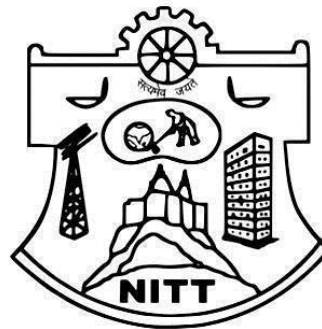


B. Tech. Degree
in
INSTRUMENTATION AND CONTROL ENGINEERING

SYLLABUS FOR
FLEXIBLE CURRICULUM

(For students admitted in 2015-16 onwards)



DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI – 620 015
TAMIL NADU, INDIA.

INSTITUTE VISION

- To provide valuable resources for industry and society through excellence in technical education and research.

INSTITUTE MISSION

- To offer state-of-the-art undergraduate, postgraduate and doctoral programmes.
- To generate new knowledge by engaging in cutting-edge research.
- To undertake collaborative projects with academia and industries.
- To develop human intellectual capability to its fullest potential.

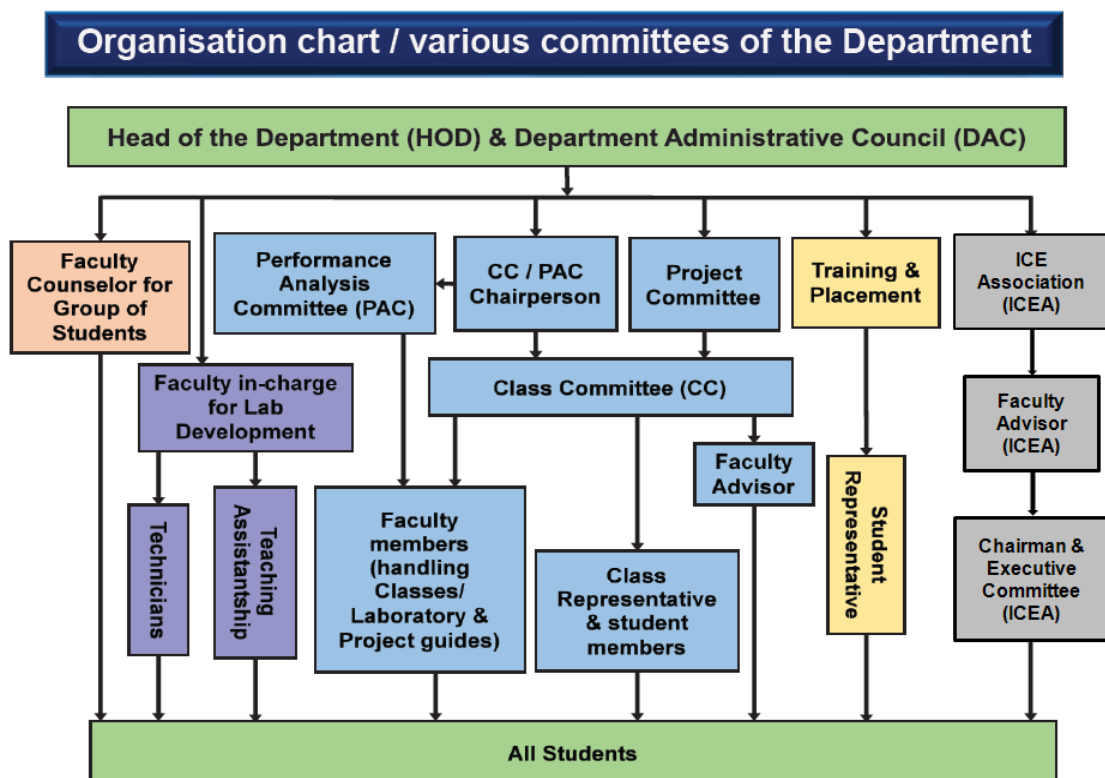
DEPARTMENT VISION

- To constantly strive to make this department a world class school in Instrumentation and Control Engineering.

DEPARTMENT MISSION

- To provide high quality education which inspire the students to realize their aspiration and potential.
- To enhance knowledge, create passion for learning, foster innovation and nurture talents towards serving the society and the country.
- To encourage faculty members to update their knowledge and carryout advanced research in cutting edge technologies.
- To exhibit excellence in research projects and consultancy services, for the benefit of the global community.

Organization Chart / Various Committees of the Department





Programme Educational Objectives (PEOs)

The major objectives of the 4-year B.Tech (ICE) programme offered by the department of Instrumentation & Control Engineering are, to prepare students

1. For employment in the core industrial/manufacturing sector
2. For employment in research and development organizations
3. For employment in electronics & IT/ITES industry
4. For graduate studies in engineering and management
5. For entrepreneurship in the long run

Programme Outcomes (POs)

The students, after undergoing the 4-year B.Tech (ICE) programme,

1. Would have developed an ability to apply the knowledge of mathematics, sciences, and engineering fundamentals to the field of instrumentation & control.
2. Would have possessed a comprehensive understanding of a wider range of electronic devices, analog and digital electronic circuits and the state-of-the-art advanced electronic systems invariably found in every measurement and instrumentation system.
3. Would have the right knowledge of and exposure to a variety of sensors, data acquisition systems, actuators, and control methodologies to readily provide innovative solutions to the day-to-day problems in the core industry (e.g. processes, power plants, automotive).
4. Would have gained adequate knowledge in microprocessors and microcontrollers, embedded systems, data structures, algorithms, computer programming and simulation software to be able to offer services in IT and management sectors.
5. Would have learnt necessary skills to develop mathematical models, and deploy appropriate techniques and IT tools to design advanced control systems and associated instrumentation for problems dealt in R & D organizations.
6. Would be thoroughly prepared and confident to take up complex problems in the field of I & C and provide sustainable solutions by (i) surveying the literature and patents, (ii) designing and conducting experiments, (iii) interpreting the data, (iv) drawing relevant conclusions, with due consideration and responsibility towards the immediate social, cultural, environmental and legal issues, and (v) documenting the research carried out.
7. Would be able to evaluate and deliver the solutions by optimally utilizing the available resources, including finances and project time, by adapting appropriate resource management techniques.
8. Would be competent to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
9. Would be proficient in English language (spoken and written) in order to communicate effectively on complex engineering activities on a global scale, make comprehensive reports and presentations, and give and receive clear instructions.
10. Would have committed to be professionally ethical.
11. Would pledge to function efficiently in various capacities as members, leaders, and directors in multi-disciplinary teams to accomplish projects of different magnitudes, and
12. Would have recognized the need for engaging themselves in independent and life-long learning in the broadest context of technological change.



CURRICULUM

The total minimum credits required for completing the B.Tech. programme in Instrumentation and Control Engineering is **176**.

MINIMUM CREDIT REQUIREMENT FOR THE VARIOUS COURSE CATEGORIES:

S.No.	COURSE CATEGORY	NO. OF COURSES	NO. OF CREDITS
1.	GENERAL INSTITUTE REQUIREMENT (GIR)	24	68
2.	PROGRAMME CORE (PC)	20	62
3.	ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)	8	16
4.	ELECTIVE COURSES (PE+OE+MI)	10	30
TOTAL		62	176

Programme Electives (PE) are offered by the Department of Instrumentation and Control Engineering for students of B.Tech. in Instrumentation and Control Engineering programme. A minimum of nine credits out of the thirty credits allotted for Electives category must be earned from the courses listed in the PE section.

To meet the minimum credit requirement for Electives, the remaining elective courses can be chosen from either PE courses offered by the Department of Instrumentation and Control Engineering, or Open Electives offered by any other Department within National Institute of Technology, Tiruchchirappalli. In addition to the above, the courses registered under B.Tech. (Minor) programme of any other Department, will be considered for Electives category.



I. GENERAL INSTITUTE REQUIREMENT (GIR)

1. MATHEMATICS

S.No.	Course Code	Course Title	Credits
1.	MAIR11	Mathematics – I	4
2.	MAIR21	Mathematics – II	4
3.	MAIR36	Algebra and Probability Theory	3
4.	MAIR43	Numerical Methods	3
Total			14

2. PHYSICS

S.No.	Course Code	Course Title	Credits
1.	PHIR11	Physics- I	3
2.	PHIR13	Physics- II	4
Total			7

3. CHEMISTRY

S.No.	Course Code	Course Title	Credits
1.	CHIR11	Chemistry- I	3
2.	CHIR13	Chemistry- II	4
Total			7

4. COMMUNICATION

S.No.	Course Code	Course Title	Credits
1.	HSIR11	English for Communication	3
2.	HSIR12	Professional Communication	3
Total			6



5. HUMANITIES

S.No.	Course Code	Course Title	Credits
1.	HSIR13	Industrial Economics and Foreign Trade	3
Total			3

6. PROFESSIONAL ETHICS

S.No.	Course Code	Course Title	Credits
1.	HSIR14	Professional Ethics and Human Values	3
Total			3

7. ENERGY AND ENVIRONMENTAL ENGINEERING

S.No.	Course Code	Course Title	Credits
1.	ENIR11	Energy and Environmental Engineering	2
Total			2

8. BASIC ENGINEERING

S.No.	Course Code	Course Title	Credits
1.	CEIR11	Basics of Civil Engineering	2
2.	MEIR11	Basics of Mechanical Engineering	2
Total			4

9. ENGINEERING GRAPHICS

S.No.	Course Code	Course Title	Credits
1.	MEIR12	Engineering Graphics	3
Total			3

**10. ENGINEERING PRACTICE**

S.No.	Course Code	Course Title	Credits
1.	PRIR11	Engineering Practice	2
Total			2

11. INTRODUCTION TO COMPUTER PROGRAMMING

S.No.	Course Code	Course Title	Credits
1.	CSIR11	Basics of Programming	3
Total			3

12. BRANCH SPECIFIC COURSE

S.No.	Course Code	Course Title	Credits
1.	ICIR15	Introduction to Instrumentation and Control Systems Engineering	2
Total			2

13. SUMMER INTERNSHIP

S.No.	Course Code	Course Title	Credits
1.	ICIR16	Internship / Industrial Training / Academic Attachment (2 To 3 Months Duration During Summer Vacation)	2
Total			2

Each student should undergo industrial training / internship for a minimum period of two months during the summer vacation of third year. Attachment with an academic institution within the country (CFTIs such as IISc / IITs / NITs / IIITs, etc.) or university abroad is also permitted in place of industrial training. The course will be evaluated at the beginning of the fourth year (VII semester) by assessing the report and seminar presentations.



