	-	-	-	-	-	2	1

List of experiments:
1. Load Test on D.C. shunt motor
2. Load test on D.C. shunt generator
3. Open circuit and load test on separately excited D.C. generator
4. Load test on D.C. series motor
5. Load test on D.C. shunt generator

6. Load test on single phase induction motor
7. No load & Blocked rotor test on three phase induction motor
8. No load characteristic of single-phase generator
9. O.C.C. and S.C.C. of three phase synchronous generator
10. Open circuit and short circuit test on single phase transformer
11. Load Test on single phase transformer
12. Calibration of ammeter and voltmeter using precision potentiometer
13. Measurement of 3-phase power & Power factor using two-watt meter method
14. Kelvin's double bridge

References :

1. Bimbra P. S., Electrical Machinery, 7/e, Khanna Publishers, 2011.
2. Theraja B. L., A Textbook of Electrical Technology, S. Chand & Company, New Delhi, 2008.

NPTEL course links that align with the syllabus:

1. **Electrical Machines - I**

   https://nptel.ac.in/courses/108/105/108105155/

Experimental learning modules:

1. http://vem-iitg.vlabs.ac.in/
2. http://em-coep.vlabs.ac.in/
3. http://vlabs.iitb.ac.in/vlabsdev/vlab_bootcamp/bootcamp/Sadhya/index.php

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

SEMESTER IV

24-219-0401 NUMERICAL AND STATISTICAL METHODS

L	T	P	C
3	1	0	3

Total hours: 64
Course Outcomes:
(The cognitive levels are given in bracket)
On completion of the course, students will be able to:

CO1: Solve algebraic and transcendental equations by numerical methods (Apply).
CO2: Perform numerical differentiation and integration (Understand).
CO3: Find the mean and variance of a probability distribution including the binomial distribution (Understand).
CO4: Use statistical tests in testing hypotheses on data (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	1
CO2	2	2	-	-	-	-	-	-	-	-	-	1
CO3	2	2	-	-	-	-	-	-	-	-	-	1
CO4	2	2	1	-	-	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)
Numerical solution of algebraic and transcendental equation by - Regula-Falsi method, Newton Raphson's method. Gauss Seidal iteration method to solve a system of equations and convergence (without proof) Newton's forward and backward interpolation formula. Lagrange interpolation, Newton's divided difference and central differences.

Module II (16 hours, End semester marks 25%)
Numerical differentiation at the tabulated points with forward, backward and central diffrences. Numerical integration with trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule. Taylor series method. Euler method, Modified Euler method, Runge–Kutta method of second and fourth order for solving 1st order ordinary differential equation

Module III (16 hours, End semester marks 25%)
Random variable (discrete and continuous) Expectation-mean and variance of probability distribution. Binomial, Poisson and Normal distribution and Fitting of this Distribution to the given data. Curve fitting- fitting of straight line, parabola, exponential.

Module IV (16 hours, End semester marks 25%)
Population and Sample-Sampling Distribution (of mean and variance) Testing of Hypothesis-level of significance, Z-test statistic, Chi square test for variance, for goodness of fit and F-test .

References:

1. Erwin Kreyzig, Advanced Engineering Mathematics, 10th ed., Wiley, 2011.
2. Grewal, B. S., Higher Engineering Mathematics, 43rd ed., Khanna Publishers, 2013
3. Kandaswamy, p., Thilagavathy, K., Gunavathy, K., Numerical methods, S Chand & Co.
4. Richard A. Johnson, Irvin Miller and John E. Freund, Probability and statistics for engineers, 8th ed.,Pearson,2010.

NPTEL course links that align with the syllabus:

1. **Numerical Analysis**
   https://nptel.ac.in/courses/108/108/108108079/
2. **Statistical Methods for Scientists and Engineers**
   https://nptel.ac.in/courses/111/105/111105077/
3. **Numerical Analysis**
   https://nptel.ac.in/courses/111/107/111107062/
4. **Numerical methods**
   https://nptel.ac.in/courses/111/107/111107105/
5. **Numerical Methods for Engineers**
   https://nptel.ac.in/courses/127/106/127106019/

Experimental learning modules:
1. http://vlabs.iitb.ac.in/vlabs-dev/labs/numerical_lab/labs/explist.php
Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

24-219-0402 TRANSDUCERS - II

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

After completion of the course, students will be able to demonstrate the ability to:

CO1: Describe working principles of various transducers/sensors (Understand).
CO2: Interpret the characteristics of the transducers/sensors (Understand).
CO3: List various standards used for selection of transducers/sensors (Remember)
CO4: Select transducers/sensors for specific applications (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)

Flow Measurement: Bernoulli's theorem: velocity and pressure profile of closed channel low, Classification of fluid flow - Reynolds number, laminar and turbulent flow – Variable head flowmeters, orifice, venturi tube, flow nozzle, pitot tube, square root extractor – Variable area flowmeter, rotameter - Quantity flow meters, positive displacement, nutating disc, reciprocating pistons, oscillating pistons, rotating vane, lobed impeller type – Electromagnetic flowmeter – Ultrasonic flowmeter – Turbine flowmeter - Mass flow meter – Anemometer.

Module II (16 hours, End semester marks 25%)

Force and torque measurement: Basic methods of force measurement, elastic force traducers, strain gauge, load cells, piezoelectric force transducers, vibrating wire force transducers, strain gauge torque meter, inductive torque meter, magneto-strictive transducers, torsion bar dynamometer, etc.

Module III (16 hours, End semester marks 25%)

Measurement of viscosity, consistency and density: units, coefficient of viscosity, basic principles of capillary viscometers, Saybolt's viscometers, rotameter type viscometers, rotating cylinder viscometer, electrical type viscometers – rotating vane consistency meter, oscillating type consistency meter - different types of density measurement: effect of temperature and pressure on density.

Measurement of humidity and moisture – basic principles – hygrometers – psychrometers - humidity charts –dew point hygrometers-electrical transducers and measurement systems for humidity, Electrical conductivity – Dielectric constant – Automatic electric psychrometer.

Module IV (16 hours, End semester marks 25%)

pH and conductivity meters – pH measurement – various types of electrodes – installation and maintenance of pH meters – conductivity meter – electrical conductivity of solution – cell construction operating principles.

Advances in sensors technology: Smart sensors, MEMS, Nano sensors, Semiconductor sensors, optical fiber sensors.

References:

1. D.V.S. Murthi, "Instrumentation and Measurement Principles", PHI, New Delhi, 2nd ed. 2012.
2. D. Patranabis, "Instrumentation and Control", Tata McGraw Hill, 2nd ed. 2011.
3. Rangan, C. S., Sarma, G. R., & Mani, V. S. "Instrumentation: Devices and Systems" Tata McGraw Hill, 2nd ed.1983.
4. B. C. Nakra and K. K. Choudhari, "Instrumentation Measurements and Analysis" McGraw Hill Education, 4th ed. 2016.
5. R. K. Jain, "Mechanical and industrial measurements" Khanna Publishers 11th ed. 1995.
6. E.O. Doebelin, "Measurement Systems", McGraw Hill, 6th ed. 2011.
7. A.K. Sawhney , "A Course in Electrical and Electronic Measurements and Instrumentation" Dhanpat rai, 19th ed. 2023

NPTEL course links that align with the syllabus:

1. **Sensors and actuators**
   https://nptel.ac.in/courses/108/108/108108147/
2. **Transducers and Instrumentation**
   https://nptel.ac.in/courses/108102191

24-219-0403 CONTROL ENGINEERING - I

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

After completion of the course, students will be able to demonstrate the ability to:

CO1: Represent the dynamical systems using transfer function models and utilize simulation tools for effective modeling.

CO2: Analyze system response and stability using time-domain methods, employing simulation tools for evaluation and tuning.

CO3: Analyze system response and stability using frequency-domain methods, including theoretical assessments and practical applications with simulation tools to evaluate frequency response characteristics

CO4: Design controllers and compensators for dynamical systems using time-domain and frequency-domain techniques, incorporating simulation tools for analysis and tuning of control strategies

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	10	11	12
CO1	3	3	2	-	3	-	-	-	-	-	-	3
CO2	3	3	2	-	3	-	-	-	-	-	-	3
CO3	3	3	2	-	3	-	-	-	-	-	-	3
CO4	3	3	2	-	3	-	-	-	-	-	-	3

Module I (16 hours, End semester marks 25%)

Introduction: Basic ideas of control systems and their classification - review of Laplace transforms - modelling of mechanical, electrical and electromechanical systems – transfer function -block diagrams reduction techniques - signal flow graphs - Mason's gain formula **Feedback characteristics of control systems:** Reduction of parameter variations by use of feedback – control over system dynamics – control of the effects of disturbances signals – regenerative feedback. Introduction to simulation software for modeling and analysis of control systems.

Module II (16 hours, End semester marks 25%)

Time domain analysis - Transient response analysis- First order systems- Initial condition response - Impulse response- Step input response- Ramp input response -Time constant - Second order system response- Transient response specifications- Response of Higher order systems - Steady state error and error constants - dynamic error constants.
Concept of stability of LTI systems -BIBO stability- Characteristic equation - Effect of feedback on closed-loop stability - Routh Hurwitz criterion - Root locus techniques - root locus construction rules - sketching of root locus, root sensitivity.
Use simulation tools to analyse the transient response of first-order and second-order systems and sketching of root locus.

Module III (16 hours, End semester marks 25%)
Frequency domain methods - Sinusoidal transfer function – Frequency response - Frequency domain specifications - peak resonance and resonant frequency- correlation with time domain specifications.
Polar plot, Nyquist plot and Bode plot for stability analysis - relative stability - gain margin and phase margin – Nyquist Stability criteria - Bandwidth and cut off frequency – Transfer function from Bode plot
Utilize simulation software to create Bode plots, Nyquist plots, and analyze frequency response characteristics.

Module IV (16 hours, End semester marks 25%)
Design of controllers and Compensators: – Conventional control laws - P, PI, PD and PID controllers – Tuning methods - Effect of P, PI, PD and PID controllers on system response of First order and Second order systems – Advanced PID controllers for industrial processes - Lead, Lag and Lead lag compensators, Root locus techniques for Compensator design, Compensator design using Frequency domain techniques. Introduction to simulation software for modeling and analysis of control systems.
Use simulation software to design and tune controllers (P, PI, PD, PID) for various dynamical systems.

References:
1. Nagarath, G., & Gopal, M. (2015). Control Systems Engineering (5th ed.). New Age International Publishers.
2. Norman S. Nise (2019). Control Systems Engineering, Wiley, seventh edition.
3. K. Ogata (2015). Modern Control Engineering, Pearson India, 5th edition.
4. G. Goodwin, S. Graebe, Mario Saglado (2001). Control System Design, Pearson education.
5. G. Franklin, J. Powel, A Naeini (2019). Feedback Control of Dynamic Systems, Pearson Education, 8th edition.
6. Karl J. Astrom and T. Hagglund (2017). PID Controllers: Theory, Design and Tuning, 3rd edition.

NPTEL course links that align with the syllabus:
1. **Control Engineering:**
https://nptel.ac.in/courses/108/106/108106098/
2. **Control Systems:**
https://nptel.ac.in/courses/107106081/

24-219-0404 POWER ELECTRONICS

L	T	P	C
3	1	0	3

Total hours: 64
Course Outcomes:
After completion of the course, students will be able to demonstrate the ability to:

- **CO1:** Describe the structure and operational characteristics of various power electronics devices.
- **CO2: E**xplain with relevant voltage and current waveforms the principle of various phase controlled rectifiers in single phase and three phase.
- **CO3:** Describe the working principle of various types of dc to dc converters and inverters.
- **CO4:** Explain the principle of operation of various types of ac voltage controllers and cycloconverter**s.**

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)
Introduction to power electronic devices: Power diode, Power MOSFET, IGBT (basic structure and characteristics)
Thyristors: Terminal characteristics of thyristor. Thyristor ratings, thyristor protection, series and parallel connection (analysis not required). Gate triggering circuits – R, RC, UJT triggering circuits.
Other members of thyristor family: DIAC, TRIAC, PUT, LASCR.

Module II (16 hours, End semester marks 25%)
Phase controlled rectifiers: Half wave circuit with RL load, Half wave circuit with RL load and freewheeling diode, Half wave circuit with RLE load. Full wave controlled converters- Single phase full wave converters with continuous and discontinuous load current. Three phase thyristor converters. Dual converters.

Module III (16 hours, End semester marks 25%)
Choppers: Principle of chopper operation- step down and step up choppers- control strategies, Types of chopper circuits, Commutation in chopper circuits.

Inverters: Single phase voltage source inverters, three phase bridge inverter, Voltage control in single phase inverters, Pulse width modulated inverters. Current source inverters.

Module IV (16 hours, End semester marks 25%)

AC voltage controllers: Principle of AC voltage controllers, Single phase voltage controllers, Sequence control of AC voltage controllers- Two stage and multistage sequence control of voltage controllers.

Cycloconverters: Principle of cycloconverter operation, Single phase to single phase circuit- Step-up cycloconverter and Step-down cycloconverter. Three phase Half wave cycloconveter.

References

1. P. S. Bimbhra- Power Electronics- Khanna Publishers.
2. Muhammad H. Rashid, Power Electronics Circuits, Devices and Applications, Pearson Education.
3. M. Ramamoorthy- An Introduction to Thyristors and Their Applications- East West Press
4. Chute and R D Chute Electronics in Industry- McGraw Hill.

NPTEL course links that align with the syllabus:

1. **Power Electronics.**
   https://archive.nptel.ac.in/courses/108102145/
2. **Advance Power Electronics and Control.**
   https://archive.nptel.ac.in/courses/108107128/
3. **Industrial Drives: Power Electronics.**
   https://archive.nptel.ac.in/courses/108/108/108108077/

24-219-0405 PNEUMATICS AND HYDRAULICS

L	T	P	C
3	1	0	3

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Total hours: 64

Course Outcomes:

(The cognitive levels are given in bracket)

On completion of the course, students will be able to:

CO1: Describe and compare the fundamentals of pneumatic components and distinguish them from hydraulic and electrical systems. *(Understand)*

CO2: Develop and analyze pneumatic control circuits for single and multiple cylinder operations using standard symbols, focusing on impulse operation, speed control, and sequence operation. *(Apply)*

CO3: Explain fluid flow principles, including compressible and incompressible flows, using key equations and scenarios for both ideal gases and viscous fluids. *(Understand)*

CO4: Explain hydraulic systems, components, applications and the latest trends in hydraulics. *(Understand)*

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	2	-	-	-	-	-	-	-	-	1
CO3	3	3	2	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module I (16 Hours. End semester examination 25% marks)

Introduction: Comparison of pneumatics, hydraulics and electrical systems. Pneumatic power supply: Compressor schemes of air production- Classification- Selection criteria- Piston reciprocating type- PV Diagram- Rotary vane type, Liquid ring type, Twin lobe (or Roots) type, Screw type compressors. Air Receiver Tank, Distribution Filters – Regulators -Lubricators (FRL unit).