14. PROJECT WORK

S.No.	Course Code	Course Title	Credits
1.	ICIR17	Project Work	6
Total			6

15. COMPREHENSIVE VIVA

S.No.	Course Code	Course Title	Credits
1.	ICIR18	Comprehensive Viva-Voice Examination	3
Total			3

Note: A Student can appear for Comprehensive Viva-Voce Examination only after completing all the Programme Core (PC) courses.

16. INDUSTRIAL LECTURE

S.No.	Course Code	Course Title	Credits
1.	ICIR19	Industrial Lecture	1
Total			1

A minimum of five lectures of two hours duration by industry experts will be arranged by the Department. The evaluation methodology, will be based on objective type questioning at the end of each lecture.

17. NSS/NCC/NSO

S.No.	Course Code	Course Title	Credits
1.	SWIR11	NSS/NCC/NSO	0
Total			0



II. PROGRAMME CORE (PC)

LIST OF ESSENTIAL PROGRAMME CORE COURSES			
S.No.	Course Code	Course Title	Credits
1.	ICPC10	Engineering Mechanics	3
2.	ICPC11	Sensors and Transducers	3
3.	ICPC12	Materials Science	3
4.	ICPC13	Thermodynamics and Fluid Mechanics	4
5.	ICPC14	Circuit Theory	4
6.	ICPC15	Digital Electronics	3
7.	ICPC16	Signals and Systems	3
8.	ICPC17	Industrial Instrumentation	3
9.	ICPC18	Analog Signal Processing	3
10.	ICPC19	Electrical and Electronic Measurements	3
11.	ICPC20	Microprocessors and Microcontrollers	3
12.	ICPC21	Control System – I	4
13.	ICPC22	Instrumentation Practices in Industries	3
14.	ICPC23	Principles of Communication Systems	3
15.	ICPC24	Control System – II	3
16.	ICPC25	Process Control	4
17.	ICPC26	Product Design and Development (Theory)	2
18.	ICPC27	Product Design and Development (Practice)	2
19.	ICPC28	Analytical Instrumentation	3
20.	ICPC29	Logic and Distributed Control System	3
TOTAL			62



III. ELECTIVE COURSES

1. PROGRAMME ELECTIVES (PE)

Students pursuing B.Tech. in Instrumentation and Control Engineering should complete at least three courses from the Programme Electives listed below.

LIST OF PROGRAMME ELECTIVES				
S.No.	Course Code	Course Title	Pre-Req.	Credits
1.	ICPE10	Optical Instrumentation	-	3
2.	ICPE11	Medical Instrumentation	-	3
3.	ICPE12	Micro Electro Mechanical System	ICPC11	3
4.	ICPE13	Automotive Instrumentation	ICPC11 ICPC17	3
5.	ICPE14	Instrumentation and Control for Power Plant	ICPC17 ICPC25	3
6.	ICPE15	Instrumentation and Control for Petrochemical Industries	ICPC17 ICPC25	3
7.	ICPE16	Instrumentation and Control for Paper and Cement Industries	ICPC17 ICPC25	3
8.	ICPE17	Instrumentation for Agricultural and Food Processing Industries	ICPC11 ICPC17	3
9.	ICPE18	Piping and Instrumentation Diagram	ICPC17 ICPC25	3
10.	ICPE19	Measurement Data Analysis	ICPC19	3
11.	ICPE20	Building Automation	-	3
12.	ICPE21	Digital Control Systems	ICPC16 ICPC21 ICPC24	3
13.	ICPE22	Neural Networks and Fuzzy Logic	-	3
14.	ICPE23	Non Linear Control	ICPC21 ICPC24	3



15.	ICPE24	System Identification and Adaptive Control	ICPC24	3
16.	ICPE25	Fault Detection and Diagnosis	-	3
17.	ICPE26	Computational Techniques in Control System	ICPC21 ICPC24	3
18.	ICPE27	Process Modelling and Optimization	ICPC24 ICPC25	3
19.	ICPE28	Control System Components	ICPC21 ICPC25	3
20.	ICPE29	Network Control System	ICPC23 ICPC29	3
21.	ICPE30	Digital Signal Processing	ICPC16	3
22.	ICPE31	Power Electronics	ICPC18	3
23.	ICPE32	Embedded System	ICPC15 ICPC20	3
24.	ICPE33	Smart and Wireless Instrumentation	ICPC20 ICPC23	3
25.	ICPE34	Digital Image Processing	ICPE29	3
26.	ICPE35	Multi Sensor Data Fusion	ICPC24	3
27.	ICPE36	Medical Imaging System	ICPE34	3
28.	ICPE37	Industrial Data Communication	ICPC29	3
29.	ICPE38	Energy Harvesting Techniques	-	3
30.	ICPE39	Smart Materials and Systems	-	3
31.	ICPE40	Hydraulics and Pneumatics	-	3
32.	ICPE41	Internet of Things System Design	-	3
33.	ICPE42	Software Design Tools for Sensing and Control	-	3
34.	ICPE43	Industrial Electric Drives	ICPE31	3



2. OPEN ELECTIVES (OE)

The courses listed below are offered by the Department of Instrumentation and Control Engineering for students of other Departments.

LIST OF OPEN ELECTIVES				
S.No.	Course Code	Course Title	Pre-Req.	Credits
1.	ICOE10	Building Automation	-	3
2.	ICOE11	Project Engineering and Management	-	3
3.	ICOE12	Medical Instrumentation	-	3
4.	ICOE13	Micro Electro Mechanical System	-	3
5.	ICOE14	Measurement and Control	-	3
6.	ICOE15	Industrial Measurements	-	3
7.	ICOE16	Virtual Instrument Design	-	3
8.	ICOE17	Neural Networks and Fuzzy Logic	-	3
9.	ICOE18	Network Control Systems	-	3
10.	ICOE19	Control System	-	3
11.	ICOE20	Energy Harvesting Techniques	-	3
12.	ICOE21	Internet of Things	-	3
13.	ICOE22	Intellectual Property Rights	-	3
14.	ICOE23	Smart Materials and Systems	-	3

3. MINOR (MI)

Students registered for B.Tech. (Minor) in Instrumentation and Control Engineering can opt to study any five of the courses listed below.

LIST OF COURSES FOR B.Tech. (MINOR) PROGRAMME				
S.No.	Course Code	Course Title	Pre-Req.	Credits
1.	ICMI10	Transducer Engineering	-	3



2.	ICMI11	Test and Measuring Instruments	-	3
3.	ICMI12	Measurements in Process Industries	-	3
4.	ICMI13	Essentials of Control Engineering	-	3
5.	ICMI14	Industrial Automation and Control	-	3

However, the above courses will also be offered as an open elective for other branch students.

Note: Student should be allowed a minimum of 50% of the total electives of a programme from Open electives and Minor, if so desired.

IV. ESSENTIAL PROGRAMME LABORATORY REQUIREMENT (ELR)

LIST OF ESSENTIAL PROGRAMME LABORATORY REQUIREMENT			
S.No.	Course Code	Course Title	Credits
1.	ICLR10	Thermodynamics and Fluid Mechanics Laboratory	2
2.	ICLR11	Circuits and Digital Laboratory	2
3.	ICLR12	Sensors and Transducers Laboratory	2
4.	ICLR13	Analog Signal Processing Laboratory	2
5.	ICLR14	Instrumentation Laboratory	2
6.	ICLR15	Microprocessors and Microcontrollers Laboratory	2
7.	ICLR16	Control Engineering Laboratory	2
8.	ICLR17	Industrial Automation and Process Control Laboratory	2
TOTAL			16

Note: students can register for 2 laboratory courses during one session along with the regular courses (PC / PE / OE / MI)



V. ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)

1. A student is eligible to register for B.Tech. (Honours) degree provided the student has:
 - i. Registered at least for twelve theory courses and two ELRs in the second year.
 - ii. Consistently obtained a minimum GPA of 8.5 in the first four sessions.
2. The student should Continue to maintain the same GPA of 8.5 in the subsequent sessions (including the Honours courses)
3. A student can obtain B.Tech. (Honours) degree
 - i. On completion of three additional theory courses specified for the Honours degree of the programme.
 - ii. On completion of all the courses registered, in the first attempt during the four years of study.

LIST OF ADVANCED LEVEL COURSES FOR B.Tech. (HONOURS)				
S.No.	Course Code	Course Title	Co-Req.	Credits
1.	ICHO10	Design of Sensors and Transducers	ICPC11	3
2.	ICHO11	Instrumentation System Design	ICPC17 ICPC22	3
3.	ICHO12	Micro System Design	ICPE12	3
4.	ICHO13	Advanced Control System Design	ICPC21 ICPC24	3
5.	ICHO14	Advanced Process Control	ICPC21 ICPC25	3
6.	ICHO15	Optimal and Robust Control	ICPC21 ICPC24	3
7.	ICHO16	Electronics for Sensor Design	ICPC14 ICPC18 ICPC20	3
8.	ICHO17	System On Chip	ICPC18	3



ICPC10 - ENGINEERING MECHANICS

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

1. To introduce the fundamentals of mechanics and machines to the instrumentation and control engineering students.
2. To explain the application of basic mechanical science concepts
3. To apply different physical principles to the analysis of mechanics and machines
4. To identify the different elements of a mechanical system and write the mathematical equations for them.

Course Content:

Forces and equilibrium – Free body diagram – Forces in equilibrium. Stress and strain – Poisson's ratio – Bulk modulus. Beams – Types of beams – Bending moment and shearing force – Bending stresses. Torsion – Torsion of circular shafts – Transmission of power.

Strain energy – Dynamic loading – Strain energy due to shear – Impact torsional loading – Strain energy due to bending – Impact loading of beams.

Linear and angular motion – Linear motion – Curvilinear motion – Relative velocity – Angular motion – Torque and angular motion – Balancing of rotational masses – Momentum – Work and energy.

Mechanisms – Velocity diagrams – Acceleration diagrams. Coriolis acceleration. Flywheels. Machines – Transmission of rotational motion. Geared systems – Gear trains. Friction – Friction clutches. Bearings. Belt drives. Gyroscopic motion – Gyroscopic couple.

Free vibrations – Simple harmonic motion. Linear and torsional vibrations of an elastic system. Transverse vibrations of beams – Whirling of shafts.

Damped and forced oscillations – Free oscillations – Damped oscillations – Undamped forced oscillations – Damped forced oscillations.

Degrees of freedom – Two rotor system – Forced vibrations.

Text Books:

1. Bolton, W. 'Mechanical Science', 3rd edition. 2006, Wiley-Blackwell Publishing. ISBN:978-1-4051-3794-2
2. Shames, Irving H., 'Engineering Mechanics: Statics and Dynamics', 4th edition, Pearson Education, 2006 ISBN: 978-81-7758-123-2.



3. Beer, Ferdinand P., Johnston, E. Russel, Mazurek, David F., and Cornwell, Phillip J. 'Vector Mechanics for Engineers: Statics and Dynamics', McGraw- Hill Education (India), 11th edition. 2015, ISBN: 978-12-5906-291-9.

Course outcomes:

After successfully completing this course, the student will be able to

1. Identify simple mechanisms and their principles of operation.
2. Write the mathematical equations for static and dynamic loading in simple mechanical systems.
3. Write the equations for energy and power in simple mechanical systems.
4. Analyze free and forced oscillations in simple dynamic systems.



ICPC11 - SENSORS AND TRANSDUCERS

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

1. To expose the students to various sensors and transducers for measuring mechanical quantities.
2. To understand the specifications of sensors and transducers.
3. To learn the basic conditioning circuits for various sensors and transducers.
4. To introduce advances in sensor technology.

Course Content:

General concepts and terminology of measurement systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measurement system, Statistical analysis of measurement data.

Resistive transducers: Potentiometers, metal and semiconductor strain gauges and signal conditioning circuits, strain gauge applications: Load and torque measurement.

Self and mutual inductive transducers- capacitive transducers, eddy current transducers, proximity sensors, tacho generators and stroboscope.

Piezoelectric transducers and their signal conditioning, Seismic transducer and its dynamic response, photoelectric transducers, Hall effect sensors, Magnetostrictive transducers, Basics of Gyroscope.

Digital displacement sensors, Fibre optic sensor, Semiconductor sensor and Smart sensors.

Text Books:

1. John P. Bentley, *Principles of Measurement Systems*, Pearson Education, 4th Edition, 2005.
2. Doebelin E.O, *Measurement Systems - Application and Design*, McGraw-Hill, 4th Edition, 2004.
3. S.M. Sze, *Semiconductor sensors*, John Wiley & Sons Inc., 3rd Edition, 2006.

Reference Books:

1. Murthy D. V. S, *Transducers and Instrumentation*, Prentice Hall, 2nd Edition, 2011
2. James W.Dally, *Instrumentation for Engineering Measurements*, Wiley, 2nd Edition, 1993
3. John G.Webster, *Sensors and Signal Conditioning*, Wiley Inter Science, 2nd Edition, 2008
4. Neubert H.K.P, *Instrument Transducers - An Introduction to their Performance and Design*, Oxford University Press, 2nd Edition, 1999.
5. Patranabis, *Sensors and Transducers*, Prentice Hall, 2nd Edition, 2003.
6. Waldemar Nawrocki, *Measurement Systems and Sensors*, Artech House, 2005



Course outcomes:

After successfully completing this course, the student will be

1. Familiar with the basics of measurement system and its input, output configuration of measurement system.
2. Familiar with both static and dynamic characteristics of measurement system.
3. Familiar with the principle and working of various sensors and transducers.
4. Able to design signal conditioning circuit for various transducers.
5. Able to identify or choose a transducer for a specific measurement application.



ICPC12 - MATERIAL SCIENCE

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

To develop an understanding of the basic principles of Material Science and apply those principles to engineering applications.

Course Content:

Introduction to crystal structure of materials, density computations, polymorphism and allotropy, Miller indices for crystallographic planes and directions, isotropy and anisotropy with respect to material properties. X-ray diffraction for determination of crystal structure. Defects in solids: point, line and planar defects and their effect on properties of materials. Phase diagrams, mono component and binary systems, Interpretation of phase diagrams, the Gibbs phase rule, the iron-carbon system.

Development of micro structure-equilibrium and non-equilibrium cooling. Time- temperature-transformation curves and their applications. Mechanical properties of materials: elasticity, elastic and plastic behaviour, stress-strain relationship, fatigue and creep, strengthening mechanisms and fracture. Thermal properties: heat capacity, thermal expansion, thermal conductivity and thermal stresses.

Electrical properties of materials: Electron energy band structures for solid materials, conduction in terms of band and atomic bonding models. Intrinsic and extrinsic semiconductors, the temperature variation of conductivity and carrier concentration. Electrical properties of polymers. Dielectric behaviour, Ferro electricity and Piezoelectricity.

Magnetic properties, diamagnetic, paramagnetic, Ferromagnetic, anti-ferromagnetic, ferromagnetic materials and their applications. Influence of temperature on magnetic characteristics of materials. Superconductivity in materials Optical properties of materials: Absorption, transmission, refraction, reflection; opacity and translucency in materials Absorption, transmission, refraction, reflection; opacity and translucency in materials. Mechanism of photon absorption. Environmental effect on materials.

Zone refining for purification of materials, Synthesis and growth of Group-III-V compounds and their applications. Selection of specific materials required for instrumentation devices, sensors, pumps, valves, pipelines and coatings.

Text Books:

1. *Callister W.D., Materials Science and Engineering: An introduction, 6th Edition, John Wiley & Sons Inc., New York 2002.*
2. *Raghavan V. Materials Science and Engineering – A first course, 5th Edition, Prentice Hall, New Delhi, 2004.*
3. *Van Vlack, LH, Elements of Materials Science and Engineering, 6th Edition, Addison – Wesley Singapore, 1989.*



Reference Books:

1. *Askeland D.R. The Science and Engineering of Materials, 6th Edition, Chapman and Hall, London, 2010.*
2. *Smith W.F. and Hashemi J., Foundations of Materials Science and Engineering, 4th Edition, Mc Graw Hill, United States, 2005*

Course outcomes:

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

1. Understand the geometry and crystallography of crystalline materials.
2. Interpretation of phase diagram and iron-carbon system.
3. Define various mechanical properties and the associated testing methods.
4. Define electrical, magnetic and optical properties of materials.
5. Select suitable materials for specific instrumentation devices.



ICPC13 - THERMODYNAMICS AND FLUID MECHANICS

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 4

Course Learning Objectives:

To develop and understanding of

1. The principles of work and energy, design principles and analysis of thermo-fluid systems.
2. The physical properties of fluids and their consequences on fluid flow.
3. The conservation principles of mass, linear momentum, and energy for fluid flow.
4. The basic forces and moments acting on simple profiles and shapes in an inviscid, steady fluid flow.

Course Content:

Basic concepts of thermodynamics: Thermodynamic equilibrium, quasi-static process, zeroth law, work and heat interactions, first law for a cycle and a process, steady flow processes, second law statements, reversibility, Carnot theorem, Clausius inequality, entropy principle. Available energy: Availability and irreversibility, properties of pure substances, phase equilibrium diagrams, Rankine cycle, reheat and regenerative cycle, properties of ideal gas, Stirling and Ericson cycles.

Heat engines: Otto, diesel and dual cycles, Brayton cycle with regeneration, inter cooling and reheat, Joule-Thompson effect.

Fundamentals of Fluid mechanics: Classification of fluids and their physical properties, Fluid statics, manometers, pressure on submerged bodies. Ideal fluid - velocity field - stream line, streak line and path line, continuity equation - Rotational and irrotational flow, stream function and potential function, Euler's equations of motion, Bernoulli's equation and its application. Classification of open channel flows - measurement of discharge using rectangular and V-notches. Dimensional analysis – Rayleigh's method - Buckingham Theorem and its applications. Laminar flow – Losses – Hagen-Poiseuille equation – Turbulent pipe flow – Friction.

Darcy Weisbach equation – Moody's diagram, minor losses – Boundary layer and its basic concepts.

Fluid machinery: Centrifugal pumps, Reciprocating pumps, Hydraulic ram, Impulse turbine, Reaction turbine.

Text Books:

1. Zemansky, *Heat and Thermodynamics, 7th edition, McGraw Hill, New York, 1997.*
2. Ojha C.S.P., Berndtsson R., Chandramouli P.N., *Fluid Mechanics and Machinery, Oxford University Press, 2010.*
3. Streeter V.L. and Wylie E.B., *'Fluid Mechanics', 9th edition, McGraw Hill, New York, 1997.*



Reference Books:

1. Van Wylen G.A., *Fundamentals of classical Thermodynamics*, 4th Edition, John Wiley and Sons, 1994.
2. Cengel Y.A., Bogles M.A., Micheal Boles, *Thermodynamics*, 2nd edition, McGraw Hill Book Company, 1994.
3. Nag P.K., *Engineering Thermodynamics*, 2nd Edition, Tata McGraw Hill, 1995.
4. Crowe C.T., Elger D.F., Williams B.C., Roberson J.A., *Engineering Fluid Mechanics* 9th Edition, John Wiley & Sons, 2009.

Course outcomes:

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

1. Understand various thermodynamic cycles and apply them to heat engines.
2. Quantify the properties of fluids.
3. Know the principles of operation of some of the widely used fluid machinery.



ICPC14 - CIRCUIT THEORY

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 4

Course Learning Objectives:

1. To introduce and impart problem solving techniques, through linear passive electrical circuits, useful for other core and elective courses of the department.
2. To introduce algorithmic and computer-oriented methods for solving large scale circuits.

Course Content:

Review of Networks and Circuits, Elemental laws (V-I characteristics) for Resistors, Inductors, and Capacitors, Circuit laws (Kirchhoff's laws), Sign convention, Basic signals (dc and ac), Elementary signals (impulse, step, ramp, exponential), Synthesis of arbitrary waveforms (rectangular, triangular etc.) from elementary signals, Voltage and Current sources (Independent and Dependent), Ladder and Bridge Circuits.

Analysis of Resistive Circuits energized by dc voltages and currents – Source Transformations, Nodal and Mesh Analysis, Principle of Superposition, Network Theorems (Thevenin's and Norton's, Maximum Power Transfer), Circuits with dependent dc Sources.

Transients with Energy Storage Elements, First and Second Order Circuits – Time-constant, Damping Ratio, Natural Frequency, Emphasis on Linear Ordinary Differential Equations, Step response of RC, RL, and RLC (series and parallel) Circuits, Resonance in Second Order Circuits.

Sinusoidal Sources and Response – Behaviour of elements with ac signals, Impedance and Admittance, Generalization of Network Theorems and Circuit Analysis, Introduction to 3- ϕ power systems. Transient and Steady-state Response of Circuits – Laplace Transformation and its application to circuit analysis, State Variables, Network Functions (Driving point impedance and admittance), Transfer function, Two-port Networks, Applications of Two-port networks, Introduction to General Linear Systems.

Network Synthesis: Properties of RC, RL, and LC driving point functions, Synthesis of networks from given transfer functions.