Valves: Basic construction- Speed control valves – Directional control valves –Time delay valves– Slide valves – Quick exhaust valve – Impulse valve- Shuttle valve - Twin pressure valve- Solenoid valve. Pneumatic cylinders: Single acting - Double acting and Duplex types of cylinders, Cushion assembly.

Module II (16 Hours. End semester examination 25% marks)

Pneumatic control circuits and systems: Valve symbols. Manual control of Single acting and Double acting Pneumatic cylinders – Impulse operation, Speed control circuits for single and double acting cylinders, Reciprocating cylinder circuit, Sequence operation of two cylinders – three cylinders and more cylinders-Time delay circuit.

Module III (16 Hours. End semester examination 25% marks)

Fluid flow: Types of fluid flow. Steady state flow of ideal gases: Compressible flow: Basic equations of Compressible flow -Continuity equation, Bernoulli's equation for compressible flow undergoing Isothermal process and Adiabatic process, Momentum equation and Equation of state. Mach number, Weight flow equation of a compressible fluid– Flow of compressible fluid through Orifices and Nozzles, Discharge coefficient, Flow of viscous incompressible fluid through circular pipe (Derivation of Hagen-Poiseuille's formula), Equations for viscous fluid flow between two parallel plates.

Module IV (16 Hours. End semester examination 25% marks)

Introduction to Hydraulics:- Applications - Elements of hydraulic systems – Advantages and disadvantages –Pascal's law, Service properties of hydraulic fluids– additives – filters and strainers– Fluid seals – Hydraulic symbols –

Hydraulic accumulators: Bladder type, Free piston type, Gravity type, Spring loaded type.

Fluid power pumps: External gear pumps- Design, Pump characteristics, Internal power losses and advantages – Internal gear pump, Vane pump.

Hydraulic valves: Direction control valves, Flow control valves-Pressure control valves

Hydraulic actuators: Linear and Rotary actuators- Hydraulic Jack – Hydraulic lift-Latest trends in Hydraulic systems.

References:

1. W.A. Blaine – Analysis and design of pneumatic system – John Wiley and sons., 2001.
2. S. R. Majumdar - Pneumatic Systems : Principles and Maintenance - Tata McGraw Hill Publishing Company Limited, 11th edition, 2004.
3. S.C. Rangwala – Fluid Mechanics – Charotar Publishing House, 44th edition, 2024.
4. F.X. Kay – Pneumatic Circuit Design – Machinery Publishing Company, 1966.
5. J. R. Fawcett- Pneumatic Circuits and Low weight Automation – Trade and Technical Press, England,1968.
6. W. Deppert and K. Stoll, Pneumatic Control-An introduction to the principles, Vogel-Ver, 1975.

NPTEL course link that align with the syllabus:

1. **Oil hydraulics and Pneumatics, IIT Madras**
   https://nptel.ac.in/courses/112/106/112106300/

Experimental Learning Modules

1. https://pc-coep.vlabs.ac.in/List%20of%20experiments.html

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

24-219-0406 SIGNALS AND SYSTEMS

L	T	P	C
3	1	0	3

Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

CO1: Understand different types of signals and systems, explaining the properties of linear time-invariant (LTI) systems and their representation using impulse functions and convolution.(Understand)

CO2: Apply the Laplace and z-transforms to analyze and characterize first-order and second-order LTI systems, demonstrating an understanding of the region of convergence and the properties of these transforms.(Apply)

CO3:Analyze the response of continuous-time LTI systems to various signal types utilizing the continuous-time Fourier series and Fourier transform including periodic and aperiodic signals.(Analyze)

CO4: Demonstrate the ability to analyze discrete-time signals using the discrete-time Fourier series and Fourier transform, while applying the sampling theorem and understanding the effects of under-sampling on signal reconstruction.(Apply)

Mapping of course outcomes with program outcomes

	O	**O2**	**O3**	**O4**	**O5**	**O 6**	**O 7**	**O 8**	**O 9**	**O10**	**O11**	**O12**
O1	3	2	2	-	3	-	-	-	-	-	-	2
O2	3	2	2	-	2	-	-	-	-	-	-	1
O3	2	3	2	-	3	-	-	-	-	-	-	1
O4	2	3	2	-	3	-	-	-	-	-	-	2

Module 1 (16 Hours, End semester marks 25%)

Introduction to Signals: Classification and representation of continuous time(CT) and discrete time signals(DT). Signal properties - Signal operations - Standard test signals: the unit step, the unit impulse, the sinusoidal, the complex exponential.

Introduction to Systems: CT and DT Systems - Properties of systems - Linear time-invariant (LTI) systems - The representation of signals in terms of impulses - convolution - Properties of LTI systems - LTI Systems described by differential and difference equations and calculation of impulse responses.

Module 2 (16 Hours, End semester marks 25%)

The Laplace Transform: The region of convergence for Laplace transforms - The inverseLaplace transform - Properties of the Laplace transform - Analysis and characterization of First-order and second-order LTI systems using the Laplace transform.

The Z-Transform: The region of convergence -Pole zero plot - Properties of the z-transform - Inverse z-transform (Partial fraction method, Long division method and Convolution method) - Analysis and characterization of LTI systems using z-transforms.

Module 3 (16 Hours, End semester marks 25%)

Continuous Time Fourier Series and Continuous Time Fourier Transform: The response of continuous-time LTI systems to complex exponentials - Fourier series representation of Continuous time periodic signals - Convergence of Fourier series - Properties - Continuous- time Fourier transform representation of Aperiodic signals - Fourier transform of periodic signals -Relation between Fourier and Laplace transforms - Properties - Fourier transform and Fourier series pairs.

Module 4 (16 Hours, End semester marks 25%)

Discrete Time Fourier Series and Discrete Time Fourier Transform: The discrete-time Fourier series - Properties - Discrete-time Fourier transform - Properties of Discrete-time Fourier transform – Frequency Response of Discrete -time systems- Transfer function.

Sampling: Introduction - Representation of a continuous-time signal by its samples - the sampling theorem -The effect of under sampling: aliasing - Sampling with a zero-order hold -Reconstruction of a signal from its samples using interpolation - Sampling of discrete-time signals.

References:

1. "Signals and Systems" by Alan V. Oppenheim, Alan S. Willsky, and Seth H. Nawab,Pearson, 2nd Edition, 1997.
2. “Signals and Systems (With Matlab Programs)”, Sanjay Sharma, S.K. Kataria & Sons, 2013.
3. "Signals and Systems" by Hwei P. Hsu, McGraw-Hill Education, 2018.
4. "Linear Systems and Signals" by B.P. Lathi, Oxford University Press, 3rd Edition, 2016.
5. "Signals, Systems, and Transforms" by Charles L. Phillips, John Parr, and Eve Riskin, Pearson, 4th Edition, 2015.
6. "Fundamentals of Signals and Systems Using the Web and MATLAB" by Edward Kamen and Bonnie Heck, Pearson, 5th Edition, 2014.
7. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 2006.
8. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.
9. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.

NPTEL Suggestions:

1. **Signals and Systems:**
   https://onlinecourses.nptel.ac.in/noc21_cs17/preview
2. **Principles of Signals and Systems:**
   https://onlinecourses.nptel.ac.in/noc22_ee04/preview

Experimental learning modules:

1. http://ssl-iitg.vlabs.ac.in/

24-219-0408 ANALOG ELECTRONICS LAB

L	T	P	C
0	0	3	1

Total hours: 48
Course Outcomes:
After completion of the course, students will be able to demonstrate the ability to:

CO1: Design and set up various linear and non-linear circuits using operational amplifiers (Apply)
CO2: Design and set up various active filter circuits and study their characteristics (Apply)
CO3: Design and set up various waveform generator circuits using op-amps and 555 ICs (Apply)
CO4: Design and set up ADC, DAC, and voltage regulator circuits (Apply)

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	7	PO8	PO9	10	11	O12
CO1	3	2	3	-	-	-	-	-	2	-	-	1
CO2	3	2	3	-	-	-	-	-	2	-	-	1
CO3	3	2	3	-	-	-	-	-	2	-	-	1
CO4	3	2	3	-	-	-	-	-	2	-	-	1

List of exercises
(6 hours, End semester marks 10%)
1. Familiarization of Operational Amplifier
2. Identification of 555 timer IC
3. Interpreting IC datasheets
4. Familiarization of CAD Tools

List of Experiments
(42 hours, End semester marks 90%)
1. Familiarisation of Operational Amplifier - inverting amplifier and non-inverting amplifier and voltage follower circuits using op-amps.
2. Measurement of operational amplifier parameters

3. Adder and subtractor circuits using op-amps
4. Schmitt trigger circuit using op-amps
5. Instrumentation amplifier and logarithmic amplifier using op-amps.
6. Design and implementation of differentiator and integrator circuits using op-amps
7. Design and implementation of comparator circuits using op-amps
8. Design and implementation of active filters low-pass, high-pass, narrow band-pass and notch filters
9. Design and implementation of waveform generator circuits using op-amps– Square, triangular and saw tooth waveform
10. Design and implementation of RC phase shift oscillator and Wien bridge oscillator using op-amps
11. Design and implementation of astable and monostable multivibrator using op-amp and 555 timer IC
12. Design and implementation of analog to digital converter
13. Design and implementation of digital-to-analog converter
14. Design and implementation of DC voltage regulator circuits
15. Design of basic circuits using CAD tools

Note: Students are required to design, simulate, and analyze the circuit using available software before implementing in hardware. Before starting the design/experiments, students must refer to the datasheet of the components.

Experimental learning modules:
1. https://ae-iitr.vlabs.ac.in/
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/analog-electronics/index.php
3. https://he-coep.vlabs.ac.in/exp/monostable-astable-oscillator/
4. https://he-coep.vlabs.ac.in/exp/digital-analog-converter/
5. https://ae-iitr.vlabs.ac.in/exp/voltage-comparator/simulation/

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by the Ministry of Education.

NPTEL course links that align with the syllabus:
1. **Analog circuits:**
   https://nptel.ac.in/courses/117/107/117107094
2. **NOC: Opamp practical applications Design, Simulation and Implementation**
   https://nptel.ac.in/courses/108108114

References

1. David A Bell, "Laboratory manual for operational amplifiers and Linear ICs", 2nd Edition, Prentice Hall
2. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Education Asia. 4th Edition.

3. D. Roy Choudhury, "Linear Integrated Circuits", New Age International Publishers, 6th Edition.

24-219-0407 DIGITAL ELECTRONICS LAB

L	T	P	C
0	0	3	1

Pre-requisites: Nil

Total hours: 64

Course Outcomes:

After completion of the course, students will be able to demonstrate the ability to:

CO1: **Formulate** digital functions using Boolean Algebra and verify experimentally (Apply).
CO2: **Utilize** datasheets for designing logic circuits (Apply).
CO3: **Design and implement** combinational logic circuits (Apply).
CO4: **Design and implement** sequential logic circuits (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	10	11	12
CO1	3	3	2	1	1	-	-	-	-	-	1	1
CO2	3	3	2	1	1	-	-	-	-	-	1	1
CO3	3	3	2	2	2	-	-	-	-	-	2	1
CO4	3	3	2	2	2	-	-	-	-	-	2	1

List of exercises
(6 hours, End semester marks 10%)

1. Familiarization of Logic Gates (AND, NAND, OR, NOR, XOR)
2. Identification of typical logic ICs
3. Interpreting IC datasheets
4. Familiarization of Verilog and SPICE

List of experiments
(42 hours, End semester marks 90%)

1. Verification & Realization of De Morgan's theorem.
2. Realization of SOP & POS functions after K-map reduction.
3. Half adder & Full adder using gates.

4. 4-bit adder/subtractor & BCD adder using IC 7483.
5. Realization of 2-bit comparator using gates and study of four-bit comparator IC 7485.
6. BCD to decimal decoder and BCD to 7-segment decoder & display.
7. Study of multiplexer IC and realization of combinational circuits using multiplexers.
8. Realization of RS, T, D & JK flip flops using gates.
9. Study of flip flop ICs (7474 & 7476).
10. Realization of ripple up and down counters and modulo-N counter using flip-flops.
11. Study of counter ICs (7490, 7493).
12. Measure and plot TTL inverter (IC 7404) transfer characteristic. Also, measure the propagation delay of a TTL gate by a ring oscillator arrangement.
13. Design of synchronous up, down & modulo-N counters.
14. Realization of 4-bit serial IN serial OUT registers using flip flops.
15. Study of shift register IC 7495, ring counter and Johnson's counter.
16. Verilog implementation of full adder, 4-bit magnitude comparator

Experiential learning modules:

1. http://cse11-iiith.vlabs.ac.in/
2. http://he-coep.vlabs.ac.in/
3. http://vlabs.iitkgp.ernet.in/dec/
4. http://cse15-iiith.vlabs.ac.in/
5. http://vlabs.iitb.ac.in/vlabs-dev/labs/dldesignlab/labs/explist.php
6. http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/cool_developers/labs/index.html
7. http://vlabs.iitb.ac.in/vlabs-dev/labs/dldgates/labs/index.php
8. http://vlabs.iitb.ac.in/vlabs-dev/labs/digital-electronics/labs/index.html
9. http://vlabs.iitkgp.Virtual_Labsernet.in/coa/

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education

NPTEL course links that align with the syllabus:
1. **Introduction to Digital Systems Design:**
http://nptel.ac.in/courses/117105080/
2. **Digital Circuits and Systems:**
https://nptel.ac.in/courses/117/106/117106114/

References :

1. Floyd T.L, Digital Fundamentals, **12/e**, Pearson Education, 2023.
2. C.H.Roth and L.L.Kimney Fundamentals of Logic Design, **11/e**, Cengage Learning, 2022.
Bhasker, Jayaram. A verilog HDL primer, **6/e**, Star Galaxy Publishing, 2023.

SEMESTER V

24-219-0501 CONTROL ENGINEERING - II

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:
After completion of the course, students will be able to demonstrate the ability to:

CO1: Identify and define fundamental concepts of state space analysis, and utilise simulation tools to illustrate these concepts.
CO2: Apply state feedback techniques to design controllers based on time domain specifications, and employ simulation tools for the design
CO3: Apply state feedback techniques to design controllers for digital control systems based on time domain specifications, and utilize simulation tools for the design
CO4: Investigate nonlinear system behavior and stability, incorporating simulation tools for analysis

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	3	-	-	-	-	-	-	1
CO2	3	3	2	-	3	-	-	-	-	-	-	1
CO3	3	3	2	-	3	-	-	-	-	-	-	1
CO4	3	3	2	-	3	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)
State space analysis
Dynamic Systems Modelling in State Space - Deriving state space models from transfer functions and vice versa- Similarity transformations and Canonical forms – Controllable, Phase variable, diagonal, Jordan canonical forms - Eigenvalues and eigenvectors - system stability - Solution of state equations of LTI systems- State transition matrix – Computation of state transition matrix using Laplace transform and Cayley Hamilton methods. Introduction to simulation software to facilitate practical understanding of state space concepts.

Module II (16 hours, End semester marks 25%)
State space-based controller design
State Space design - Controllability and Observability from state space models – Kalman test – Gilbert test – Duality- Pole zero cancellation - design of state feedback controllers from time domain specifications – dominant poles - pole placement - Ackerman's formula– design of full order and reduced order observers – separation principle. Use simulation tools to design state space-based controllers.

Module III (16 hours, End semester marks 25%)
Introduction to digital control systems
Sampled data control systems - stability tests – Jury's test – compensation techniques by root locus method - analytical design - dead beat control - selection of sampling frequency.
State space models for digital control systems - Controllability and observability of digital control systems – Loss of controllability and observability on discretization - Pole placement using state feedback for digital control systems. Utilise simulation software to analyse and design sampled data control systems

Module IV (16 hours, End semester marks 25%)
Analysis of nonlinear systems
Nonlinear systems - Common physical nonlinearities - phase plane method - Singular points - construction of phase trajectories - system analysis by phase plane method - describing function method - describing function of common nonlinearities - limit cycles - stability of nonlinear systems - Stability of non-linear systems - Lyapunov's first and second methods – Variable gradient method for generation of Lyapunov function - Lyapunov method for linear systems – Lyapunov equation. Utilise simulation tools to investigate nonlinear phenomena.

References:

1. K. Ogata - Modern Control Engineering, Pearson India, 5th edition, 2015.
2. K. Ogata - Discrete-Time Control Systems, 3rd Edition, Prentice Hall, 2010.
3. Benjamin C Kuo, Digital Control Systems, 2nd edition, Oxford University Press, 2007.
4. M. Gopal - Digital Control and State Variable Methods, 4th Edition, Tata McGraw-Hill, 2016.
5. Hassan K Khalil, Nonlinear Systems, 3rd edition, Prentice Hall International (UK), 2002.
6. Norman S. Nise - Control System Engineering, 8th Edition, Wiley, 2024.
7. I. J. Nagrath and M. Gopal - Control Systems Engineering, 7th Edition, New Age International, 2021.
8. M. Gopal - Modern Control System Theory, 4th Edition, New Age International, 2022.

NPTEL course links that align with the syllabus:

1. **Control Engineering:**
   https://nptel.ac.in/courses/108/106/108106098/
2. **Control Systems:**

https://nptel.ac.in/courses/107106081/

3. **Control Systems:**
https://archive.nptel.ac.in/courses/108/106/108106150/
4. **Nonlinear System Analysis:**
https://archive.nptel.ac.in/courses/108/106/108106162/

24-219-0502 DIGITAL SIGNAL PROCESSING

L	T	P	C
3	1	0	3

Total hours: 64
Course Outcomes:

On completion of the course, students will be able to:

CO1: Apply Z-Transform, DTFT, DFT, and related techniques such as circular convolution, overlap- save, and overlap-add for discrete-time signal processing. (Understand).
CO2: Design FIR filters using window methods and IIR filters using transformation techniques like impulse invariance and bilinear transformation. (Apply).
CO3: Implement discrete-time systems using FIR and IIR filter structures and apply multi-rate processing techniques such as decimation, interpolation, and anti-aliasing. (Apply).
CO4: Analyze efficient DFT computation using FFT, signal processing architectures, and finite word length effects in DSP systems. (Understand).

Mapping of course outcomes with Program outcomes.

	PO	PO	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	2	-	-	-	-	-	-	2
CO2	3	2	3	-	3	-	-	-	-	-	-	2
CO3	3	2	3	-	3	-	-	-	-	-	-	2
CO4	3	2	2	-	3	-	-	-	-	-	-	2

Module I (16 hours, End semester marks 25%)

Review of sampling, Z-Transform and DTFT

The Discrete Fourier Transform: DFT as a linear transformation (Matrix Relation), IDFT, Properties of DFT and examples. Circular convolution, linear convolution using circular convolution, Filtering of long data sequences, overlap save and overlap-add methods. Relation between DTFT, DFS, DFT and Z-transform. Frequency Analysis of Signals using the DFT

Module II (16 hours, End semester marks 25%)

Design of FIR Filters - Symmetric and Anti-symmetric FIR Filters, Design of linear phase FIR filters using Window methods, (rectangular, Hamming and Hanning). Design of IIR Digital Filters from Analog Filters (Butterworth), IIR Filter Design by Impulse Invariance and Bilinear Transformation, Frequency Transformations in the Analog Domain.

Module III (16 hours, End semester marks 25%)

Structures for the realization of Discrete-Time Systems - Block diagram and signal flow graph representations of filters. FIR Filter Structures: Linear structures, Direct Form. IIR Filter Structures: Direct Form, Transposed Form, Cascade Form and Parallel Form. Multi-rate Digital Signal Processing: Decimation and Interpolation (Time domain and Frequency Domain Interpretation), Anti-aliasing and anti-imaging filter.

Module IV (16 hours, End semester marks 25%)

Efficient Computation of DFT: Fast Fourier Transform and computational advantage over DFT, Radix-2 Decimation in Time FFT Algorithm. Computer architecture for signal processing: Harvard Architecture, pipelining, MAC, Introduction to TMS320C67xx digital signal processor, Functional Block Diagram. Finite word length effects in DSP systems: Introduction, fixed-point and floating-point DSP arithmetic, ADC quantization noise.

References

1. John G. Proakis and Dimitris G. Manolakis – Digital signal processing principles, algorithms and applications, 4th Edition, Prentice Hall India, 2014
2. Alan V. Openheim and Ronald W. Schafer – Discrete time signal processing, 3rd Edition, Pearson Education India, 2014
3. Sen M.Kuo, Woon-Seng Gan, Digital Signal Processors: Architectures, Implementations and Applications, Pearson Education, (2005) ISBN 10: 0130352144
4. Emmanuel C. Ifeachor & Barni W. Jerris, Digital Signal Processing, A practical approach, Pearson education, 2/e, (2001), ISBN 978-0201596199.
5. Andreas Antoniou, Digital Filters Analysis & Design, Prentice Hall India, (2018), ISBN-13: 978-0071846035
6. Lyons, Richard G., Understanding Digital Signal Processing, Prentice Hall, 3/e, (2010), ISBN 978-8131764367
7. Mitra S. K., Digital Signal Processing: A Computer based Approach, McGraw Hill, 4 th Ed., 2014.
8. Salivahanan S., Digital Signal Processing, McGraw Hill, 4 th Ed., 2019.

NTEL course links that align with the syllabus:

1. **Digital Signal Processing**
   http://nptel.ac.in/courses/117102060/
2. **Discrete Time Signal Processing**
   https://nptel.ac.in/courses/117/105/117105134/
3. Online courses from
   a. Swayam (https://swayam.gov.in/),
   b. Stanfrd online (https:// online.stanford.edu/) and
   c. MIT Open Courseware (https://ocw.mit.edu/).

Experiential learning modules:

1. http://vlabs.iitkgp.ernet.in/dsp/

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

24-219-0503 MICROPROCESSORS AND MICROCONTROLLERS

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

After completion of the course, students will be able to demonstrate the ability to:

CO1: Explain the architecture of 8085 and 8086 microprocessors (Understand).
CO2: Develop assembly language programs for 8085 microprocessor and 8051 microcontroller (Apply).
CO3: Explain the architecture of 8051 microcontroller (Understand).
CO4: Design systems based on 8085 microprocessor and 8051 microcontroller (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	1	-	-	-	-	-	-	1
CO2	3	3	2	-	1	-	-	-	-	-	-	1
CO3	3	3	2	-	1	-	-	-	-	-	-	1
CO4	3	3	2	-	1	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)

8085 Microprocessor: Architecture – functional block diagram, registers, ALU, bus systems, timing and control signals, machine cycles and timing diagrams, instruction set and assembly language programming.

Module II (16 hours, End semester marks 25%)

Hardware interfacing with 8085: Memory interfacing and concept of I/O device interfacing. 8255 PPI - architecture, various modes of operation & control words, interfacing of 8255 with 8085. Interrupt structure of 8085 microprocessor, 8259 programmable interrupt controller. Interfacing I/O devices with 8085 - Keyboard, LED display, D/A & A/D converters.

Module III (16 hours, End semester marks 25%)

Intel 8086 microprocessor family: Internal architecture of 8086 - bus interface unit, execution unit, pipelining, and register organization. Bus system, memory addressing, physical memory organization, memory banking, memory segmentation and interrupts. Internal architecture of 80186, basic features of Intel 80286, 80386 and 80486

Module IV (16 hours, End semester marks 25%)

8051 microcontroller: Internal architecture, signals, I/O ports, memory organization & interfacing, timing and control, port operations. 8051 timers and counters, and interrupts in 8051. Instruction set of 8051 and simple programs.

References:

1. Ramesh S Goankar, Microprocessor Architecture, Programming and Applications, 6th ed, Penram International Publishing India Pvt Ltd.

2. Ayala, Kenneth J. 8051 Microcontroller. Cengage Learning, 3th ed, 2007.

3. Mathur S, Microprocessor 8086: Architecture, Programming and Interfacing, Prentice Hall India Learning Private Limited,2011.

4. Avtar Singh & Walter A. Triebel "8088 & 8086 Microprocessor" 4th ed, Pearson Education, 2002

NPTEL course links that align with the syllabus:

1. **Microcontrollers and application**
   https://nptel.ac.in/courses/117/104/117104072/
2. **Digital computer organization**
   https://nptel.ac.in/courses/117/105/117105078/

24-219-0504 ANALYTICAL INSTRUMENTS

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

(The cognitive levels are given in bracket)

On completion of the course, students will be able to:

CO1: Explain the fundamentals of analytical instruments and UV-Visible Spectroscopy. (Understand)

CO2: Describe the principle and instrumentation of infrared, Raman, and thermo-analytical techniques. (Understand)

CO3: Outline the principle and instrumentation of NMR, ESR, X-ray spectrometry and Mass spectroscopy. (Understand)

CO4: Explain the principle and instrumentation of Chromatography, advanced microscopy techniques and automated chemical analysis. (Understand)

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	3	3	2	-	2	-	-	-	-	-	-	1
CO2	3	3	2	-	2	-	-	-	-	-	-	1
CO3	3	3	2	-	2	-	-	-	-	-	-	1
CO4	3	3	2	-	2	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)

Fundamentals of analytical instruments: Elements of an analytical instrument – Performance requirements of analytical instruments- instrument calibration techniques: calibration curve method, standard addition method, method of internal standard.

Spectroscopic methods of analysis: Basics of Spectral methods of analysis, various ranges of electromagnetic radiation. Interaction of E.M. radiation with matter. absorbance transmittance-relationship.

UV-Visible Spectroscopy- Beer-Lambert's Law-its limitations. Concept of emission, absorption and scattering techniques. Instrumentation for UV-Visible Spectroscopy.

Module II (16 hours, End semester marks 25%)

Infrared Spectrophotometers: wave number - basic principle- radiation sources, monochromators, entrance and exit slits, detectors- quantum type detector, thermal detectors.

Fourier Transform Infrared Spectroscopy (FTIR) –Instrumentation and principle.

Attenuated Total Reflectance (ATR) Technique- Instrumentation and principle.

Raman spectrometer: Raman Effect – basic principle, resonance enhanced Raman scattering, surface enhanced Raman scattering, Raman spectrometer – comparison of Raman and IR spectroscopy.

Atomic absorption spectrometry – sources, components and instrumentation.

Thermo analytical instruments: Thermo gravimetric analysis(TGA) – differential thermal analysis (DTA)– differential scanning calorimetric(DSC)-Principle and Instrumentation.

Module III (16 hours, End semester marks 25%)

Nuclear Magnetic Resonance Spectrometer: Principles of NMR- Chemical shift-types of NMR spectrometers-cw-NMR spectroscopy, FTNMR spectroscopy – constructional details of NMR

Electron Spin Resonance Spectrometers: Principle and Instrumentation

X-ray Spectrometers: different types of x-ray spectroscopy: x-ray emission spectroscopy, x-ray fluorescence spectroscopy, x-ray absorption spectroscopy, x-ray diffraction spectroscopy – principle and instrumentation.

Mass Spectrometer: basic mass spectrometer – principle of operation – magnetic deflection mass spectrometer – the time-of-flight mass spectrometer – radiofrequency mass spectrometer.

Module IV (16 hours, End semester marks 25%)

Chromatography – General principles – Classification – Gas and liquid chromatography – – GLC and HPLC - Chromatographic detectors – Principles and Instrumentation

Electron Microscopy – TEM, SEM- principle, Instrumentation, analysis

Scanning tunneling microscopy- Principles, Instrumentation, analysis, applications.

Atomic force microscopy –Principles, Instrumentation, analysis, applications.

Automated Chemical Analysis systems: Benefits of automation in chemical analysis-Segmented Flow Analysis-Flow Injection Analysis.

References:

1. R.S. Khandpur, Handbook of Analytical Instruments, 2nd ed, Tata McGraw-Hill,2006
2. Willard, Merritt Dean and Settle, Instrument Methods of analysis, East-west Press, 1997,7th edition.
3. Skoog. D.A and West.D.M, Principles of Instrumental Analysis, Holt Saunders Publications,3rd edition,1985.
4. Ewing.G.W, Instrumental Methods of Analysis, McGraw-Hill, 1992, 3rd edition.
5. Mann.CK., Vickers.T.J, and Gullick.W.H, Instrumental Analysis, Harper and Row Publications

6. Robert.D. Braun, Introduction to Instrumental Analysis, McGraw-Hill, 2nd edition, 2016.
7. Frank.A.Settle, Handbook of Instrumental Techniques for Analytical Chemistry, Prentice Hall,1997, 2nd edition.

NPTEL course link that align with the syllabus:

1. **Fundamentals of spectroscopy, IISER Pune**
   https://nptel.ac.in/courses/104106122

Experimental learning modules:

1. http://ccnsb06-iiith.vlabs.ac.in/
2. http://mas-iiith.vlabs.ac.in/

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by the Ministry of Education.

24-219-0505 ENGINEERING MANAGEMENT

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

(The cognitive levels are given in bracket)

On completion of the course, students will be able to:

CO1: Explain the existing practices of management and organisational theories (Understand).
CO2: Discuss the tools and techniques used in managerial jobs (Analyse).
CO3: Apply different management theories in decision making (Apply).
CO4: Analyse and understand an organisation and its complexities (Analyse).

Module I (16 hours, End semester marks 25%)

Principles of management: Introduction-Evolution of management – Management functions organizational structure. Economics: Sources of finance – Elements of Economics – Supply, demand, price, savings, consumption -time value of money.

Module II (16 hours, End semester marks 25%)

Costing: Types – breakeven analysis Accountancy: Jounal,Ledger,Trial Balance, profit and loss account and balance sheet – inferences(ratio analysis)

Module III (16 hours, End semester marks 25%)

Quantitative Techniques: LPP-Assignment problems-Transportation problems-Routing Problems- CPM and PERT

Module IV (16 hours, End semester marks 25%)

Operations Management: Plant location-layout-Inventory management-Quality management.Human Resources Management: Human resource planning-job analysis-job description recruitment and selection-appraisal-compensation-training-maintenance-separation. Marketing concepts:Marketing mix-environment-market segmentation-physical distribution promotion

References:

1. O.P.Khanna – Industrial Engineering and Management-Dhanpath Rai and Sons, New Delhi
2. Paul Samuelson – Economics – McGraw Hill
3. S.G. Huneryager and I.L. Hechman – Human Relations in Management – D.B. Tarapurvala and sons
4. S.Elion – Elements of production planning and control – Macmillian Co.
5. I.M. Pandy – Financial Management – Vikas Publishing & Co.
6. E.S. Baffa – Modern production management – John Wiley and Sons.
7. I.W. Burr – Engineering Statistics and quality control – McGraw Hill.