Text Books:

1. Hayt, W.H, Kemmerly J.E. & Durbin, *Engineering Circuit Analysis, McGraw Hill Publications, 8th edition, 2013.*
2. Ramakalyan, A., *Linear Circuits: Analysis & Synthesis, Oxford Univ. Press, 2005.*

Reference Books:

1. Van Valkenburg, *Network Analysis, Prentice Hall, 3rd Edition, 2006*
2. Van Valkenburg, M.E., *Introduction to Modern Network Synthesis, Wiley, 1960.*



Course outcomes:

At the end of the course student will be able to

1. Analyze the basic concepts of A.C and D.C circuits using the network theorems
2. Find transient and frequency response of the electrical circuits.
3. Realize two port networks.



ICPC15 - DIGITAL ELECTRONICS

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

The subject aims to provide the student with

1. An understanding of number system, codes and their conversions.
2. The capability to reduce Boolean expression using K-map and tabular methods.
3. The ability to design and analyze combinational and sequential logic circuits for a given problem statement.
4. An understanding of Digital hardware and different types of logic families

Course Content:

Review of number systems and logic gates, Algebraic reductions, Binary codes -Weighted and non-weighted, number compliments, Binary arithmetic, Error detecting and error correcting codes, SOP, POS Canonical logic forms, Karnaugh maps and Quine-McClusky methods, Don't care conditions, minimization of multiple output functions.

Synthesis of combinational functions: Arithmetic circuits-Adder/Subtractor, carry look-ahead adder, signed number addition and subtraction, BCD adders. IC adders. Multiplexers, implementation of combinational functions using multiplexers, de-multiplexers, decoders, code converters, Digital ICs for combinational logic circuits, Complexity and propagation delay analysis of circuits.

Sequential Logic: Basic latch circuit, Debouncing of a switch, Flip-Flops: truth table and excitation table, conversion of Flip-flops, integrated circuit flip-flops. Race in sequential circuits, Shift Registers, Counters - Synchronous, Asynchronous, Up-Down, Design of counters.

Analysis of clocked sequential circuits, Design with state equations, Moore and Mealy graphs, State reduction and assignment, Sequence detection, Hazards. Programmable logic devices, Design using Programmable Logic Devices (ROM, PLA, PAL, FPGA).

Digital Hardware: Logic levels, Realization of logic gates, different logic families (TTL, ECL and CMOS), Logic levels, voltages and currents, fan-in, fan-out, speed, power dissipation. Comparison of logic families, Interfacing between different families.

Text Books:

1. *M.M. Mano, Digital Logic and Computer Design, Pearson, 4th Edition, 2014.*
2. *J.P. Uyemura, A First Course in Digital Systems Design, Brooks/Cole Publishing Co.*
3. *W. H. Gothmann, "Digital Electronics - An Introduction to Theory and Practice", Prentice Hall of India, 2000*
4. *C. H. Roth, Fundamentals of Logic design, Jaico Publishers, 1998.*
5. *S. Brown and Z Vranesic, Fundamentals of Logic Design with VHDL Design, Tata McGraw-Hill, 2000*



6. V. P. Nelson, H.T. Nagle, E.D. Carroll and J.D. Irwin, *Digital Logic Circuit Analysis and Design*, Prentice Hall International, 1995

Reference Books:

1. J.M. Rabaey, *Digital Integrated Circuits: A Design Perspective, 2nd Edition*, Prentice Hall of India, 2003.
2. N.H.E. Weste, and K. Eshraghian, *Principles of CMOS VLSI Design: A Systems Perspective, 3rd Edition*, Pearson Education Inc., (Asia), 2005

Course outcomes:

On completion of the course, the student will

1. Understand how digital and logic computing is built from the fundamentals of semiconductor electronics and learn the capability to use abstractions to analyze and design digital electronic circuits.
2. Gain knowledge on the basic logics and techniques related with digital computing.
3. Develop expertise to design and implement various complicated digital systems to be applicable for signal measurement and processing.



ICPC16 - SIGNALS AND SYSTEMS

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

1. This course introduces the student to general theory of signals and systems and makes the student familiar with the mathematical tools available to analyze the signals and systems in the first three units.
2. The student is introduced to random phenomena in real-world and the mathematical models to classify them in the fourth unit.
3. The use of pseudo-random signals in identifying systems is introduced in the fifth unit of the course.

Course Content:

Introduction to signals – Transformation of the independent variable – Basic continuous-time signals – Basic discrete-time signals – Step and Impulse functions – Sampling theorem. Introduction to systems – Properties of systems – Classification of systems – Mathematical model of systems – Concept of state variable – Normal form of system equations – Initial conditions.

Impulse response of physical systems – Stability analysis of dynamic systems – Introduction to convolution – Convolution integral – System impulse response and step response using Laplace transform – Numerical convolution. Z-transform – Convergence of Z-transform – Properties of Z-transform – Inversion of Z-transform – Application of Z-transform in analysis of discrete-time systems – Evaluation of discrete-time system frequency response – Inverse systems – Deconvolution.

Representation of signals in terms of elementary signals – Condition of orthogonality – Representation of signals by elementary sinusoids – Fourier series representation of periodic signals – Power spectrum.

Fourier transform – System frequency response – Realizability of frequency response – Energy spectrum. Calculation of simple transforms. Discrete-Fourier transform (DFT) – Properties of Discrete Fourier Transform – Circular convolution.

Classification of random signals – Auto-correlation function – Properties of auto-correlation function – Measurement of auto-correlation function – Application of auto-correlation functions. Cross correlation functions. Sum of random processes- Spectral density – Relation of spectral density to auto-correlation function

Auto-correlation function of system output - Cross-correlation between system input and output. White noise - Analysis of linear systems in time-domain using white noise - Mean and mean square value of system output. Generation of pseudo random binary noise (PRBN) and its use in system identification - Analysis in the frequency domain.



Text Books:

1. Gabel R.A. and Robert R.A., *Signals and Linear Systems*, John Wiley and Sons, 3rd Edition, 1987..
2. Oppenheim A.V., *Wilsky and Nawab, Signals and Systems*, Pearson India Education Services Private limited India, 2nd Edition, 2016.
3. Chen C.T., *Systems and Signal Analysis - A Fresh Look*, Oxford University Press India, 3rd Edition, 2004, ISBN100195756617.

Reference Books:

1. Cooper G.R and Mc Gillem C.D, *Probabilistic Methods of Signals and System Analysis*, Oxford University Press, 3rd Edition, 1999.
2. Chesmond, Wilson and Lepla, *Advanced Control System Technology*, Viva Books, 1st Edition, 1998.
3. Ziemer R.E., Tranter W.H., and Fannin D.R., *Signals and Systems: Continuous and Discrete*, Prentice Hall, 4th Edition, 1998.

Course outcomes:

1. The student will get a general understanding of continuous-time and discrete-time signals and systems.
2. The student will be able to analyze signals and systems using transforms.
3. The student will be able to classify random signals using statistical concepts and characterize systems using pseudo-random signals.



ICPC17 - INDUSTRIAL INSTRUMENTATION

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

To expose the students to various measurement techniques used for the measurement of temperature, flow, pressure and level in process industries.

Course Content:

Temperature measurement: Introduction to temperature measurements, Thermocouple, Resistance Temperature Detector, Thermistor and its measuring circuits, Radiation pyrometers and thermal imaging.

Pressure measurement: Introduction, definition and units, Mechanical, Electro-mechanical pressure measuring instruments. Low pressure measurement, Transmitter definition types, I/P and P/I Converters.

Level measurement: Introduction, Mechanical and electrical methods of level measurement.

Flow measurement: Introduction, definition and units, classification of flow meters, differential pressure and variable area flow meters, Positive displacement flow meters, Electro Magnetic flow meters.

Flow measurement: Hot wire anemometer, laser Doppler anemometer, ultrasonic, vortex and cross correlation flow meters, and measurement of mass flow rate.

Text Books:

1. Ernest.O.Doebelin and Dhanesh.N.Manik, *Doebelin's Measurement Systems, McGraw Hill Education, 6th Edition, 2011.*
2. B.G.Liptak, *Process Measurement and Analysis, 4th Edition, CRC Press, 2003.*
3. Patranabis D, *Principles of Industrial Instrumentation, Tata McGraw Hill, 3rd Edition, 2010.*

Reference Books:

1. B.E.Noltingk, *Instrumentation Reference Book, 2ndEdition, Butterworth Heinemann, 1995.*
2. Douglas M. Considine, *Process / Industrial Instruments & Controls Handbook, 5th Edition, McGraw Hill, Singapore, 1999.*
3. Andrew W.G, *Applied Instrumentation in Process Industries – A survey, Vol I &Vol II, Gulf Publishing Company, Houston, 2001*
4. Spitzer D. W., *Industrial Flow measurement, ISA press, 3rd Edition, 2005.*
5. Tony.R.Kuphaldt, *Lessons in Industrial Instrumentation, Version 2.02, April 2014.*



Course outcomes:

After successfully completing this course, the student will be

1. Familiar with the different temperature measurement techniques used in process industries.
2. Familiar with various flow instrumentation used in industrial flow measurement.
3. Able to understand the working principle of different pressure transmitters and level sensors used in industries.
4. Able to identify or choose temperature, flow, pressure and level measuring device for specific process measurement.



ICPC18 - ANALOG SIGNAL PROCESSING

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

Real world looks for system-level design skills in both analog and digital domains. The main focus of the course is analog system design. It will cover the design and test of practical circuits based on op-amps and other ICs.

Real world signals are processed for a variety of reasons, such as to remove unwanted noise, to correct distortion, to make them suitable for transmission. Analog signal processing unit comprises of various blocks which includes the theory of amplification, filtering, analysing, transmitting and reproducing the analog signals.

This course is designed to expose students to

1. The fundamental to the theory of analog signal processing
2. Various analog signal processing circuits and hardware implementation.

Course Content:

Introduction to analog signals and systems, Random signal analysis, application of statistical methods to the measurement of waveforms.

Analog signal processing circuits: amplifiers, analog multipliers, integrators, differentiators, active and passive filters, current-to-voltage and voltage-to-current converter, analog-to-digital converter, digital-to-analog converter, voltage-to-frequency converter, frequency-to-voltage converter, switched capacitor filter, Phase locked loop, Schmitt trigger, automatic gain control, regulators, wave form generators, oscillators.

Case studies: bridge linearization, PLL design using divider and multipliers, regulator design, transmitter design and realization of controllers.

Text Books:

1. Sergio Franco, *Design with operational amplifiers and analog integrated circuits*, 4th edition Mc-Graw Hill Inc. 2014.
2. Wai-Kai-Chen, *The circuits and filters Handbook*, CRC press, 2nd edition, 2003.
3. Gabel R.A. and Robert R.A., *Signals and Linear Systems*, John Wiley and Sons, 3rd Edition, 2009

Reference Books:

1. Cooper G.R and Mc Gillem C.D, *Probabilistic Methods of Signals and System Analysis*, Oxford University Press, 3rd Edition, 1998.
2. Arie F.Arbel, *Analog Signal Processing and Instrumentation*, Cambridge University press, 1984.