8. A.J. Duncan – Quality Control and industrial statistics – Richard D. Irwing Inc.

NPTEL course link that align with the syllabus:

1. **Economics/management/entrepreneurship**
   https://nptel.ac.in/courses/110/105/110105067/

Experimental learning modules:

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

24-219-0506 CONTROL SYSTEM LAB

L	T	P	C
0	0	3	1

Total hours: 48

Course Outcomes:

On completion of this course the student will be able to:

CO1: Use laboratory techniques, tools, and practices of control engineering.

CO2: Design and implement control systems for single-input single-output linear time-invariant systems and nonlinear systems.

CO3: Report concisely the results of the work in the laboratory accurately in appropriate detail.

CO4: Work in a team and communicate effectively to perform the design and implementation of control schemes for various processes.

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						1		3		3		3
CO2	3	2	2	2	2	3	3	2				3
CO3					1	2	3	3	3			3
CO4									3	3		3

List of Experiments

1 **Step response of a second order system**.
Objective: Design a second-order system (eg: RLC network) to analyse the following:
A. The effect of damping factor (ξ: = 0, <1,=1,>1) on the unit step response using simulatio study.
B. Verification of the delay time, rise time, peak overshoot and settling time with the theoretical values.
C. Performance analysis of hardware setup and comparison with the simulation results

2 **Performance Analysis using Root-Locus Method**.
Objective: Plot the root locus of the given transfer function to analyse the following usin simulation:
A. Verification of the critical gain, natural frequency ω_0 with the theoretical values

B. The effect of controller gain K on the stability
C. The sensitivity analysis by giving small perturbations in given poles and zeros
D. The effect of the addition of poles and zeros on the given system.

3 **Stability Analysis by Frequency Response Methods.**
Objective: Plot the i) Bode plot and ii) Nyquist plot of the given transfer functions to analyse th following using simulation:
A. Determination of Gain Margin and Phase Margin
B. Verification of GM and PM with the theoretical values
C. The effect of controller gain K on the stability,
D. The effect of the addition of poles and zeros on the given system (especially the poles at origin).

4 **Realisation of lead compensator.**
Objective: Design, set up and analyse the gain and phase plots of a lead compensator b hardware experimentation using i) passive elements and ii) active components.

5 **Realisation of lag compensator.**
Objective: Design, set up and analyse the gain and phase plots of a lag compensator by hardware experimentation using i) passive elements and ii) active components.

6 **Design of compensator in frequency domain and time domain.**
Objective: Design a compensator for the given system to satisfy the given specifications
A. Time domain specifications using simulation tools
B. Frequency domain specifications employing simulation tools

7 **State space model for analysis and design**
Objective: Study and analysis of state variable model of a given system (eg. DC Motor spee control/ Servo motor/etc) and design a controller by pole-placement technique incorporatin simulation tools.
A. Determine the open loop stability, controllability and observability
B. Analyse the effect of system parameters on eigenvalues and system performance. C. Design controller by pole-placement technique.

8 **PID Controller Design**
Objective: Design and analysis of a PID controller for a given system (eg. DC Motor spee control/ Servo motor/etc) using simulation tools
A. Design of PID controller to meet the given specifications
B. Study the effect of tuning of PID controller on the above system

9 **Phase plane analysis of nonlinear autonomous systems**
Objective: Study and analysis of phase trajectory of a given nonlinear autonomous system usin state space model in simulation tools.
A. Determination and verification of the singular points,
B. Stability Analysis of the system at various singular points from phase Portraits

10 **Transfer Function of Armature and Field Controlled DC Motor**

Objective: Obtain the transfer function of the armature and field controlled DC motor b experiment.

11 **Transfer function of Separately excited DC Generator.**

Objective: Obtain the open loop transfer function of a separately excited DC Generator b experiment.

12 **Transfer function of A.C. Servo motor.**

Objective: Obtain the open loop transfer function of AC Servo motor by experiment.

13 **Closed loop performance of inverted pendulum.**

Objective: Study of performance characteristics of inverted pendulum by experiment.

A. Determine the various unknown parameters of an inverted pendulum experimentally,

B. Obtain and analyse the non-linear and linearised models,

C. Design and implement various state feedback controllers to analyse the performance of th system.

14 **Performance analysis of magnetic levitation system.**

Objective: Study of performance of magnetic levitation system by experiment.

A. Obtain and analyse the dynamics of a magnetic levitation system,

B. Design and implement various loop controllers to analyse the performance of th experimental system while tracking in presence/absence of disturbances.

15 **Closed loop performance of Twin rotor system**

Objective: Study of performance characteristics of Twin rotor system by experiment.

16 **Mass Spring Damper system**

Objective: Study of performance characteristics of Mass-Damper-Spring system by experiment.

A. Determine the various unknown parameters of a mass spring damper system experimental to obtain transfer function/ state space models,

B. Design and implement various state feedback controllers to analyse the performance of th system while regulation and tracking

References:

1. Lab manuals provided.
2. Nagarath, G., & Gopal, M. (2015). Control Systems Engineering (5th ed.). New Age International Publishers.
3. Norman S. Nise (2019). Control Systems Engineering, Wiley, seventh edition.
4. K. Ogata (2015). Modern Control Engineering, Pearson India, 5th edition.
5. G. Goodwin, S. Graebe, Mario Saglado (2001). Control System Design, Pearson education.
6. G. Franklin, J. Powel, A Naeini (2019). Feedback Control of Dynamic Systems, Pearson Education, 8th edition.
7. Karl J. Astrom and T. Hagglund (2017). PID Controllers: Theory, Design and Tuning, 3rd edition.

NPTEL course links that align with the syllabus:

1. **Control Engineering:**
   https://nptel.ac.in/courses/108/106/108106098/
2. **Control Systems:**
   https://nptel.ac.in/courses/107106081/

Experimental learning modules:

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

24-219-0507 TRANSDUCERS AND INDUSTRIAL INSTRUMENTATION

L	T	P	C
0	0	3	1

Pre-requisites: 24-219-0402, 24-219-0305
Total hours: 48
Course Outcomes:
After completion of the course, students will be able to demonstrate the ability to:

CO1: Obtain the characteristics of various temperature sensors, force sensors and displacement sensors (Apply)
CO2: Elucidate working of industrial devices used to measure level and flow (Apply).
CO3: Demonstrate the working of industrial devices for measuring viscosity and conductivity (Understand).
CO4: Apply calibration and measurement on pressure gauge and PH meter (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	1	-	1	1
CO2	3	3	3	2	2	-	-	-	1	-	1	1
CO3	3	3	3	2	2	-	-	-	1	-	1	1
CO4	3	3	3	2	2	-	-	-	1	-	1	1

List of experiments:
1. Strain guage characteristics
2. Load cell characteristics
3. Characteristics of Thermistor
4. Characteristics of RTD
5. Characteristics of Thermocouple
6. Characteristics of LVDT
7. Characteristics of Capacitive sensor
8. Measurement of flow using Orifice meter, Rotameter and Venturimeter
9. Level measurement using different techniques
10. Pressure gauge calibration using dead weight tester
11. Measure flow using EM flow meter and ultrasonic flow meter

12. Conductivity meter calibration and measurements of conductivity of test solutions
13. Measurement of PH
14. Determination of viscosity coefficient
15. Characteristics of LDR, photo diode and photo transistor

Experiential learning modules:

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education

1. http://sl-coep.vlabs.ac.in/
2. http://eerc03-iiith.vlabs.ac.in/
3. http://fm-nitk.vlabs.ac.in/

NPTEL course links that align with the syllabus:

1. **Microcontrollers and application**
   https://nptel.ac.in/courses/117/104/117104072/

2. **Digital computer organization**
   https://nptel.ac.in/courses/117/105/117105078/

References :

1. D.V.S. Murthi, "Instrumentation and Measurement Principles", PHI, New Delhi, 2nd ed. 2012.
2. D. Patranabis, "Instrumentation and Control", Tata McGraw Hill, 2nd ed. 2011.
3. E.O. Doebelin, "Measurement Systems", McGraw Hill, 6th ed. 2011.

24-219-0601 VACUUM AND CRYOGENIC INSTRUMENTATION

L	T	P	C
3	**1**	**0**	**3**

Total hours: 64

Course Outcomes:
(The cognitive levels are given in bracket)
On completion of the course, students will be able to:

CO1: Understand gas kinetic theory, pressure, gas flow, gas-surface interactions, and vacuum pump principles and regimes. (Understand).
CO2: Understand vacuum instrumentation, leak detection, and diverse vacuum applications across industries.(Understand).
CO3: Understand low temperature properties of engineering materials and cryogenic fluids, and the production of low temperatures using various liquefaction and cooling methods. (Understand).
CO4: Grasp cryogenic instrumentation and fluid storage systems, and explore cryogenics applications in various fields.(Understand).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	1
CO2	3	2	-	-	3	2	-	-	-	-	-	1
CO3	3	3	3	2	-	-	-	-	-	-	-	1
CO4	3	3	2	-	3	-	-	-	-	-	-	2

Module I (16 hours, End semester marks 25%)
Basic Theory: Gas kinetic theory, pressure, conductance, gas flow regimes, vapor pressure, pumping speed, throughput. Gas surface interactions: physisorption, chemisorption, condensation. Vacuum Pumps: Mechanical, diffusion, molecular drag, turbo molecular, cryopumps, ion pumps - general working principles, operating regimes.

Module II (16 hours, End semester marks 25%)

Vacuum Instrumentation: Vacuum gauges (Mechanical phenomena gauges - Transport phenomena gauges – Ionization phenomena gauges), gas regulators, flow meters, residual gas analyzers.
Problem Solving: Leak detection and detectors, gas signatures.
Vacuum Applications: Freeze drying, packaging, vacuum coating, microelectronics, particle accelerators, distillation, metallurgical processes, television and X-ray tubes, cryogenic insulation, space simulation.

Module III (16 hours, End semester marks 25%)
Low temperature – Basic ideas: Low Temperature properties of Engineering Materials, Mechanical properties- Thermal properties- Electric and magnetic properties – Cryogenic fluids and their properties.
Production of low temperature – Liquefaction systems ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Magnetic Cooling.

Module IV (16 hours, End semester marks 25%)
Cryogenic instrumentation: Pressure, flow-level, and temperature measurements. Cryogenic fluid storage and transfer systems: Cryogenic Storage vessels.

Applications of Cryogenics: Applications in space, Food Processing, superconductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry.

References:

1. Harris, Nigel S. Modern vacuum practice. 2007.
2. Roth, A. Vacuum Technology, North-Holland. 2012.
3. Rao, V. V., T. B. Gosh, and K. L. Chopra. Vacuum Science and Technology. Vol. 1. Allied Publishers, 2012.
4. Scott, R. B. Cryogenic Engineering. Hassell Street Press, 2021.
5. Barron, R. F. Cryogenic Systems. Oxford University Press, 1994.

NPTEL course links that align with the syllabus:

1. **Introduction to Cryogenic Engineering:** https://nptel.ac.in/courses/112/101/112101004/
2. **Vacuum Technology and Process Application :** https://archive.nptel.ac.in/courses/127/105/127105231/

24-219-0602 EMBEDDED SYSTEMS

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:
After completion of the course, students will be able to demonstrate the ability to:

CO1: Describe the role of individual components involved in a typical embedded system (Understand).
CO2: Analyse different computing elements and select the most appropriate one for an embedded system (Analyse).
CO3: Develop program for an embedded system (Apply).
CO4: Design, implement and test an embedded system (Analyse).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	3	-	-	-	-	-	-	1
CO2	3	2	2	-	3	-	-	-	-	-	-	1
CO3	3	2	2	-	3	-	-	-	-	-	-	1
CO4	3	2	2	-	3	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)
Embedded Systems: Overview of embedded systems, features, requirements and applications of embedded systems, recent trends in the embedded system design, introduction to RTOS, common architectures for the ES design, embedded software design issues, interfacing and communication Links, introduction to development and testing tools.

Module II (16 hours, End semester marks 25%)
Embedded system controllers: Microchip PIC16 family, PIC16F887 processor architecture - features, memory organization, on chip peripherals, Watchdog timer, ADC, Data EEPROM.
Interfacing: Interfacing standards, USART-RS232, RS 485, SPI, basic concepts of I2C, USB, Interfacing a temperature sensor with PIC16F877.

Module III (16 hours, End semester marks 25%)
Embedded Software and Programming: Programming in embedded environment, embedded operating systems. – Features of Embedded C++. Software implementation(eg: temperature sensor with PIC16F877),Testing, Validation and debugging, system-on-chip.

Module IV (16 hours, End semester marks 25%)
ARM Processors: Popular ARM architectures, Registers, Current Program Status Register (CPSR), Processor modes, Register organization, Instruction set overview, Interrupts, ARM Cortex M3-LPC1343 programmer's model: Memory system, Data processing, processor and memory organization, data operations, flow of control, pipelining in ARM, ARM bus (AMBA), Clock Control & Internal Oscillators, Reset & Power management, Inbuilt peripherals.

References:
1. A. Silberschatz, P. B.Galvin and G. Gagne, Operating System Concepts 8th ed., John Wiley & Sons, Inc., 2017
2. K.V.K.K. Prasad, Embedded/Real Time Systems: Concepts, Design and Programming, Dreamtech Press, New Delhi, India, 2003.
3. Douglas V. Hall, "Microprocessors and Interfacing Programming and Hardware", 3rd ed., McGraw HillBook, Company, 2017
4. Microchip - Microcontroller application notes / data sheets.
5. Joseph Yiu, The Definitive Guide to the ARM Cortex-M3, Second Edition, Newnes, 2nd ed., 2009, ISBN: 978-0-12-382090-7
6. LPC User Manual: www.nxp.com/documents/user_manual/UM10375.pdf
7. LPC Datasheet: www.nxp.com/documents/data_sheet/LPC1311_13_42_43.pdf
8. Daniel W. Lewis, Fundamentals of Embedded Software, where C and assembly meet, Pearson Education 2001.
9. John B. Peatman, Design with PIC Microcontrollers, Pearson Education, 2002.
10. Wayne Wolf, Computers as Components: Principles of Embedded Computing System Design, 2nd ed., Elsevier Publication 2008.
11. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide – Designing and Optimizing System Software, Elsevier Publications, 2007.

NPTEL course links that align with the syllabus:

1. **ARM based development**
   https://nptel.ac.in/courses/117/106/117106111/
2. **Embedded Systems:**
   https://nptel.ac.in/courses/108102045

24-219-0603 PROCESS CONTROL

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:
(The cognitive levels are given in bracket)

On completion of the course, students will be able to

CO1: Explain process characteristics, process modelling, and the effects of disturbances on different types of processes. (Understand)
CO2: Describe various controller modes and tuning methods for effective process control. (Apply)
CO3: Apply principles for selecting and designing final control elements, including control valves and actuators, for specific processes. (Apply)
CO4: Explain advanced control systems and multivariable process control techniques in industrial applications. (Understand)

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	1	-	-	-	-	-	-	1
CO2	3	3	2	-	1	-	-	-	-	-	-	1
CO3	3	3	2	-	1	-	-	-	-	-	-	1
CO4	3	3	2	-	1	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)
Process characteristics: Process equation, degrees of freedom, modelling of simple systems – thermal, gas, liquid systems. Process lag, load disturbance and their effect on processes. Self-regulating processes, interacting and non- interacting processes, continuous and batch process.