Course outcomes:

On completion of this course, the student will understand

1. The fundamental to the theory of analog signal processing
2. Various analog signal processing circuits and hardware implementation



ICPC19 - ELECTRICAL AND ELECTRONIC MEASUREMENTS

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

The course is designed to equip the students to understand the design and principle of common electrical, electronic and digital instruments for measurement of electrical and electronic quantities.

Course Content:

Electrical measurements: General features and Classification of electro mechanical instruments. Principles of Moving coil, moving iron, dynamometer type, rectifier type, thermal instruments. Extension of instrument range: shunt and multipliers, CT and PT.

Measurement of Power: Electrodynamometer wattmeter's, Low Power Factor (LPF) wattmeter, errors, calibration of wattmeter. Single and three phase power measurement, Hall effect wattmeter, thermal type wattmeter.

Measurement of resistance, inductance and capacitance: Low, high and precise resistance measurement, Megger, Ohmmeters, Classical AC bridges: Inductance and capacitance measurements. Detectors in bridge measurement, bridge screening, Wagner earth, transformer ratio bridges.

Electronic and digital measurements: Electronic voltmeter, current measurement with electronic instruments, Digital voltmeter, Analog and digital multi-meters, Digital frequency meters. Digital LCR meter, Q-Meter, Digital wattmeter and energy meters.

CRO, DSO, Function generators, Signal generators, Waveform analyzers, Spectrum analyzers, Distortion analyzers, LED and LCD displays.

Text Books:

1. *Golding, E.W. and Widdis, F.C., Electrical Measurements and Measuring Instruments, A.H.Wheeler and Co, 5th Edition, 2011.*
2. *David A. Bell, Electronic Instrumentation and Measurements, Oxford University Press, 3rd Edition, 2013.*
3. *Shawney A K, A course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Sons. 19th revised edition, 2014.*

Reference Books:

1. *Cooper, W.D. and Helfric, A.D., Electronic Instrumentation and Measurement Techniques, Prentice Hall, 1st Edition, 2009.*
2. *Kalsi.H.S, Electronic Instrumentation, Tata McGraw Hill Education Private Limited, 3rd Edition, 2012.*



Course outcomes:

After successfully completing this course, the student will be

1. Familiar with various measuring instruments (ammeters, voltmeters, wattmeter's, energy meters extension of meters, current and voltage transformers) used to detect electrical quantities.
2. Able to design suitable DC and AC bridges for the measurement of R, L, C and Frequency measurement.
3. Able to understand the analog and digital measurements.
4. Familiar with the operation and usage of various analyzing instruments.



ICPC20 - MICROPROCESSORS AND MICROCONTROLLERS

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

The aim of this course is to study the architecture, programming language and interfacing concepts of a microprocessors and microcontrollers.

Course Content:

Introduction to computer architecture and organization, Architecture of 8-bit and 16 bit microprocessors, bus configurations, CPU module.

Introduction to assembly language and machine language programming, instruction set of a typical 8-bit and 16 bit microprocessor, subroutines and stacks, programming exercises.

Timing diagrams, Memory families, memory interfacing, programmable peripheral interface chips, interfacing of input-output ports, programmable interval timer.

Serial and parallel data transfer schemes, interrupts and interrupt service procedure. Programmable interrupt controller. Programmed and interrupt driven data transfer. Programmable DMA controller, UART.

Architectures of 8051 Microcontroller, Bus configuration, programming the ports, Timers, serial interface, LCD interface, ADC interface, interrupt programming, Programming exercises, Applications.

Text Books:

1. *Ramesh Goankar, Microprocessor Architecture, Programming and applications with the 8085, 6th Edition, Penram International Publishing house, 2013.*
2. *Douglas V. Hall, Microprocessors and Interfacing-Programming and Hardware, 2nd Edition, Mc Graw Hill, 1999.*
3. *Kenneth J.Ayala, The 8051 Micro controller, Thomson Delmar Learning, 3rd Edition, 2004.*

Reference Books:

1. *Myke Predko, Programming and Customizing the 8051 micro controller, Tata-McGraw Hill, 3rd reprint 2007.*
2. *N.Mathivanan, Microprocessors, PC Hardware and Interfacing, PHI Learning Private Limited, 10th reprint 2013.*

Course outcomes:

Student will be able to

1. Understand the various functional blocks of microprocessor and microcontrollers.
2. Understand and Write an assembly language programming
3. Interface the peripherals with microprocessor and microcontrollers.



ICPC21 - CONTROL SYSTEM - I

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 4

Course Learning Objectives:

1. To teach a variety of classical methods and techniques for designing control systems.
2. To introduce and teach the iterative nature of most designs in order to achieve working systems.

Course Content:

Review of Systems, Mathematical Models – Differential Equations, Linear Approximations, and Transfer Functions, Block Diagrams and Signal Flow Graphs

Feedback Control System Characteristics, and Performance Specifications on transients and steady-state, Stability of Linear Feedback Systems – Routh-Hurwitz criterion.

The Root Locus Method, Feedback Control System Analysis & Performance Specifications in Time-Domain, Design of Lead, Lag, and PID Controllers using Root Locus.

Frequency Response Methods, Nyquist's Stability Criterion, Bode Plots, Performance Specifications in Frequency-Domain, Stability Margins.

Design of Lag and PID controllers in Frequency Domain, Design of Lag-Lead Controllers using time-domain and frequency-domain methods.

Text Books:

1. Dorf, R.C., & Bishop, R.H., *Modern Control Systems, 13th edition, Prentice Hall, 2016.*
2. Franklin, G.F., David Powell, J., & Emami-Naeini, A., *Feedback Control of Dynamic Systems, 7th edition, Prentice Hall, 2014.*

Reference Books:

1. Nise, N.S., *Control Systems Engineering, 7th edition, Wiley, 2015.*
2. Dutton, K., Thompson, S., & Barralough, B., *The Art of Control Engineering, Prentice Hall, 1997.*

Course outcomes:

1. The student understands translating physical phenomena into corresponding mathematical descriptions, and applies appropriate tools to analyze the behaviour of systems.
2. The student learns to deploy classical graphical tools to analyze and design control systems in time-domain.
3. The student understands that the frequency domain is a complementary point of view, and learns to design control systems in frequency-domain.
4. The student is exposed to the PID controllers prevalent in the Industry.



ICPC22 - INSTRUMENTATION PRACTICES IN INDUSTRIES

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

1. To expose the students to requirement of standards and calibration techniques, safety mechanisms in instruments used in process industries.
2. To understand and solve the EMI and EMC problems in industrial measurements.
3. To make the students to draw the specification of the industrial instruments and prepare the instrumentation project documents.

Course Content:

Selection and Application: Selection and application of temperature, pressure, flow and level measuring instruments.

Standards and Calibration: Introduction to standards and calibration, calibration of temperature, pressure and flow measuring devices.

EMC: Introduction, interference coupling mechanism, basics of circuit layout and grounding, concepts of interfaces, filtering and shielding.

Safety: Introduction, electrical hazards, hazardous areas and classification, non-hazardous areas, enclosures-NEMA types, fuses and circuit breakers. Protection methods: Purging, explosion proofing and intrinsic safety.

Specifications: Specification of instruments, preparation of project documentation, process flow sheet, instrument index sheet, instrument specifications sheet, panel drawing and specifications, instrument specifications. Project procedure, schedules, vendor drawing, tender documentation, selection of measurement method and control panels.

Text Books:

1. *Noltingk B.E., Instrumentation Reference Book, 2nd Edition, Butterworth Heinemann, 1995.*
2. *Liptak B.G, Process Measurement and Analysis, 4th Edition, Chilton Book Company, Radnor, Pennsylvania, 2003.*
3. *Andrew W.G, Applied Instrumentation in Process Industries – A survey, Vol I &Vol II, Gulf Publishing Company, Houston, 2001*
4. *Spitzer D. W., Industrial Flow measurement, ISA press, 3rd Edition, 2005.*

Reference Books:

1. *Patranabis D., Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Company Ltd, 3rd edition, 2010.*
2. *Lawrence D. Goettsche, Maintenance of Instruments and Systems, International society of automation, 2nd Edition, 2005.*



3. Henry W.Ott, *Electromagnetic Compatibility Engineering*, A John Wiley & Sons, INC., Publication,2009.

Course outcomes:

The students will be

1. In a position to select the appropriate instrument for a given process measurement problem.
2. In a position to identify and classify the use of instruments in process industries according to the safety practices in industry.
3. In a position to prepare a instruments specification and understand the procedure and process involved in project documentation.



ICPC23 - PRINCIPLES OF COMMUNICATION SYSTEMS

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

To introduce the principles of analog and digital communication systems involving different modulation and demodulation schemes.

Course Content:

Amplitude modulation: AM, generation of AM waves, demodulation, DSBSC, SSB, VSB, FDM, AM receivers, Optical Communication, Microwave communications and Satellite Communications

Angle modulation: Phase and Frequency modulation, Single-tone, narrow band, wide band and multi tone FM, generation and demodulation of FM, FM receivers.

Pulse Analog modulations: Sampling theorem, Time Division Multiplexing, PAM, Pulse time modulation.

Pulse Digital modulation: PCM, Measure of Information, Channel capacity, DPCM, DM, Digital multiplexers.

Noise: SNR, Noise in AM and FM receivers, Noise in FM reception, FM Threshold effect, Pre-emphasis and de-emphasis, Noise in PCM system, Destination SNR in PCM system with quantization and channel noise, output SNR in DM system.

Text Books:

1. S.Haykin, *Communication Systems, 4th Edition, John Wiley & Sons, 2000.*
2. H.Taub & D.Schilling, *Principles of Communication System, 3rd Edition, Tata McGraw Hill, 2007*
3. J.S.Beasley&G.M.Miler, *Modern Electronic Communication, 9th Edition, Prentice-Hall, 2008.*

Reference Books:

1. B.P.Lathi, *Modern Analog And Digital Communication systems, 3rd Edition, Oxford University Press, 2007*
2. B.Carlson, *Communication Systems, 3rd Edition, McGraw Hill Book Co., 1986.*
3. Sam Shanmugam, *Digital and analog Communication Systems, John Wiley, 1985.*

Course outcomes:

Student can able to

1. Develop an understanding of need for modulation and generation & detection of Analog modulation techniques.
2. Explore AM and FM Super heterodyne receiver working principle.



3. Discuss the techniques for generation and detection of pulse Analog modulation techniques
4. To understand the basic operation involved in PCM like sampling, quantization & encoding and are able to calculate and derive entropy and channel capacity.
5. To compare different communication system with various modulation techniques in the presence of noise by analytically.