Module II (16 hours, End semester marks 25%)
Controller modes: Basic control action, two position, multiposition, floating control modes. Continuous controller modes - proportional, integral, derivative. Composite controller modes - P-I,

P-D, P-I-D, pneumatic and electronic controllers to realize various control actions. Digital algorithms for PID controllers.

Controller tuning Methods: Evaluation criteria - IAE, ISE, ITAE. Process reaction curve method, continuous oscillation method, damped oscillation method. Auto tuning.

Module III (16 hours, End semester marks 25%)

Final control elements: Pneumatic, hydraulic and electrical actuators, Valve positioners. Pneumatic and electrical dampers, Control valves types, construction details, various plug characteristics. Valve sizing. Selection of control valves. Inherent and installed valve characteristics. Fail-safe operation, Cavitation and flashing in control valves

Module IV (16 hours, End semester marks 25%)

Advanced control system: Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariable process control, interaction of control loops- Control pairing methods.

Case Studies: Distillation column, boiler drum level control and chemical reactor control.

Adaptive and Inferential control: Adaptive Control- Gain scheduling-Model Reference Adaptive Control- Self tuning regulator- Inferential control

References:

1. G.Stephanopoulos, Chemical Process Control-An Introduction to Theory and Practice Prentice Hall of India, New Delhi, 2nd Edition, 2005.
2. D.R. Coughanowr, Process Systems Analysis and Control, McGraw Hill, Singapore, 3rd Edition, 2017.
3. B.W. Bequette, Process Control Modeling, Design and Simulation, Prentice Hall of India, New Delhi, 2004.
4. Curtis D. Johnson. Process Control Instrumentation Technology. John Wiley & Sons, Inc., USA.,8th edition,2005.
5. D.P. Eckman – Automatic Process Control – Wiley Eastern, 4 September 2009

NPTEL course links that align with the syllabus:

1. **Process Control and Instrumentation, IIT Kharagpur**
   https://nptel.ac.in/courses/103105064
2. **Chemical Process Control, IIT Bombay**
   https://nptel.ac.in/courses/103101142

24-219-0604 OPTOELECTRONIC INSTRUMENTATION

L	T	P	C
3	1	0	3

Total Hours: 64

Course Outcomes: After completion of this course, the student will be able to

- **CO1**: Understand and apply the principles of interferometry. (Understand)
- **CO2:** Demonstrate knowledge of light modulation techniques, and modern display technologies (Apply).
- **CO3:** Understand the fundamental principles of laser operation, different types of lasers, and their diverse applications (Understand).
- **CO4:** Analyze the structure, properties, and signal transmission capabilities of optical fibers, and evaluate their applications (Apply).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	3	2	-	-	-	-	-	-	1
CO2	3	2	2	-	3	-	1	-	-	-	-	1
CO3	3	-	-	2	-	3	2	-	-	-	-	1
CO4	3	3	-	-	3	-	-	-	2	-	-	1

Module 1 (16 Hours, End semester marks 25%)

Interferometers: Fabry-Perot and Michelson interferometers – Interference filters – Interferometeric method of measurement of optical parameters – Optical spectrum analyser.

Module 2 (16 Hours, End semester marks 25%)

Modulation of light: Internal and external modulation - Birefringence – Optical activity – Electro-optic effect – Magneto-optic devices – Acousto-optic effect.

Display devices: Electroluminescence – Injection Luminescence – Light emitting diode – Plasma displays – Liquid crystal displays.

Module 3 (16 Hours, End semester marks 25%)

Lasers: Principles of operation –Einstein relations – population inversion– Classes of lasers – Solid state: Nd-YAG laser, Ruby laser, gas: He-Ne laser, Argon ion laser, CO_2 laser and liquid dye lasers – Q-switching and mode locking –Properties of laser light.

Applications of lasers: Distance measurement – Holography – Principles and applications – Pollution monitoring, industry and biomedical applications.

Module 4 (16 Hours, End semester marks 25%)

Optical fibers: Introduction to optical fiber – Fiber characteristics, Light guidance through fibers – Different types of fibers– Losses in the optical fiber – Dispersion – optical time domain reflectometer(OTDR)- Advantages and disadvantages of optical fibers, Connectors and splices.
Applications of optical fibres: Optical fibre communication – fibre optic sensors – measurement of temperature, pressure, displacement, strain, acceleration and fluid level.

References:

1. "Optical Interferometry",P. Hariharan, AcademicPress.,2nd Edition, 2022.
2. "*Electro-Optical Systems for Sensing and Signal Processing*", H. N. Ahmed, Artech House, 2021.
3. "Lasers: Principles, Types, and Applications" by K. Thyagarajan, Ajoy Ghatak, Springer, 3rd Edition, 2023.
4. "*Introduction to Fiber Optics*" by John Crisp, Barry Elliott, Newnes, 4th Edition, 2023
5. J. Wilson and J.F.B. Hawkes – Optoelectronics: An Introduction – Prentice Hall of India
6. "Lasers: Theory and Applications", K. Thygarajan and A.K. Ghatak – Plenum Press 2011.
7. "Optical Fiber Communications-Principles and Practice",John M. Senior, Pearson Education Limited, 2009.

Experimental learning modules:

1. http://vlab.amrita.edu/index.php?sub=1&brch=281

2. http://vlab.amrita.edu/index.php?sub=1&brch=189

NPTEL course links that align with the syllabus:

1. **Optical Communications- Introduction:**
   https://nptel.ac.in/courses/117/104/117104127/
2. **Optical Communications:**
   https://nptel.ac.in/courses/117/101/117101054/

24-219-0605 MICROPROCESSOR AND MICROCONTROLLER LAB

L	T	P	C
0	0	3	1

Total hours: 48

Course Outcomes:
After completion of the course, students will be able to demonstrate the ability to:

CO1: Write and execute Assembly Language Programmes (ALP) for data manipulation in 8085 microprocessor (Apply).
CO2: Develop ALP to interface peripherals with 8085 microprocessor (Apply). **CO3:** Write and execute ALP for data manipulation in 8051 microcontroller (Apply). **CO4:** Develop ALP to interface peripherals with 8051 microcontroller (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	-	-	-	1	-	1	1
CO2	3	3	3	2	2	-	-	-	1	-	1	1
CO3	3	3	3	2	2	-	-	-	1	-	1	1
CO4	3	3	3	2	2	-	-	-	1	-	1	1

List of experiments:
Using 8085 trainer kit/8051 trainer kit.
1. Addition / subtraction / multiplication / division of 8bit data
2. Data transfer/exchange between specified memory locations
3. Checking parity
4. Checking odd or even
5. Sorting (Ascending/Descending) of data.
6. Largest/smallest from a series
7. Addition / subtraction / multiplication / division of 16 bit data
8. Sum of series
9. Hiding and masking of a bit
10. Block data transfer

The following interfacing experiments to be done using 8085/8051
1. Blinking LED
2. DC motor interfacing
3. Stepper motor interfacing
4. ADC interfacing
5. DAC interfacing
6. 7 segment display interfacing
7. LCD interfacing

Experiential learning modules:

1. http://vlabs.iitkgp.ac.in/rtes/#
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/8051-Microcontroller-Lab/index.php
3. https://sourceforge.net/projects/simulator8085/
4. https://edsim51.com/

NPTEL course links that align with the syllabus:

1. **Microcontrollers and application**
   https://nptel.ac.in/courses/117/104/117104072/
2. **Microprocessors and microcontrollers**
   https://archive.nptel.ac.in/courses/108/105/108105102/

References :

1. Ramesh S Goankar, Microprocessor Architecture, Programming and Applications, 6th ed, Penram International Publishing India Pvt Ltd.
2. Ayala, Kenneth J. 8051 Microcontroller. Cengage Learning, 3th ed, 2007.

24-219-0606 VIRTUAL INSTRUMENTATION LAB

L	T	P	C
0	0	3	1

Total Hours: 48

Course Outcomes: After completion of this course, the student will be able to

CO1: Apply fundamental concepts of LabVIEW software to develop virtual instruments for engineering applications.
CO2: Design and implement programs using data structures such as loops, arrays, clusters, and charts to solve complex problems
CO3: Develop modular programs using sub-VIs and manage file-based input/output operations efficiently for various applications.
CO4: Perform real-time data acquisition and control by interfacing DAQ systems with sensors to create virtual instruments for measurements like voltage, temperature, and pressure.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	3	-	-	-	-	-	-	2
CO2	3	3	3	2	3	-	-	-	-	-	-	2
CO3	2	3	3	2	3	-	-	-	-	-	-	2
CO4	3	3	3	3	3	1	-	-	-	-	-	2

List of Experiments:

1. Familiarization of LabVIEW.
2. Programming exercises on boolean and logic operations.
3. Programming exercises for loops and charts.
4. Programming exercises for clusters and arrays.
5. Programming exercises for strings and graphs.
6. Programming exercises on case and sequence structures.
7. Programming exercises on SubVI.
8. Programming exercises on file Input / Output.
9. Developing voltmeter using DAQ cards.
10. Developing signal generators using DAQ cards.
11. Response characteristics of thermistor.

12. Real time temperature and pressure acquisition using Virtual Instrumentation.

References:

1. "Hands-On Introduction to LabVIEW for Scientists and Engineers", John Essick, Oxford University Press, 4th edition, 2020.

2. "LabVIEW Graphical Programming", Richard Jennings and Fabiola De la Cueva, McGraw Hill, 5th Edition, 2019.

3. "LabVIEW A Complete Guide", Gerardus Blokdyk, 2021.

4. "Virtual Instrumentation using LabView", Jovitha Jerome, PHI Publishers, ISBN 978-81-203-40305,2010.

5. "Lab View Graphical Programming", Gary Johnson, McGraw Hill, Second edition 2006.

Experimental learning modules:

1. https://www.ni.com/getting-started/labview-basics/
2. https://www.ni.com/getting-started/labview-basics/

20-211-0607 SEMINAR

L	T	P	C
1	0	0	1

Course Outcomes:
(The cognitive levels are given in bracket)
On completion of the course the student will be able to:

CO1: Exhibit an ability to understand contemporary / emerging technology for various processes and systems (Understand).
CO2: Exhibit an ability to share knowledge effectively in oral and written form and formulate documents (Apply).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	1	2	-	-	-	-	-	-	-	-	2
CO2	-	-	-	2	-	-	-	-	-	-	-	3

Course Contents:
Students shall individually prepare and submit a seminar report on a topic of current relevance related to the field of Instrumentation Engineering. The references shall include journals, conference proceedings, reputed magazines and books, technical reports and URLs. Each student shall present a seminar of about 30 minutes duration on the selected topic.

SEMESTER VII

24-219-0701 BIOMEDICAL INSTRUMENTATION

L	T	P	C
3	1	0	3

Total hours: 64
Course Outcomes:
(The cognitive levels are given in bracket)
On completion of the course, students will be able to:

CO1: Understand different concepts related to electrophysiology, biopotentials, cardiovascular measurements and blood pressure measurements. (Understand).
CO2: Understand different concepts related to clinical laboratory equipment (Understand).
CO3: Understand different concepts related to respiratory and pulmonary measurements and electrical safety in biomedical equipment (Understand).
CO4: Grasp ideas regarding medical imaging systems and biotelemetry (Understand).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	-	-	-	-	-	-	-	1
CO2	3	3	3	-	-	-	-	-	-	-	-	1
CO3	3	3	3	-	-	-	-	-	-	-	-	1
CO4	3	3	2	-	-	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)
Electrophysiology: Review of physiology and anatomy, resting potential, action potential, bioelectric potentials, electrode theory, bipolar and unipolar electrodes, surface electrodes, needle electrode and microelectrode, physiological transducers-selection criteria and its application.
Bioelectric potential and cardiovascular measurements: ECG recording system, Heart sound measurement – phonocardiography (PCG), Foetal monitor-ECG- phonocardiography, vector cardiograph, cardiac arrhythmia's monitoring system. EMG, EEG - Lead systems – ECG, EEG, EMG Evoked potential response, ERG and EOG recording system, Nerve conduction
velocity, Blood Pressure measurement – Direct and indirect methods

Module II (16 hours, End semester marks 25%)

Clinical Laboratory Equipment: Chemical tests in clinical laboratory, Automated Biochemical Analysis System. Blood gas analyzer, Acid –base balance, Blood PH measurement, blood PCO2, blood PO2, Intra –arterial blood gas analyzers, Blood cell counters- types of blood cells, - methods of cell counting -coulter counter- Automatic recognition and differential blood cell counting. Medical diagnosis with chemical test, Spectrophotometer, colorimeter, automated chemical analyser.

Module III (16 hours, End semester marks 25%)

Respiratory and pulmonary measurements: Physiology of respiratory system, pulmonary function measurements, respiratory rate measurement- artificial respirator- oximeter, pulmonary function measurements–spirometer–photo plethysmography and body plethysmography, diathermy, nerve stimulator, Heart lung machine, Haemodialysis, ventilators, incubators.

Electrical safety: Sources of electrical hazards in medical environment and safety techniques for checking safety parameters of biomedical equipment.

Module IV (16 hours, End semester marks 25%)

Medical imaging systems: X ray machine, Computer tomography, ultrasonic imaging system, magnetic resonance imaging system, thermal imaging system, positron emission tomography, Ultrasonography,

Biotelemetry: Principles – Types – Single channel and Multichannel, Introduction to telemedicine – Principles and applications.

References:

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata Mc Graw Hill, 5th Edition (2023)
2. L. Cromwell, F. J. Weibell and L. A. Pfeiffer, Biomedical Instrumentation Measurements, Pearson Education India, 4th Edition (2016)
3. A. C. Kak and Malcolm Slaney, Principles of Computerized Tomographic Imaging, SIAM (Society for Industrial and Applied Mathematics), 2nd Edition (2001)
4. J. G. Webster, Medical Instrumentation, Application and Design, John Wiley & Sons, Inc., 5th Edition (2023)

NPTEL course links that align with the syllabus:

1. **Introductory Neuroscience & Neuro-Instrumentation:** https://nptel.ac.in/courses/108108167

24-219-0702 ADVANCED PROCESS CONTROL

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:(The cognitive levels are given in bracket)

On completion of the course, students will be able to

CO1: Explain PC-based process automation systems and different control architectures. (Understand)
CO2: Design and implement PLC ladder programs, understanding PLC components and architecture. (Apply)
CO3: Utilize advanced PLC instructions for data manipulation and implement troubleshooting and maintenance practices for PLC systems. (Apply)
CO4: Describe DCS architectures, interfacing, and communication protocols like HART and Fieldbus. (Understand)

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	O10	11	O12
CO1	3	3	2	-	2	-	-	-	-	-	-	1
CO2	3	3	3	-	2	-	-	-	-	-	-	1
CO3	3	3	3	-	2	-	-	-	-	-	-	1
CO4	3	3	2	-	2	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)

Review of PC based control design for process automation: Functional Block diagram of Computer control of process - Data Acquisition system (DAS) - Sampling Consideration - Direct Digital Control System - DDC Software - Position algorithm - Velocity algorithm - Comparison - Controller drift - Integral Overshoot - SCADA - Distributed Control system architecture and comparison with respect to different performance attributes.