ICPC24 - CONTROL SYSTEM – II

Course type: Programme Core (PC)

Pre-requisites: -

No.of Credits: 3

Course Learning Objectives:

1. To introduce and teach advanced methods and techniques of linear system analysis and design from modern and digital control theory, and emphasize their interrelation.
2. To introduce mathematical modeling, analysis, and design of a larger class of systems in a unified framework.

Course Content:

State-space Models – Review of vectors and matrices, Canonical Models from Differential Equations and Transfer Functions, Interconnection of subsystems.

Analysis of Linear State Equations – First order scalar differential equations, System modes and modal decomposition, State Transition Matrix, Time-varying matrix case.

Lyapunov's stability theory for Linear Systems – Equilibrium points and stability concepts, Stability definitions, Linear system stability, The Direct method of Lyapunov, Use of Lyapunov's method in feedback design.

Controllability & Observability – Definitions, Controllability/Observability Criteria, Design of state feedback control systems, Full-order and Reduced-order Observer Design, Kalman canonical forms, Stabilizability & Detectability.

Digital Control Systems, Closed-loop Feedback Sampled-Data Systems, Stability Analysis, Implementation of Digital Controllers.

Text Books:

1. Hespanha, J.P., *Linear Systems Theory*, Princeton Univ. Press, 2009.
2. Brogan, W.L., *Modern Control Theory*, 3rd edition, Prentice Hall, 1990.

Reference Books:

1. Sontag, E.D., *Mathematical Control Theory*, 2nd edition, Springer Verlag, 2014.
2. Hinrichsen, D., & Pritchard, A.J., *Mathematical System Theory – I*, Springer, 2010.

Course outcomes:

1. The student is exposed to an appropriate modern paradigm for the study of larger scale multi-input-multi-output systems.
2. The student understands the importance of linear algebra and matrix theory in designing practical control systems.
3. The student is motivated to study more general systems and their stability using Lyapunov's theory.



4. The student learns to implement modern control systems using a digital computer in the loop.



ICPC25 - PROCESS CONTROL

Course type: Programme Core (PC)

Pre-requisites: -

No. of Credits: 4

Course Learning Objectives:

1. To introduce students the terminology, concepts and practices of process modeling and automatic process control.
2. To impart knowledgeable in the design of control systems and controller tuning for processes.

Course Content:

Process Control System: Terms and objectives, piping and Instrumentation diagram, instrument terms and symbols. Regulatory and servo control, classification of variables. Process characteristics: Process equation, degrees of freedom, modeling of simple system, Self-regulating processes, interacting and non- interacting processes, Process lag, load disturbance and their effect on processes.

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, Integral wind-up and prevention. Auto/Manual transfer, Bumpless transfer. Response of controllers for different test inputs. Selection of control modes for processes like level, pressure, temperature and flow.

Controller tuning Methods: Evaluation criteria - IAE, ISE, ITAE. Process reaction curve method, continuous oscillation method, damped oscillation method. Auto tuning. Closed loop response of I & II order systems, with and without valve, measuring element dynamics.

Final control elements: Pneumatic 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 Instrument air supply specifications.

Advanced control system: Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariable process control, interaction of control loops. Case Studies: Distillation column, boiler drum level control and chemical reactor control.

Text Books:

1. *G. Stephanopoulos, Chemical Process Control-An Introduction to Theory and Practice Prentice Hall of India, New Delhi, 3rd Edition, 2008.*
2. *D.R. Coughanowr, Process Systems Analysis and Control, McGraw Hill, Singapore, 3rd Edition, 2009.*
3. *B.W. Bequette, Process Control Modeling, Design and Simulation, Prentice Hall of India, New Delhi, 2004.*



Reference Books:

1. C.L.Smith and A.B Corripio., *Principles and Practice of Automatic Process Control*, John Wiley and Sons, New York, 2nd Edition 1998.
2. Paul W.Murriel, *Fundamentals of Process Control Theory*, 3rd Edition, ISA press, New York, 2000.

Course outcomes:

At the end of the course student will be able to

1. To identify the type of process and different control schemes.
2. To design PID controller for any process adopting suitable tuning methodology
3. To understand different control strategies and control loops in distillation column and boilers.



ICPC26 - PRODUCT DESIGN AND DEVELOPMENT (THEORY)

Course type: Programme Core (PC)

Pre-requisites: -

No.of Credits: 2

Course Learning Objectives:

1. The aim of this course is to inculcate into the student the spirit of innovation and entrepreneurship. This is achieved in this course by making the students to develop a marketable product on their own as a group. At the end of this two semester course, the students will learn how to know the needs of the society and solve them using the technical knowledge at their disposal.
2. In this semester the students will learn some of the general concepts needed for new product development and simultaneously learn how to interact with the society outside the campus to learn about its needs. They also learn about how to get prototypes fabricated outside the campus.

Course Content:

TOPICS COVERED BY LECTURES

Introduction to product design – Product planning – Identifying customer needs – Project selection – Concept generation – Concept testing – Concept selection. Product specification – Product architecture – Industrial design – Robust design. Product development economics – Design for manufacturing – Supply chain design – Intellectual property – Design for environment.

PRACTICAL WORK

Interaction with public outside the campus- identifying customer needs- product selection based on customer needs- concept generation- concept testing.

Identifying fabrication requirements- Identifying fabricators for the project- costing- financial model for the product development- finding outside finance for product development if possible.. patent search for the product.

SUMMER VACATION WORK

Students shall actively get information about fabrication of their product prototype, especially if it involves outside fabrication units. If they have decided on the final design, they may start work on their alpha prototypes.

Course Evaluation:

Only the theoretical component will be evaluated during this semester. The practical component is evaluated at the end of the next semester.

Text Books:

1. *Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, 3rd Edition, Tata McGraw Hill.*
2. *Kevin Otto and Kristin Wood, Product Design, Pearson Education, 2003.*



ICPC27 - PRODUCT DESIGN AND DEVELOPMENT (PRACTICE)

Course type: Programme Core (PC)

Pre-requisites: ICPC26

No.of Credits: 2

Course Learning Objectives:

1. The aim of this course is to inculcate into the student the spirit of innovation and entrepreneurship. This is achieved in this course by making the students to develop a marketable product on their own as a group. At the end of this two semester course, the students will learn how to know the needs of the society and solve them using the technical knowledge at their disposal.
2. In this semester the students will fabricate an alpha prototype and test it for its conformity to the design specifications. After demonstration of the alpha prototype, they proceed to fabricate a beta prototype that is acceptable in the market-place.

Practical work:

1. Alpha prototype fabrication and testing
2. Beta prototype fabrication and customer acceptance survey

Course outcomes:

After this two semester course:

1. The student will know how to make market surveys for new product development
2. The student will know the entire cycle of new product design and development.
3. The student will know how to fabricate prototypes of new products and test them.



ICPC28 - ANALYTICAL INSTRUMENTATION

Course type: Programme Core (PC)

Pre-requisites: -

No.of Credits: 3

Course Learning Objectives:

This course teaches the student about the analysis of materials which is an important requirement of process control and quality control in industry. The objective of this course is to make the student understand the basic principles used in various analytical methods. The student is then exposed to the various instruments used in the analysis of materials.

Course Content:

Electromagnetic radiation and its interaction with matter – Beer's law – Spectral methods of analysis –Absorption spectroscopy – Radiation sources – Monochromators – Filters – Prisms – Diffraction gratings – Detectors – Choice of solvents. UV-Visible spectrometers – single-beam and double-beam instruments.

Infrared spectrophotometer – IR sources – Cells – detectors – sample preparation. Analysis using Attenuated Total Reflectance (ATR). Atomic absorption spectrometry (AAS) – Wavelength choice –Sources – Cells – Detectors. Flame emission spectrometry. Atomic fluorescence spectrometry.

X-ray spectroscopy – X-ray absorption methods – X-ray fluorescence methods – X-ray diffraction. Radioactive measurement – Units of radioactivity – Application of radio-nuclides in analysis – Radioactivity detectors. Nuclear magnetic Resonance (NMR) spectroscopy – Basic principles – Continuous-wave NMR spectrometer – Pulsed Fourier Transform NMR spectrometer – NMR applications.

Sampling – Sample collection for gas, liquid, and solid analysis. pH measurement – Basic principles –Ion selective electrodes – Glass and reference electrodes – pH meter and its calibration. Electrical conductivity measurement – Measuring circuit – Water and steam purity measurement using electrical conductivity. Oxygen measurement – Paramagnetic oxygen analyzers – Ceramic electrode for high temperature oxygen measurement – Dissolved oxygen measurement.

Flue gas analysis for pollution control – Measurement of CO, carbon di-oxide, NOX and SOX, dust and smoke measurement. Chromatography – Basic principles of liquid and gas chromatography – Column details – Detectors for chromatography – Thermal conductivity detector – Flame ionization detector – Flame photometric detector – Electron capture detector – Effect of temperature programming – High pressure liquid chromatography (HPLC).

Text Books:

1. Braun, Robert D., *Introduction to Instrumental Analysis*, Pharma Book Syndicate, Hyderabad. 2006.
2. Ewing, G.W., *Instrumental Methods of Analysis*, 5th Edition, McGraw Hill, Singapore, 1992.
3. Jain, R.K., *Mechanical and Industrial Measurements*, Khanna Publishers, Delhi, 1999.



Reference Books:

1. *Liptak, B.G. Process Measurement and Analysis, 4th Edition, CRC Press, Washington, 2003.*
2. *Considine, D.M. Process/Industrial Instruments and Controls Handbook, 4th Edition, McGraw Hill, Singapore, 1993.*
3. *Sherman, R.E. and Rhodes L.J., Analytical Instrumentation, ISA Press, New York, 1996.*

Course outcomes:

After successfully completing this course,

1. The student learns the relevance of material sampling and analysis in process control and quality control in industry.
2. The student knows the various physical principles behind the various widely used analytical methods in the industry.
3. The student becomes familiar with the various analytical instruments used widely in the industry.



ICPC29 - LOGIC AND DISTRIBUTED CONTROL SYSTEM

Course type: Programme Core (PC)

Pre-requisites: -

No.of Credits: 3

Course Learning Objectives:

1. To introduce the importance of process automation techniques.
2. To impart required knowledge in PLC based programming.
3. To expose to distributed control system and different communication protocols.

Course Content:

Review of PC based control design for process automation: Functional Block diagram of Computer control of process - Mathematical representation – Sampling Consideration- Data Acquisition system (DAS) and SCADA, Hybrid, Direct Digital Control System, Distributed Control system architecture and Comparison with respect to different performance attributes.