Module II (16 hours, End semester marks 25%)

Introduction to PLC: Definition and Evolution of PLC, PLC Architecture, PLC Input and Output modules, central processing unit, CPUs and Programmer/monitors, Solid state memory, the processor, Input modules (Interfaces), Power supplies.

Programming of PLC: Fundamentals of PLC ladder diagram, Basic components and their symbols in ladder diagram, Process scanning considerations - Boolean logic and relay logic, Analog and discrete Input-output (I/O) devices, Programming instructions - Registers - Timer and counter types along with waveform, sequencer function, latch instruction.

Module III (16 hours, End semester marks 25%)
PLC Data manipulation instruction - Arithmetic and comparison instruction- Skip, MCR and ZCL instruction – PID and other important instruction set. PLC Installation, troubleshooting and maintenance - selection criteria for PLC. Design of alarm and interlocks, networking of PLC – levels of industrial control - types of networking - OSI Model - Case studies using above instruction sets.

Module IV (16 hours, End semester marks 25%)
Distributed Control system: Local Control Unit (LCU) architecture - Comparison of different LCU architectures – LCU Process Interfacing Issues: - Block diagram, Overview of different LCU security design approaches, Manual and redundant backup designs. LCU communication Facilities - Communication system requirements – Architectural Issues – Introduction to HART and Field bus protocol.

References:

1. John W. Webb and Ronald A Reis, Programmable Logic Controllers -Principles and Applications, 4th Edition, Prentice Hall Inc., New Jersey, 5th edition, 2016
2. Gary Dunning , "Introduction to Programmable Logic Controller", Cengage Learning India Pvt. Ltd., Third Edition, 2006
3. Curtis D. Johnson, Process Control Instrumentation Technology, Pearson New International, 8th Edition, 2014.
4. Krishna Kant, Computer-based Industrial Control, Prentice Hall, New Delhi, 2nd Edition, 2011.
5. Lukcas M.P Distributed Control Systems, Van Nostrand Reinhold Co., New York, 1986.
6. Frank D. Petruzella, Programmable Logic Controllers, 2nd Edition, McGraw Hill, New York, 6th edition, 2023.

NPTEL course links that align with the syllabus:
1. **Advanced Process Control, IIT Bombay**
   https://nptel.ac.in/courses/103101003
2. **Process Control and Instrumentation, IIT Guwahati**
   https://nptel.ac.in/courses/103103037

Experimental learning modules:
1. http://ial-coep.vlabs.ac.in/
2. http://plc-coep.vlabs.ac.in/

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by the Ministry of Education.

24-219-0703 POWER PLANT AND INDUSTRIAL INSTRUMENTATION

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

(The cognitive levels are given in bracket)

On completion of the course, students will be able to:

CO1: Describe the different methods of power generation with a particular stress on thermal power generation (Understand)

CO2: Explain the various measurements involved in power generation plants (Understand).

CO3: Describe the different types of devices used for analysis in power plants (Understand).

CO4: Elucidate the different types of controls and control loops (Understand).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2

Module I (16 Hours. End semester marks: 25%)

Overview of power generation: Brief survey of methods of power generation – Hydro, thermal, nuclear, solar and wind power - Thermal power plants – Block diagram – Details of boiler processes, Nuclear reactor control loops – Description – Function – Safety measures in nuclear reactor control- Importance of instrumentation in power generation.

Module II (16 Hours. End semester marks: 25%)

Electrical measurements - Measurement of High Voltages and current, power, frequency and power factor – Non electrical parameters – Flow of feed water, fuel, air and steam with correction factor for temperature – Steam pressure and steam temperature – Drum level measurement. ANSI symbols for lines, valves, heat transfer, dryer, material handling equipment, storage vessels- flow sheet codes and lines. Graphical symbol for pipe fittings, valves and piping, instrumentation symbols, standards specifications.

Module III (16 hours, End semester marks 25%)
Flue gas oxygen analyser –Measurement of Carbon dioxide in flue gas, Analysis of impurities in feed water and steam – Dissolved oxygen analyser – Chromatography – pH meter – Fuel analyser – Pollution monitoring instruments. Radiation detector – Smoke density measurement – Dust monitor.

Module IV (16 hours, End semester marks 25%)
Combustion control – Air/fuel ratio control – Furnace draft control – Drum level control – Main steam and reheat steam temperature control – Super heater control – Air temperature – Deaerator control –Pulverizer control – Distributed control system in power plants – Interlocks in boiler operation. Speed, vibration, shell temperature monitoring and control – Steam pressure control – Lubricant oil temperature control – Cooling system.

References:

1. E.L. Wakil MM – Power plant technology– First Edition, McGraw Hill, 2017.
2. P.K. Nag, 'Power Plant Engineering', Fourth Edition, Tata McGraw Hill, 2017.
3. R.K.Jain, 'Mechanical and Industrial Measurements', Khanna Publishers, New Delhi, 1995.
4. K.Krishnaswamy and M.Ponni Bala,"Powerplant Instrumentation", Second Edition, PHI Learning Pvt. Ltd., 2014.

NPTEL course links that align with the syllabus:

1. **Power plant Engineering**
   http://nptel.ac.in/courses/112107291/
2. **Fundamentals of nuclear power generation**
   https://nptel.ac.in/courses/112/103/112103243/

24-219-0704 COMMUNICATION SYSTEMS AND TELEMETRY

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes: (The cognitive levels are given in bracket)
On completion of the course, students will be able to:

- **CO1:** Explain types and concepts on analog Communication and the effect of Noise
- **CO2:** Explain the types of Digital communication both Baseband and Broad band(Understand).
- **CO3:** Illustrate the concept of Analog telemetry (Understand).
- **CO4:** Analyse and design digital telecontrol system in industries (Apply).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	-	-	-	-	-	-	-	-	1
CO2	1	2	3	-	-	-	-	-	-	-	-	1
CO3	1	2	3	-	-	-	-	-	-	-	-	1
CO4	2	3	3	2	-	-	-	-	-	-	-	1

Module I (16 hours, End semester marks 25%)

Analog Communication: Introduction, elements of communication, modulation-amplitude modulation and demodulation, angle modulation and demodulation-frequency modulation, phase modulation (Frequency spectrum, modulation index and average power).

Noise in communication systems: Thermal noise (white noise), Shot noise, Partition noise, Flicker noise, Burst noise, Signal to noise ratio, Noise factor, Noise temperature, Narrow band noise

Module II (16 hours, End semester marks 25%)

Digital Communication: Digital Communication system, Pulse Code Modulation (PCM): Pulse Modulation, Sampling process, Aliasing, Reconstruction, PAM, Quantization. Delta modulation, DPCM.
Digital modulation schemes: ASK, PSK, FSK, QPSK,QAM
Multiplexing: Frequency division multiplexing, Time division multiplexing.

Module III (16 hours, End semester marks 25%)

Telemetry system: Functional blocks of telemetry– methods of telemetry –pneumatic and hydraulic telemetry, telemetry standards.
Landline telemetry: Electrical Telemetry – current, voltage, synchro and position. Optical telemetry: Trends in fibre optic device development, Examples of optical telemetry system

Module IV (16 hours, End semester marks 25%)

Telecontrol system: Digital techniques in telecontrol, remote transmission, signaling, adjustment, guidance and regulation reliability of telecontrol installations. Satellite telemetry

Introduction to wireless Sensor Networks
Case Study: Telemetry system in process industries, and telecontrol system.

References:

1. E.L. Gruenberg – Handbook of telemetry and remote control – McGraw Hill.
2. R.E. Young – Telemetry Engineering – Little Book Ltd., J.K.
3. G. Swoboda – Telecontrol methods and applications of telemetry and remote control – Reinhold publishing company U. K
4. Couch: Analog and Digital Communication. 8e, Pearson Education India, 2013
5. H.Taub and Schilling Principles of Communication Systems, , TMH, 2007 6. Blake, Electronic Communication system, Cengage, 2/e, 2012.
6. Simon Haykin, Communication Systems, Wiley 4/e, 2006.

NPTEL course links that align with the syllabus:

1. **Communication Engineering, IIT Delhi**
   https://nptel.ac.in/courses/117/102/117102059/
2. **Analog communication, IIT Kharagpur**
   https://nptel.ac.in/courses/117/105/117105143/

24-219-0705 ROBOTICS AND AUTOMATION

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes:

After completion of the course, students will be able to demonstrate the ability to:

CO1: Explain fundamental concepts of robotics, including types of robots, robotic systems, degrees of freedom, and various applications across industries (Understand).

CO2: Identify and classify sensors, actuators, and end effectors used in robotics, understanding their roles in robotic perception and action, along with design considerations for specific applications (Understand).

CO3: Apply kinematic and static principles for analyzing robot motion, including forward and inverse kinematics, Jacobians, and force transmission, using modeling techniques such as DH notation (Apply).

CO4: Apply dynamic modeling techniques and trajectory planning methods to design and implement collision-free paths and control strategies for robotic systems, and develop basic AI-based control and programming techniques to enhance robot functionality and adaptability (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	10	11	12
CO1	3	3	2	-	-	-	-	-	-	-	-	3
CO2	3	3	2	-	-	-	-	-	-	-	-	3
CO3	3	3	2	-	3	-	-	-	-	-	-	3
CO4	3	3	2	-	3	-	-	-	-	-	-	3

Module I (16 hours, End semester marks 25%)

Introduction : Robots, brief history of robots, Asimov's laws of robotics, Types of Robots, Basic robotic system, Degree of freedom, Robot anatomy, robot motions, Robot joints, Work volume, Robot drive systems, coordinate systems- Cartesian, cylindrical, polar, joint arm. SCARA robot.

Robot Applications: medical, mining, space, defence, security, domestic, entertainment, Industrial Applications-Material handling, machine loading and unloading, welding, Spray painting, Machining.

Module II (16 hours, End semester marks 25%)
Sensor classification- Internal sensors- Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors- Range, proximity, touch, force-torque sensing;
Vision - Elements of vision sensor
Actuators for robots- classification-Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages;
End effectors – classification, mechanical grippers, special tools, Magnetic grippers, Vacuum grippers, adhesive grippers, Active and passive grippers, selection and design considerations of grippers in robot.

Module III (16 hours, End semester marks 25%)
Robot Kinematics and Statics
Introduction to manipulator kinematics: position and orientation of rigid bodies, planar and spatial mechanism description, homogenous transformations, Denavit-Hartenberg (DH) notation, forward and inverse kinematic analysis, examples, case studies of modeling on real robot mechanism; linear and rotational velocity of rigid bodies: velocity propagation from link to link, jacobian, singularities; static forces in manipulators: jacobians in force domain. Utilize RoboAnalyzer for kinematic analysis, such as forward and inverse kinematics.

Module IV (16 hours, End semester marks 25%)
Robot Dynamics, Trajectory Planning and Programming
Dynamic modeling: Lagrangian formulation, examples, trajectory generation: general consideration in path description and generation, joint space schemes, collision free path planning; robot control; overview of robot motion planning; robot programming methods. Use RoboAnalyzer to model dynamic behaviors and trajectory planning.
Artificial Intelligence: Goals of AI research, AI techniques, Search techniques in problem solving
Robot Programming: Methods of robot programming**,** lead through programming methods, Program as a path in space, Methods of defining positions in space, Motion interpolation, branching.
Expert systems: Characteristics, rule based system architectures, Non production system architectures.

References:
1. Introduction to Robotics by S K Saha, Mc Graw Hill Education, 2014.
2. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning., 2009.
3. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2003.
4. Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
5. Robotics Technology and Flexible Automation, Second Edition, S. R. Deb, 2017.
6. http://www.roboanalyzer.com/uploads/2/5/8/8/2588919/roboanalyzerusermanual.pdf

NPTEL course links that align with the syllabus:

1. **Robotics:**

https://onlinecourses.nptel.ac.in/noc21_me76/preview

2. **Robotics:**

https://nptel.ac.in/courses/112105249

Experimental learning modules:

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by the Ministry of Education.

24-219-0706 PROCESS CONTROL LAB

L	T	P	C
0	0	3	1

Total hours: 48

Course Outcomes:

After completion of the course, students will be able to:

CO1: Demonstrate and explain ON-OFF control action.
CO2: Demonstrate and explain continuous composite control actions
CO3: Demonstrate and explain cascade, feedforward and ratio control.
CO4: Demonstrate and explain the characteristics of typical industrial control loops
CO5: Demonstrate Process loop tuning.

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	-	2	-	-	-	-	-	-	1
CO2	3	3	2	-	2	-	-	-	-	-	-	1
CO3	3	3	2	-	2	-	-	-	-	-	-	1
CO4	3	3	2	-	2	-	-	-	-	-	-	1
CO5	3	3	2		2							1

List of Experiments:

1. Response of ON-OFF Controlled process
2. Proportional Controlled Process
3. Integral and Derivative Controlled Process
4. Cascade control
5. Feedforward control
6. Ratio control
7. Pressure Control Loop
8. Flow Control Loop
9. Temperature Control Loop
10. Level Control Loop

11. Reaction Curve method of Loop Tuning
12. Continuous Oscillation method of Loop Tuning

References:

1. Lab manuals.
2. Curtis Johnson, Process Control Instrumentation Technology, Prentice Hall of India Pvt Ltd. Control and Instrumentation Laboratory, http://vlabs.iitkgp.ac.in/ctrl/index.html

NPTEL course links that align with the syllabus

1. Process Control - Design, Analysis And Assessment
https://archive.nptel.ac.in/courses/103106148/

24-219-0707 DIGITAL SIGNAL PROCESSING LAB

L	T	P	C
0	0	3	1

Total hours:48
Course Outcomes:

(The cognitive levels are given in bracket)

CO1: Implement the basic signal processing algorithms, offline and in real time using software/ dedicated DSP hardware (Understand).

CO2: Design, implement and characterize various digital filers in offline and in real time using software/dedicated DSP hardware (Apply).

CO3: Apply DSP algorithms to real life problems (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3		3				2			2
CO2	3	3	3	2	3				2	2	2	3
CO3	3	3	3	3	3	2		2	3	2	2	3

The list of experiments is only indicative. A minimum subset of built-in functions in the software (e.g. MATLAB/ Scilab / Python) is to be used so that the students develop data structures and algorithms from scratch. Experiments are to be implemented in a combination of software and hardware platforms.

1. Visualization of basic signals
2. Properties of LTI systems.
3. Working in the Z-plane, poles and zeros, graphical calculation of phase and magnitude responses.
4. Linear convolution – Response of an LTI system to an arbitrary input.
5. Discrete Fourier transform – Fast Fourier Transform algorithms – Decimation in time and Decimation in frequency FFT algorithms, Inverse discrete Fourier transform.
6. Circular convolution and Linear Convolution.
7. Filtering long signals using FFT algorithms – Overlap – save and overlap – add methods.

8. Frequency response of FIR filters - Minimum Phase filters, Linear phase filters.
9. FIR filter design – Window-based method – impulse response, step response, pulse response, response to sinusoids; FIR filters having arbitrary frequency response – Design using frequency sampling method.
10. IIR filter design – Butterworth and Chebyshev designs, Impulse invariant and Bi-linear transformation methods.
11. Realization of digital filters.
12. Processing of signals in STFT domain
13. Finite word length effects – coefficient quantization and rounding of adders/ multipliers – in DSP system implementation.
14. Application of DSP algorithms to speech/music and Image processing.
15. A mini project applying DSP algorithms to a relevant problem of current importance.

Experiential learning modules:

1. http://vlabs.iitkgp.ernet.in/dsp/
2. http://ssl-iitg.vlabs.ac.in/

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by the Ministry of Education.

References:

1. Mitra S.K.,Digital Signal Processing: A Computer Based Approach, McGraw – Hill Publishing Company, 2013.
2. Emmanuel C. Ifeacher, Barry W. Jervis ,Digital Signal Processing: A Practical Approach,

   Second Edition, Pearson Education, 2004.
3. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 4thEdition, Pearson India, 2007.
4. Oppenheim A.V., Schafer R.W, Digital Signal Processing, Pearson India,2015.
5. Boaz Porat, A Course in Digital Signal Processing, Wiley India Pvt. Ltd., 2012.
6. The Manuals of the Digital Signal Processors manufactured by Texas Instruments or Analog Devices (Available online on the web pages of Texas Instruments or Analog Devices).
7. Vinay K. Ingle, John G. Proakis, Digital Signal Processing Using MATLAB, Cengage Learning, 2011

NPTEL course links that align with the syllabus:

1. **Digital Signal Processing**

   https://nptel.ac.in/courses/117102060/

2. Discrete time Signal Processing

https://nptel.ac.in/courses/117/105/117105134/

24-219-0708 MINI PROJECT

L	T	P	C
0	0	0	1

Course outcomes:

(The cognitive levels are given in bracket)

On completion of this course the student will be able to:

CO1: Work independently on a specific problem relevant to research or industry (Apply).

CO2: Develop teamwork skills in a group (Apply).

CO3: Design models based on the knowledge acquired in a specific area (Apply).

CO4: Explore the wider aspects of product development (Analyse).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	10	11	12
CO1	3	3	3	1	1	1	1	1	1	1	1	1
CO2	1	1	1	3	3	3	1	1	1	1	1	1
CO3	3	3	3	2	2	2	1	1	1	1	1	1
CO4	1	2	3	3	3	3	2	2	2	1	1	1

Course Plan:

Each batch of 3 to 5 students shall design, develop and realize an Instrumentation related product. Basic elements of product design must be considered. Each student shall submit a project report at the end of the semester. The project report should contain the design and engineering documents including Bill of Materials and test results. Product has to be demonstrated for its full design specifications. Innovative design concepts, reliability and aesthetic/ergonomic aspects shall be given due weightage.

24-219-0709 Elective II: Digital Image Processing

L	T	P	C
3	1	0	3

Total hours: 64

Course Description: This course provides a comprehensive introduction to the fundamental principles of digital image processing. This course covers the fundamentals of digital image processing. The course includes a mathematical framework for image representation and various image enhancement techniques such as noise and distortion removal. The course also details image processing techniques such as image segmentation and popular image compression techniques.

Course Outcomes:

After completion of the course, students will be able to

CO1: Explain the fundamentals of digital image representation and image enhancement techniques

CO2: Explain the image restoration methods in digital image processing.

CO3: Explain the basic image segmentation methods in digital image processing.

CO4: Explain the commonly used image compression algorithms.

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	O10	11	O12
CO1	3	3	2	-	-	1	-	-	-	-	-	3
CO2	3	3	2	-	-	1	-	-	-	-	-	3
CO3	3	3	2	-	-	1	-	-	-	-	-	3
CO4	3	3	2	-	-	1	-	-	-	-	-	3

Module I (16 hours, End semester marks 25%)

Digital Image fundamentals: representation, elements of visual perception, simple image formation model, image sampling and quantization.

Image Enhancement: Spatial Domain Methods - point processing, intensity transformations, histogram processing, image subtraction, image averaging. Spatial filtering - smoothing filters, and sharpening filters. Frequency Domain methods – 2D FFT, low pass filtering, high pass filtering, homomorphic filtering, and generation of spatial masks from frequency domain specifications.

Module II (16 hours, End semester marks 25%)

Image restoration: Degradation model, algebraic approach to restoration, inverse filtering, least means square filters, constrained least squares restoration, interactive restoration. Inverse filtering- removal of blur caused by uniform linear motion, Weiner filtering, Geometric transformations-spatial transformations.

Module III (16 hours, End semester marks 25%)

Image Segmentation: Detection of discontinuities - point, line, edge, and combined detection, edge linking and boundary detection, local and global processing using Hough transform, thresholding, region-oriented segmentation – basic formulation, region growing by pixel aggregation, region splitting and merging, and use of motion in segmentation.

Module IV (16 hours, End semester marks 25%)

Image Compression: Redundancies and their removal methods, fidelity criteria, image compression models, Huffman and arithmetic coding, run length coding, error-free compression, lossy compression, , transform-based compression, lossy and lossless predictive coding, JPEG, MPEG.

References:

1. Gonzalez and Woods, Digital Image Processing, Pearson Education, 4th Edition, 2018.

2. S Jayaraman, S Esakkirajan, T Veerakumar, Digital Image Processing, McGraw Hill, 2nd Edition, 2020.

3. Fundamentals of Digital Image Processing by Anil K Jain, Pearson Education, 2015.

4. Kenneth R Castleman, Digital image processing, Pearson Education, 2nd Edition, 2003

5. Digital Image Processing by William K Pratt, 4th Edition, Wiley, 2007.

NPTEL course links that align with the syllabus:

1. **Digital Image Processing, IIT Kharagpur**
   https://nptel.ac.in/courses/106/105/106105032
2. **Digital Image Processing, IIT Kharagpur**

https://onlinecourses.nptel.ac.in/noc22_ee116

Experimental learning modules:

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

SEMESTER VIII

24-219-0801 PROJECT WORK

L	T	P	C
0	0	0	10

Course Outcome:
On completion of the course the student will be able to:

CO1: Think innovatively on the development of components, products, processes, or technologies
in the field of Instrumentation engineering (Apply).

CO2: Formulate a project proposal through extensive study of literature and/or discussion with learned resource persons in industry or around (Analyse).

CO3: Apply knowledge gained in solving engineering problems (Apply).

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	1	1	1	1	1	1
CO2	1	2	3	3	3	3	2	2	2	1	1	1
CO3	3	3	3	2	2	2	1	1	1	1	1	1

Course Plan:
In depth study of the topic assigned.

- Review and finalization of the approach to the problem relating to the assigned topic.
- Preparing a detailed action plan for conducting the investigation, including teamwork.
- Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed.
- Final development of product/process, testing, results, conclusions and future directions.
- Preparing a paper for Conference presentation/Publication in Journals, if possible.
- Preparing a report in the standard format for being evaluated by the assessment board.
- Final project presentation and viva voce by the assessment board.

B.Tech (Honours) in Instrumentation and Control Engineering

DEPARTMENT OF INSTRUMENTATION

2024 Admission onwards(IV-VII Semester)

B.Tech (Honours) in Instrumentation and Control Engineering

Subject Code	Offering Semester	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total Marks	Mode of Learning
							CA	SE		
24-219-0411	**4**	MOOC-H1	0	0	0	3	0	0	100	Online
24-219-0515	**5**	INDUSTRY 4.0	3	1	0	3	50	50	100	Online
24-219-0516	**5**	MOOC-H2	0	0	0	3	0	0	100	Online
24-219-0615	**6**	INSTRUMENTATION SYSTEM DESIGN	3	1	0	3	50	50	100	Class Room
24-219-0616	**6**	MOOC-H3	0	0	0	3	0	0	100	Online
24-219-0716	**7**	LOW POWER VLSI	3	1	0	3	50	50	100	Class Room

SYLLABUS

24-219-0515 INDUSTRY 4.0

Pre-requisites: Nil

		P	C
		0	3

Total hours: 64

Course Outcomes (COs): At the end of the course, students should be able to

CO1 Illustrate the fundamentals of Industrial IoT and Industry 4.0

CO2 Understand the enabling technologies for Industry 4.0

CO3 Apply machine learning and big data for Industry 4.0

CO4 Explain the cloud computing and security issues.

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	2	3		3							3
CO 2	3	2	3		3							3
CO 3	3	2	3		3							3
CO 4	3	2	3		3							3

Module I
Introduction to Industry 4.0

Overview and evolution of Industry 4.0, Key aspects and components of Industry 4.0.- Industrial IoT (IIoT) – Introduction, IIoT reference architecture, overview of three tier topology of IIoT (edge tier, platform tier and enterprise tier) - Basics of cyber physical systems (CPS), CPS and IIoT, Applications of IIoT- Industrial Internet Systems (IIS) – Fundamentals, elements of IIS (analytics, intelligent machines and connected people).- Applications of Industry 4.0.

Module II
Enabling Technologies in Industry 4.0.

Smart factories – Introduction, characteristics of smart factories, benefits, smart factories versus traditional factories. - Industrial sensing – Smart sensors, enhanced sensors (virtual sensors, self-calibration, self-testing, self-learning), introduction to tool condition monitoring. - Introduction to customized and modular robotic systems (basics only), Additive Manufacturing (AM) - Introduction, The general AM process chain, advantages and limitations of AM. Advantages of 3D printing technology for Industry 4.0

Module III
Big Data and AI in Industry 4.0

Big Data – Introduction, characteristics of big data, big data sources, big data acquisition and storage, necessity of big data analytics (basics only). - Machine learning and artificial intelligence for industry 4.0 (overview only), applications of ML in industries. -Blockchain for Industry 4.0 – Introduction, challenges for blockchain implementation.

Module IV
Recent Trends

Data Security (basics only) – types of cyber security threats, Need for security in IIoT (software security, network security, mobile device security) Introduction to Cloud Computing for Industry 4.0 (Overview and advantages only). - Introduction to Smart supply chain management - Advantages of IIoT in inventory management. -Introduction to Industry 5.0. -Case study (application and benefits of IIoT only) – Manufacturing industry and Automotive industry.

References:

1. Industry 4.0: Concepts, Processes and Systems Ravi Kant and Hema Gurung CRC Press 1st Edition, 2024.
2. Introduction to Industrial Internet of Things and Industry 4.0, Sudip Misra, Chandana Roy, Anadarup Mukherjee, CRC Press, 1st Edition, 2021.
3. Industry 4.0: The Industrial Internet of Things, Alasdair Gilchrist, APress, 1st Edition, 2016.
4. Industrial IoT Application Architecture and Use Cases Suresh, Malarvizhi Nandagopal, Pethuru Raj, E. A. Neeba, Jenn Wei Lin, CRC Press, 1st Edition, 2020.
5. Hands On Industrial Internet of Things, Giacomo Veneri and Antonio Capasso Packt, 1st Edition, 2018.
6. Industrial Internet of Things: Technologies and Research Directions, Anand Sharma, Sunil Kumar Jangir, Manish Kumar, Dilip Kumar Choubey, Tarun Shrivastava, S. Balamurugan, CRC Press, 1st Edition, 2022.
7. 5G-Enabled Industrial IoT Networks, Amitava Ghosh, Rapeepat Ratasuk, Peter Rost, Simone Redana, Artech House, 1st Edition, 2022.
8. IoT Product Design and Development: Best Practices for Industrial, Consumer and Business Applications, Ahmad Fattahi, Wiley, 1st Edition, 2023.
9. Industrial Internet of Things (IIoT): Intelligent Analytics for Predictive Maintenance R. Anandan, S. Gopalakrishnan, Souvik Pal and Noor Zaman Wiley, 1st Edition, 2022.
10. Technology for People: Industry 5.0 = Industry 4.0 + Society 5.0, Mune Moğol Sever, Literaturk Academia, 1st Edition, 2024.

NPTEL course links that align with the syllabus:

1. https://nptel.ac.in/courses/106105195

Experiential learning modules:

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by the Ministry of Education.

24-219-0615 INSTRUMENTATION SYSTEM DESIGN

Pre-requisites: Nil

		P	C
		0	3

Total hours: 64

Course Outcomes (COs): At the end of the course, students should be able to

CO1 Design signal conditioning circuits for temperature sensors, V/I and I/V converters

CO2 Design of transmitters, data logger, PID controller and alarm circuits

CO3 Carry out orifice and control valve sizing for different services

CO4 Design control panels and automation systems with PLCs

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO 1	3	3	3									3
CO 2	3	3	3									3
CO 3	3	3	3									3
CO 4	3	3	3		3							3

Module I

Introduction and Standards: Concepts of instrument design, functional requirements and specifications. Standards – Military, Industrial, and Commercial standards. BIS standards, ANSI standards, NEMA standards, DIN standards.

Piping and Instrumentation Diagram: P & I D Symbols, line numbering, line schedule, overview of various stages in P&I D development, P&I D for pumps, compressors process vessels, absorber and evaporator.

Design of signal conditioning circuits: Design of V/I Converter and I/V Converter, Signal conditioning circuit for pH electrodes, Design of Air-purge Level Measurement, Signal conditioning circuit for Thermocouple, RTD and Thermistor, Overview of Cold Junction Compensation and Linearization – software and Hardware approaches.

Module II
Design of Transmitters : Overview of 2 wire and 4 wire transmitters, Design of RTD based Temperature Transmitter, Thermocouple based Temperature Transmitter and Smart Transmitters.
Control Valves : Characteristics, valve equation, types of valves- Globe valve, ball valve, gate valve, butterfly valve, needle valve, valve positioner, valve selection criteria.

Module III
Orifice and Control valve sizing - Orifice, Venturi and flow nozzle sizing - Liquid, Gas and steam services.
Control valve sizing – Liquid, Gas and steam services. Overview of Rotameter Design
Design of Data logger and PID controller: Design of ON/OFF Controller using Linear Integrated Circuits, Electronic PID Controller, Basics of Microcontroller based digital two-degree of freedom PID Controller, Microcontroller based Data Logger, Basic architecture of PC based Data Acquisition Cards.

Module IV
Control Panel Design

Basics of operating console and control room panel design. Control room environment for electronic equipment - heat dissipation, forced air circulation and humidity considerations. Grounding and shielding- protection against electrostatic discharge.