Programmable logic controller (PLC) basics: Definition, overview of PLC systems, Block diagram of PLC. General PLC programming procedures: ON/OFF instruction, Timer instruction sets, Counter Instruction sets -Design, development and simulation of PLC programme using above instruction sets for simple applications.

PLC Data manipulation instruction - Arithmetic and comparison instruction- Skip, MCR and ZCL instruction – PID and other important instruction set. PLC Installation, troubleshooting and maintenance. Design of alarm and interlocks, networking of PLC – Case studies using above instruction sets.

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, secure control output design, Manual and redundant backup designs.

LCU communication Facilities - Communication system requirements – Architectural Issues – Operator Interfaces – Engineering Interfaces. Development of FCU diagram for simple control applications. Introduction to HART and Field bus protocol.

Text Books:

1. John W. Webb and Ronald A Reis, *Programmable Logic Controllers - Principles and Applications, 4th Edition, Prentice Hall Inc., New Jersey, 1999.*
2. Lukcas M.P *Distributed Control Systems, Van Nostrand Reinhold Co., New York, 1986.*
3. Frank D. Petruzella, *Programmable Logic Controllers, 5th Edition, McGraw Hill, New York, 2016.*

Reference Books:

1. *Deshpande P.B and Ash R.H, Elements of Process Control Applications, ISA Press, New York, 1995.*
2. *Curtis D. Johnson, Process Control Instrumentation Technology, 8th Edition, Prentice Hall, New Delhi, 2005.*



3. Krishna Kant, *Computer-based Industrial Control*, Prentice Hall, New Delhi, 2009.

Course outcomes:

At the end of the course, student will be familiar with

1. The popular process automation technologies.
2. Design and development of PLC ladder programming for simple process applications.
3. The different security design approaches, Engineering and operator interface issues for designing Distributed control system.
4. The latest communication technologies like HART and Field bus protocol.



ICMI10 – TRANSDUCER ENGINEERING

Course Type: Minor (MI)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

1. To expose the students to various sensors and transducers for measuring mechanical quantities.
2. To understand the specifications of sensors and transducers.
3. To learn the basic conditioning circuits for various sensors and transducers.
4. To introduce advances in sensor technology.

Course Content:

General concepts and terminology of measurement systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measurement system, Statistical analysis of measurement data.

Resistive transducers: Potentiometers, metal and semiconductor strain gauges and signal conditioning circuits, strain gauge applications: Load and torque measurement.

Self and mutual inductive transducers- capacitive transducers, eddy current transducers, proximity sensors, tacho generators and stroboscope.

Piezoelectric transducers and their signal conditioning, Seismic transducer and its dynamic response, photoelectric transducers, Hall effect sensors, Magnetostrictive transducers, Basics of Gyroscope.

Digital displacement sensors, Fibre optic sensor, Semiconductor sensor and Smart sensors.

Text Books:

1. *John P. Bentley, Principles of Measurement Systems, Pearson Education, 4th Edition, 2005.*
2. *Doebelin E.O, Measurement Systems - Application and Design, McGraw-Hill, 4th Edition, 2004.*
3. *S.M. Sze, Semiconductor sensors, John Wiley & Sons Inc., 1994.*

Reference Books:

1. *Murthy D. V. S, Transducers and Instrumentation, Prentice Hall, 2nd Edition, 2011.*
2. *James W.Dally, Instrumentation for Engineering Measurements, Wiley, 2nd Edition, 1993.*
3. *John G.Webster, Sensors and Signal Conditioning, Wiley Inter Science, 2nd Edition, 2008.*



Course Outcomes:

After successfully completing this course, the student will be

1. Familiar with the basics of measurement system and its input, output configuration of measurement system.
2. Familiar with both static and dynamic characteristics of measurement system.
3. Familiar with the principle and working of various sensors and transducers.
4. Able to design signal conditioning circuit for various transducers.
5. Able to identify or choose a transducer for a specific measurement application.



ICMI11 – TEST AND MEASURING INSTRUMENTS

Course Type: Minor (MI)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

The course is designed to make the students familiar with test and measuring instruments commonly used.

Course Content:

Electrical measurements: General features and Classification of electro mechanical instruments. Principles of Moving coil, moving iron instruments. Extension of instrument range: shunt and multipliers, CT and PT.

Measurement of Power: Electrodynamometer's, Low Power Factor (LPF) wattmeter, errors, calibration of wattmeter. Single and three phase power measurement, Hall effect wattmeter, thermal type wattmeter.

Different methods of measuring low, medium and high resistances, measurement of inductance & capacitance with the help of AC Bridges, Q Meter.

Digital Measurement of Electrical Quantities: Concept of digital measurement, block diagram Study of digital voltmeter, Digital multimeter, Digital LCR meter, Q-Meter, Digital wattmeter and energy meters.

CRO, DSO, Function generator, Audio frequency signal generation, Waveform analyzers, Spectrum analyzers.

Text Books:

1. *Golding, E.W. and Widdis, F.C., Electrical Measurements and Measuring Instruments, A.H.Wheeler and Co, 5th Edition, 2011.*
2. *David A. Bell, Electronic Instrumentation and Measurements, Oxford University Press, 3rd Edition, 2013.*
3. *Shawney A K, A course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai and Sons. 19th revised edition,2013.*

Reference Books:

1. *Cooper, W.D. and Helfric , A.D., Electronic Instrumentation and Measurement Techniques, Prentice Hall, 1st Edition, 2009.*
2. *Kalsi.H.S, Electronic Instrumentation, Tata Mcgraw Hill Education Private Limited, 3rd Edition, 2012.*



Course Outcomes:

After successfully completing this course, the student will be

1. Familiar with various measuring instruments (ammeters, voltmeters, wattmeters, energy meters extension of meters, current and voltage transformers) used to detect electrical quantities.
2. Able to design suitable DC and AC bridges for the measurement of R, L, C and Frequency measurement.
3. Able to understand the analog and digital measurements.
4. Familiar with the operation and usage of various analyzing instruments.



ICMI12 – MEASUREMENTS IN PROCESS INDUSTRIES

Course Type: Minor (MI)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

To expose the students to various measurement techniques used for the measurement of temperature, flow, pressure and level in process industries.

Course Content:

Temperature measurement: Introduction to temperature measurements, Thermocouple, Resistance Temperature Detector, Thermistor and its measuring circuits, Radiation pyrometers and thermal imaging.

Pressure measurement: Introduction, definition and units, Mechanical, Electro-mechanical pressure measuring instruments. Low pressure measurement, Transmitter definition types, I/P and P/I Converters.

Level measurement: Introduction, Mechanical and electrical methods of level measurement.

Flow measurement: Introduction, definition and units, classification of flow meters, differential pressure and variable area flow meters, Positive displacement flow meters, Electro Magnetic flow meters, Hot wire anemometer and ultrasonic flow meters. Calibration and selection of Flow meters

Text Books:

1. Doebelin E.O., *Measurement Systems - Application and Design*, Tata McGraw Hill publishing company, 5th Edition, 2008.
2. Patranabis D, *Principles of Industrial Instrumentation*, Tata McGraw Hill, 3rd Edition, 2010.

Reference Books:

1. B.E.Noltingk, *Instrumentation Reference Book*, 2nd Edition, Butterworth Heinemann, 1995.
2. B.G.Liptak, *Process Measurement and Analysis*, 4th Edition, Chilton Book Company, Radnor, Pennsylvania, 2003.
3. Douglas M. Considine, *Process / Industrial Instruments & Controls Handbook*, 5th Edition, McGraw Hill, Singapore, 1999.
4. Andrew W.G, *Applied Instrumentation in Process Industries – A survey*, Vol I & Vol II, Gulf Publishing Company, Houston, 2001
5. Spitzer D. W., *Industrial Flow measurement*, ISA press, 3rd Edition, 2005

Course Outcomes:

After successfully completing this course, the student will be

1. Familiar with the different temperature measurement techniques used in process industries.
2. Familiar with various flow instrumentation used in industrial flow measurement.



3. Able to understand the working principle of different pressure transmitters and level sensors used in industries.
4. Able to identify or choose temperature, flow, pressure and level measuring device for specific process measurement.



ICMI13 – ESSENTIALS OF CONTROL ENGINEERING

Course Type: Minor (MI)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

This course is designed to expose students to

1. The fundamentals of feedback control system.
2. The variety of classical control schemes using simulation software.

Course Content:

Introduction to control system – Open loop and Closed loop system – Feedback system characteristics – Block diagram reduction techniques – Signal flow graph.

Order and type of system – time domain and frequency domain response of different system characteristics using simulation software – Introduction of stability – Routh Hurwitz stability criteria.

Introduction to root locus – plotting of root locus and stability analysis using simulation software. Introduction to bode and Nyquist plot – Plotting of bode and Nyquist plot using simulation software - Gain Margin and Phase margin calculation.

Introduction to different compensator design – the design of different compensator design using simulation software. PID controller design using simulation software.

Application of control system for different domain with case studies.

Text Books:

1. *Dorf, R.C., & Bishop, R.H., Modern Control Systems, 13th edition, Prentice Hall, 2016.*
2. *Katsuhiko Ogata Modern Control Engineering, 5 edition, Pearson, 2009.*

Reference Books:

1. *Gopal.M., Control Systems: Principles and Design, McGraw Hill Education; 4 edition, 2012.*

Course Outcomes:

1. The student learns the importance of feedback control system.
2. The student understands time domain and frequency domain techniques using simulation software.
3. The student is exposed to classical control design using simulation software.



ICMI14 – INDUSTRIAL AUTOMATION AND CONTROL

Course Type: Minor (MI)

Pre-requisites: -

No. of Credits: 3

Course Learning Objectives:

This course is designed to expose students to understand the process automation concepts like Programmable logic controller and Distributed control system.

Course Content:

Introduction and overview of Industrial automation – Block diagram of PLC – different types of PLC – Type of input and output – Introduction to relay logic- Application of PLC.

Introduction to Ladder logic programming – Basic instructions – Timer and Counter instruction- Arithmetic and logical instruction – MCR, PID controller and other essential instruction sets - Case studies and examples for each instruction set.

Introduction to high level PLC language – Programming of PLC using simulation software – Real time interface and control of process rig/switches using PLC.

Introduction to DCS and SCADA - Block diagram – function of each component – Security objective – Operation and engineering station interface – Communication requirements .

Development of different control block using DCS simulation software – Real time control of test rigs using DCS. Introduction to HART, Fieldbus and Profi bus – Application and case studies of large scale process control using DCS.