Design of Alarm and Annunciation circuit : Alarm and Annunciation Circuits using Analog and Digital Circuits – Design of Programmable Logic Controller for any two simple applications

Reference:

1. Instrument Engineers Handbook - Process Control and Optimization, Bela G. Liptak, CRC Press, 4th Edition, Vol.2, 2008.
2. Introduction to Process Engineering and Design, Thakore and Bhatt, McGraw Hill, 2nd Edition, 2007.
3. Process Control Instrumentation Technology, C. D. Johnson, Prentice Hall, 8th Edition, 2015.
4. Electronic Instrument Design , Kim Fowler, Oxford, Reprint 2015.
5. Principles of Measurement Systems, Bentley, Pearson Education, 4th Edition, 2015.
6. Flow Measurement Engineering Handbook, R.W. Miller, McGraw Hill, 1996.
7. Measurement Systems Application and Design E.O. Dobelin, McGraw Hill, 4th Edition, 1989.
8. Process/Industrial Instruments and Controls Handbook Gregory K. McMillan, Douglas M. Considine, Mc Graw Hill, 5th Edition, 1999.
9. Hand Book of transducer, Harry N Nortan, PHI, 1st Edition, 1989.
10. A Course in Electronic Measurements and Instrumentation, A K Sawhney, Dhanpath Rai & Co., 2021.
11. Piping and Instrumentation Diagram Development, Moe Toghraei, Wiley, 1st Edition, 2019.

NPTEL course links that align with the syllabus:

1. https://archive.nptel.ac.in/courses/108/105/108105064/
2. https://nptel.ac.in/courses/108105088

Experimental learning modules:

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by Ministry of Education.

24-219-0715 LOW POWER VLSI

Pre-requisites: Nil

,	`	P	C
		0	3

Total hours: 64

Course Outcomes (COs)

At the end of the course, students should be able to:

CO1 Model the capacitive, short circuit and leakage power dissipation in CMOS circuits

CO2 Design lower power CMOS circuits by applying various techniques for power reduction

CO3 Implement logic circuits using clocked and non-clocked design styles

CO4 Implement the logic functions using adiabatic and reversible logic structures

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									3
CO2	3	3	3									3
CO3	3	3	3		2							3
CO4	3	3	3		2							3

Module I

Sources of power dissipation in CMOS circuits

Dynamic Power Dissipation - Charging and Discharging capacitance power dissipation.
Short Circuit Power dissipation - Short Circuit Current of Inverter, Short circuit current dependency with input and output load, Glitching Power. Static Power Dissipation - Leakage Power Dissipation.
Gate level power analysis - Capacitive, internal, and Static power dissipation of gate level circuit.

Module II

Power Reduction Techniques

Supply voltage Scaling Approaches - Multi VDD and Dynamic VDD Leakage power reduction Techniques - Transistor stacking, VTCMOS, MTCMOS, DTCMOS,
Dynamic power dissipation - Power gating, Clock gating, Transistor and Gate Sizing for Dynamic and Leakage Power Reduction.

Module III

Circuit design styles

Clocked design style - Basic concept, Domino logic (domino NAND gate), Differential Current Switch Logic.
Non-clocked circuit design style - fully complementary logic, NMOS and pseudo–NMOS logic, differential cascade voltage switch logic (DCVS)

Module IV

Adiabatic switching

Adiabatic charging, adiabatic amplification, One stage and two stage adiabatic buffer, Adiabatic logic gates, pulsed power supplies, Reversible logic basic concepts

References:

1. Practical Low-Power Digital VLSI Design, Gray K. Yeap, Springer India, 2008.
2. Low-power CMOS VLSI Circuit Design, Kaushik Roy and Sharat C. Prasad, Wiley, 2009.
3. Low Power Digital CMOS Design, Anantha P. Chandrakasan, Robert W. Brodersen, Kluwer Academic, 2012.
4. Low power CMOS Circuits, Christian Piguet, Taylor and Francis, 2018.
5. Low Voltage, Low Power VLSI Subsystem, Kiat -Seng Yeo, Kaushik, Roy, McGraw Hill Education, 2017.

Video Links (NPTEL, SWAYAM…)

1 https://archive.nptel.ac.in/courses/106/105/106105034/

Experiential learning modules:

Any relevant Experiential learning module from Virtual Lab and courses from NPTEL may be included as and when it is made available by the Ministry of Education.

List of Courses for B.Tech Minors in Robotics

DEPARTMENT OF INSTRUMENTATION

List of Courses for B.Tech Minor in Robotics, offered at Department of Instrumentation for B.Tech Instrumentation and Control Engineering 2024 Admission Onwards

Subject Code	Offering Semester	Subject	L H/W	T H/W	P/D H/W	C	Marks		Total Marks	Mode of Learning
							CA	SE		
24-219-0309	**3**	INTRODUCTION TO ROBOTICS	3	1	0	3	50	50	100	Class Room
24-219-0409	**4**	MOOC-M1	0	0	0	3	0	0	100	Online
24-219-0410	**4**	MOOC-M2	0	0	0	3	0	0	100	Online
24-219-0513	**5**	INTRODUCTION TO INDUSTRIAL AUTOMATION	3	1	0	3	50	50	100	Class Room
24-219-0514	**5**	MOOC-M3	0	0	0	3	0	0	100	Online
24-219-0614	**6**	MINI PROJECT	0	0	6	3	50	50	100	Class Room

SYLLABUS

24-219-0309 INTRODUCTION TO ROBOTICS

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes: After the completion of the course the student will be able to

CO1 Explain the subsystems, types, applications and history of robots.

CO2 Identify and explain the working of various sensors and actuators, and select suitable ones for different robotic systems.

CO3 Apply kinematic principles and Jacobian matrices to analyze robot motion and static forces in manipulators.

CO4 Understand robot dynamics, generate collision-free trajectories, and apply robot programming and control techniques.

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	3
CO2	3	3	3	-	-	-	-	-	-	-	-	3
CO3	3	3	2	-	-	-	-	-	-	-	-	3
CO4	3	3	2	-	-	-	-	-	-	-	-	3

Module I:

Introduction to Robotics

Introduction to robotics: brief history, types and applications of robots, present status and future trends in robotics, overview of robot subsystems challenges in robotics, characteristics of robots, Robot Applications- medical, mining, space, defence, security, domestic, entertainment, Industrial Applications-Material handling, welding, Spray painting, Machining; robot configurations and concept of work space, types of actuators and sensors in robotics, types of grippers; wheeled, legged and tracked robots.

Module II:

Sensor classification- touch, force, proximity, vision sensors.

Internal sensors-Position sensors, velocity sensors, acceleration sensors, Force sensors; External sensors-contact type, non contact type; Vision - Elements of vision sensor, image acquisition, image processing; Selection of sensors.

Actuators for robots- classification-Electric, Hydraulic, Pneumatic actuators; their advantages and disadvantages; Electric actuators- Stepper motors, DC motors, DC servo motors and their drivers, AC motors, Linear actuators, selection of motors; Hydraulic actuators- Components and typical circuit, advantages, and disadvantages; Pneumatic Actuators- Components and typical circuit, advantages, and disadvantages.

Module III:

Robot Kinematics and Statics

Introduction to manipulator kinematics: position and orientation of rigid bodies, planar and spatial mechanism description, homogenous transformations, Denavit-Hartenberg (DH) notation, forward and inverse kinematic analysis, examples, case studies of modeling on real robot mechanism; linear and rotational velocity of rigid bodies: velocity propagation from link to link, jacobian, singularities; static forces in manipulators: jacobians in force domain.

Module IV:

Robot Dynamics, Trajectory Planning and Programming

Dynamic modeling: Lagrangian formulation, examples, trajectory generation: general consideration in path description and generation, joint space schemes, collision free path planning; robot control; overview of robot motion planning; robot programming methods.

Text Books

1. Introduction to Robotics by S K Saha, Mc Graw Hill Education, 2014.
2. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning., 2009.
3. R K Mittal and I J Nagrath, “Robotics and Control”, Tata McGraw Hill, New Delhi,2003.
4. Introduction to Robotics (Mechanics and control), John. J. Craig, Pearson Education Asia 2002.
5. Robotics Technology and Flexible Automation, Second Edition, S. R. Deb, 2017.

NPTEL course links that align with the syllabus:

1. Introduction to robotics
   https://onlinecourses.nptel.ac.in/noc22_cs54/preview
2. Introduction to robotics
   https://onlinecourses.nptel.ac.in/noc20_de11/preview

24-219-0513 INTRODUCTION TO INDUSTRIAL AUTOMATION

L	T	P	C
3	1	0	3

Total hours: 64

Course Outcomes: After the completion of the course the student will be able to

CO1 Understand the types and trends in automation and flexible manufacturing systems.

CO2 Identify and describe the sensors and actuators used in automation systems.

CO3 Explain the principles of material handling systems and CNC components

CO4 Apply PLC programming techniques and describe inspection automation methods.

Mapping of course outcomes with Program outcomes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	3
CO2	3	3	3	-	-	-	-	-	-	-	-	3
CO3	3	3	2	-	-	-	-	-	-	-	-	3
CO4	3	3	2	-	-	-	-	-	-	-	-	3

Module 1

Automation methodologies: Concept of Mechanization and Automation – Types of Automation Detroit type Automation, Automated flow lines, Fundamentals of Transfer Lines.

Trends in manufacturing – GT and Cellular Manufacturing, Flexible manufacturing systems – features of FMS, computer integrated manufacturing – need for AI and expert systems in CIM, Automated assembly system – flexible assembly automation.

Module 2

Sensors and actuators for automation: Classification of position and motion sensors, inductive type, electromechanical switches, rotary position sensors – resolver, encoders, LVDT, RVDT, photo electric, thermo electric, capacitive, magnetic detectors, impedance type gauging transducers, linear potentiometer, strain gauges. Practical examples on design, selection and implementation of sensor systems, calibration of sensors.

Electrical, Hydraulic and pneumatic actuators and their comparison, Examples - use of Electrical, Hydraulic and pneumatic actuators in industrial automation.

Module 3

Material Handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods.

Elements of CNC systems: servomotor and servo system design trends, stepper motors and controls. Drive systems. Accessories, and selection of drives for CNC machines.

Pneumatic/Hydraulic Automation: control valves – direction, pressure and flow. cascade and Karnaugh Veitch map methods

Module 4

Automation Control: Sequence control and programmable controllers – logic control and sequencing elements, ladder diagram, PLC, programming the PLC. Practical Examples on PLC ladder programming.

Inspection automation: Inspection automation, off-line and on-line inspections, computerized coordinate measuring machine – CMM construction. non-contact inspection methods. machine vision systems.

Text Books:

1. Automation, Production Systems and Computer Integrated Manufacturing, Groover M.P, Prentice – Hall Ltd., 2016.

2. Computer Control of Manufacturing Systems‖ YoramKoren, Tata McGraw-Hill Edition 2017.

3. CNC Machines, Radhakrishnan P., New Central Book Agency, 2013.

4. Pneumatic Control for Industrial Automation, Peter Rohner, Gordon Smith, 2005.

5. Mechatronics: A Multidisciplinary Approach, 4/E‖, W. Bolton. Pearson Education India, 2014.

NPTEL course links that align with the syllabus:

1. Industrial Automation and Control https://onlinecourses.nptel.ac.in/noc21_me67/preview

24-219-0614 MINI PROJECT

L	T	P	C
0	0	3	3

Preamble

This Minor Mini Project in Robotics aims to introduce students to research and development within the field of Robotics. Conducted in a group of three or four students under faculty supervision, the project encourages students to explore current research or propose innovative ideas, blending theoretical concepts with practical implementation. Focusing on areas such as mechanical design, electronics, control systems, and intelligent decision-making, the project fosters hands-on learning and teamwork. It serves as a foundation for future academic or industrial R&D by developing problem-solving skills and exposing students to real-world robotic applications.

The assignment to normally include:

- Conducting a comprehensive survey and review of published literature relevant to the assigned topic.
- Formulating an action plan for the investigation, outlining the workflow and distribution of tasks within the team.
- Developing a preliminary approach or strategy to address the identified problem.
- Preparing detailed block-level system design documentation to illustrate the proposed solution architecture.
- Performing initial analysis, modelling, simulation, experimental setup, design, or feasibility studies to validate the chosen approach.
- Compiling the findings into a structured written report to be presented before the department for evaluation and feedback.

Course Outcomes: After the completion of the course the student will be able to

CO1 Analyze real-world problems in the domain and propose effective, innovative solutions (Analyze).

CO2 Develop a structured work plan and coordinate efficiently within a team to meet project deadlines (Apply)

CO3 Validate proposed solutions through theoretical analysis and practical experimentation (Evaluate).

CO4 Document technical findings effectively and enhance written and verbal communication skills (Apply).

CO5 Present project outcomes confidently and defend design choices and methodologies with clarity (Evaluate).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	-	-	3	3	-	2
CO2	3	-	-	3	-	-	-	3	3	3	3	-
CO3	3	3	3	3	3	-	-	-	-	3	-	-
CO4	-	-	-	-	3	-	-	3	3	3	-	1
CO5	3	3	3	3	-	-	-	3	-	3	3	1

Assessment Pattern

The End Semester Evaluation (ESE) will be conducted internally and will assess the project based on the developed product, the submitted report, and a viva-voce examination. The evaluation will be carried out by a three-member committee appointed by the Head of the Department. This committee will include the HoD or a senior faculty member, the academic coordinator of the program, and the project guide or coordinator. The assessment will focus on the extent of project completion, demonstration of functionality as per specifications, quality of the presentation, performance in the oral examination, depth of technical understanding, and the level of individual involvement throughout the project.

The Continuous Internal Evaluation (CIE) is carried out through a minimum of two formal project reviews to assess the progress of the mini project. During the first review, students are expected to present a novel concept, system, or design, backed by a comprehensive literature review of existing solutions within their chosen domain. In the second review, the focus shifts to the implementation phase, where students must detail how their proposed solution has been realized. The review committee will evaluate how effectively the implementation aligns with the proposed design. At this stage, a well-developed, fully functional, and integrated product is expected as the outcome. The final CIE score is calculated as the average of the marks awarded in both reviews.

A zeroth review may be conducted prior to the official start of the project, providing students an opportunity to present their area of interest, problem domain, or engage in open brainstorming sessions to explore innovative ideas. This review is intended to guide project direction and encourage creativity but will not be considered in the CIE evaluation.

Marks Distribution

Total Marks	CIE	ESE
100	50	50

Continuous Internal Evaluation Pattern:

Attendance : 5 Marks

Marks awarded by Guide : 10 Marks

Project Report : 10 Marks

Evaluation by the Committee : 25 Marks

End Semester Examination Pattern:

Demonstration : 30 Marks

Project report : 10 Marks

Viva voce : 10 Marks

Course Plan

In this course, each student group comprising three to four members is expected to design and develop a moderately complex software or hardware system with practical applications. The final output should be a functional working model, incorporating the fundamentals of product design. Students must identify a project topic of interest in consultation with the Faculty-in-Charge or Project Advisor. A thorough literature review should be conducted to gather relevant information. Based on this, the group must define clear objectives and develop a suitable methodology to achieve them. The project should involve design, fabrication, coding, or system development, depending on the nature of the work. Throughout the semester, the novelty and innovation of the project must be demonstrated through tangible results. The project's progress will be evaluated through at least two formal reviews, overseen by a review committee appointed by the Head of the Department. At the end of the semester, students are required to submit a comprehensive project report and demonstrate the final product, ensuring it meets all functional and design specifications. Additional credit will be given for projects that incorporate innovative design principles, address reliability, and consider aesthetics and ergonomic aspects.