Text Books:

1. *John W. Webb and Ronald A Reis, Programmable Logic Controllers - Principles and Applications, 5th Edition, Prentice Hall Inc., New Jersey, 2002.*
2. *Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., New York, 1986.*
3. *Frank D. Petruzella, Programmable Logic Controllers, 4th Edition, McGraw Hill, New York, 2010.*

Reference Books:

1. *Deshpande P.B and Ash R.H, Elements of Process Control Applications, ISA Press, New York, 1995.*
2. *Curtis D. Johnson, Process Control Instrumentation Technology, 8th Edition, Prentice Hall, New Delhi, 2005.*
3. *Krishna Kant, Computer-based Industrial Control, 2nd edition, Prentice Hall, New Delhi, 2011.*



Course Outcomes:

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

1. Understand the popular process automation technologies.
2. Design and development of PLC ladder programming for simple process applications.
3. Understand the different security design approaches, Engineering and operator interface issues for designing Distributed control system.
4. Know the latest communication technologies like HART and Field bus protocol



ICLR10 – THERMODYNAMICS AND FLUID MECHANICS LABORATORY

Course Type: Essential Laboratory Requirement (ELR)

No. of Credits: 2

Course Learning Objectives:

1. To understand the principles of thermal energy and its transformation to mechanical energy.
2. Thermodynamics - concepts and properties, first and second law
3. It provides a working knowledge of thermodynamics & fluid mechanics.

List of Experiments:

Thermodynamics

1. Performance test on Petrol and Diesel Engines with Mechanical and Electrical Dynamometers
2. Morse test on multi-cylinder petrol engine
3. Determination of volumetric efficiency on Diesel engine and Two stage reciprocating Air compressor
4. COP in compression refrigerator cycle
5. Test on Air conditioning system
6. Viscosity index of lubricant
7. Study of steam power plant

Fluid Mechanics

1. Determination of pipe friction
2. Calibration of flow meters – Venturimeter and Orifice meter
3. Determination of discharge coefficients for notches
4. Determination of minor losses
5. Centrifugal pump
6. Submersible pump
7. Jet pump
8. Gear pump
9. Screw pump

Reference Books:

1. *Zemansky, Heat and Thermodynamics, 7th edition, McGraw Hill, New York, 1997.*
2. *Ojha C.S.P., Berndtsson R., Chandramouli P.N., Fluid Mechanics and Machinery, Oxford University Press, 2010.*

Course Outcomes:

1. An understanding of heat, work, internal energy, 1st and 2nd law of thermodynamics
2. An understanding of Dimensional Analysis, fluid statics and dynamics
3. An understanding of fluid mechanics fundamentals, including concepts of mass and momentum conservation.
4. An ability to apply the Bernoulli equation & control volume analysis to solve problems in fluid mechanics.



ICLR11 – CIRCUITS AND DIGITAL LABORATORY

Course Type: Essential Laboratory Requirement (ELR)

No. of Credits: 2

Course Learning Objectives:

1. To understand the principles of thermal energy and its transformation to mechanical energy.
2. Thermodynamics - concepts and properties, first and second law
3. It provides a working knowledge of thermodynamics & fluid mechanics.

List of Experiments:

1. Verification of Electrical Circuit laws and network theorems.
2. Time Response of RL, RC and RLC circuits.
3. Frequency Response of RL, RC and RLC circuits, resonance.
4. A.C. circuits and Network realization.
5. Design and verification of combinational logic circuits.
6. Design and verification of sequential logic circuits.

Reference Books:

1. *Hayt, W.H, Kemmerly J.E. & Durbin, Engineering Circuit Analysis, McGraw Hill Publications, 8th edition, 2013.*
2. *Ramakalyan, A., Linear Circuits: Analysis & Synthesis, Oxford Univ. Press, 2005.*
3. *Van Valkenburg, Network Analysis, Prentice Hall, 3rd Edition, 2006*
4. *Van Valkenburg, M.E., Introduction to Modern Network Synthesis, Wiley, 1960.*
5. *M.M. Mano, Digital Logic and Computer Design, Pearson, 4th Edition, 2014.*

Course Outcomes:

At the end of the course student will be

1. Familiar with electrical circuit laws and network theorem verifications.
2. Familiar with time response and frequency response of RL, RC and RLC circuits.
3. Able to design and verify sequential and combinational logic circuits.



ICLR12 – SENSORS AND TRANSDUCERS LABORATORY

Course Type: Essential Laboratory Requirement (ELR)

No. of Credits: 2

Course Learning Objectives:

The aim of this lab is to fortify the students with an adequate work experience in the measurement of different quantities and also then expertise in handling the instruments involved.

List of Experiments:

1. Characteristics of (Resistive and Thermo emf) temperature sensor
2. Characteristics of Piezoelectric measurement system
3. Measurement of displacement using LVDT
4. Characteristics of Hall effect sensor
5. Measurement of strain using strain gauges
6. Measurement of torque using Strain gauges
7. Measurement using proximity sensors
8. Characteristics of capacitive measurement systems
9. Loading effects of Potentiometer
10. Design of Opto-coupler using photoelectric transducers
11. Characteristics of Micro pressure and Micro accelerometer sensing device
12. Study of speed measuring devices and Gyroscope

Reference Books:

1. *John P. Bentley, Principles of Measurement Systems, Pearson Education, 4th Edition, 2005.*
2. *Ernest.O.Doebelin and Dhanesh.N.Manik, Doebelin's Measurement Systems, McGraw Hill Education, 6th Edition, 2011.*

Course Outcomes:

At the end of the course student will be able to

1. Design a signal conditioning circuits for transducers and test its characteristics.
2. Draw the specification of transducer for a given application.



ICLR13 – ANALOG SIGNAL PROCESSING LABORATORY

Course type: Essential Laboratory Requirement (ELR)

No. of Credits: 2

Course Learning Objectives:

Real world looks for system-level design skills in both analog and digital domains. The main focus of the lab is analog system design. It will cover the design and test of practical circuits based on op-amps and other ICs.

This lab course enables the students to study, design and implement various practical circuits. It also imparts a sound knowledge about the applications of Op-amp. The objective is to provide working practice in simulation tools & experiment test bench to learn the design and testing of various circuits

List of experiments:

1. Design of amplifiers using various modes and its implementation issues
2. Filter design using various methodologies for different set of specifications
3. Sensor linearization and bridge linearization using op-amps
4. Design of waveform generators using op-amp
5. PLL design
6. Regulator design
7. Analog to digital conversion & digital to analog conversion
8. Regenerative feedback circuit design - Schmitt trigger and Multivibrator
9. Transmitter design

Text Books:

1. Sergio Franco, *Design with operational amplifiers and analog integrated circuits*, 4th edition Mc-Graw Hill Inc. 2014.
2. Wai-Kai-Chen *The circuits and filters Handbook*, CRC press, 2nd edition, 2003.
3. Arie F.Arbel, *Analog Signal Processing and Instrumentation*, Cambridge University press, 1980.

Course Outcomes:

On completion of this lab course, the student will understand the design and testing concepts of various practical circuits.



ICLR14 – INSTRUMENTATION LABORATORY

Course Type: Essential Laboratory Requirement (ELR)

No. of Credits: 2

Course Learning Objectives:

The aim of this lab is to impart an adequate knowledge and expertise to handle equipment generally available in an industry.

List of Experiments:

1. Design of temperature transmitter using RTD.
2. Design of cold junction compensation circuit for Thermocouple.
3. Design of IC temperature transmitters.
4. Design of Linearization circuit for thermistor.
5. Study of zero elevation and suppression in differential pressure transmitter
6. Performance evaluation of pressure gauges using Dead weight tester.
7. Measurement of level using differential pressure transmitter.
8. Design of alarms and annunciators for process variable measurements.
9. Design of pressure/force transmitter

Reference Books:

1. *Doebelin E.O, Measurement Systems: Application and Design, McGraw Hill, 5th Edition, 2004.*
2. *Patranabis D, Principles of Industrial Instrumentation, Tata McGraw Hill, 3rd Edition, 2010.*
3. *Roy D.Choudary and Shail Jain, Linear Integrated Circuits, New Age International, 2010.*

Course Outcomes:

At the end of the course student will be able to understand and analyse Instrumentation systems and their applications to various industries.



ICLR15 – MICROPROCESSORS AND MICROCONTROLLERS LABORATORY

Course Type: Essential Laboratory Requirement (ELR)

No. of Credits: 2

Course Learning Objectives:

The aim of this laboratory course is to make students:

1. To interface the microprocessor with external peripherals.
2. Familiar with ARM processor to learn how a program gets executed in a microprocessor/microcontroller.
3. Fabricate a micro-controller circuit board using KiCAD open-source PCB design tool.
4. Program a micro-controller using a C language based compiler.

As a part of this laboratory course, the students will have to interface microprocessor with external peripherals.

The students have to practice the ARM processor programming in the LPC2148 kit.

Students have to fabricate a 8051-based hardware board and perform the microcontroller experiments.

List of Experiments:

1. Programming exercises to programmable peripheral interface.
2. Programming exercises using interrupts.
3. Programming exercises to use the timer.
4. Familiarization with 8051 micro-controller board and its assembler.
5. Programming exercises using 8051 micro-controller.
6. Basic I/O operations and ADC Interfacing using KEIL software.
7. Counting Pulses using Interrupt and Serial Data Transmission.
8. Interfacing 8051 with DAC.
9. Interfacing 8051 with stepper motor.
10. Real time clock and memory interfacing with 8051.
11. Programming exercise using ARM processor.

Reference Books:

1. *Ramesh Goankar, Microprocessor Architecture, Programming and applications with the 8085/8080A, 3rd Edition, Penram International Publishing house, 2002.*
2. *Kenneth J.Ayala, The 8051 Micro controller, Thomson Delmar Learning, 3rd Edition, 2004.*
3. *Andrew N. Sloss, Dominic Symes, and Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Morgan Kaufmann Publishers, 2004.*

Course Outcomes:

Upon completion of the lab course, Student can able to

1. Know the various functional blocks of microprocessor and microcontrollers.
2. Gain adequate knowledge in assembly language programming and C programming.
3. Interface the peripherals with microprocessor and microcontrollers.



ICLR16 – CONTROL ENGINEERING LABORATORY

Course Type: Essential Laboratory Requirement (ELR)

No. of Credits: 2

Course Learning Objectives:

1. To provide knowledge on analysis and design of control system.
2. Students can apply MATLAB Real-time programming to collect and process data.

List of Experiments:

1. Time response characteristics of a second order system.
2. Frequency response characteristics of a second order system.
3. Constant gain compensation in time and frequency domain.
4. Compensating Networks - Characteristics
5. Design of compensation networks - Lead, Lag, Lead-lag
6. Design of state feedback controller.
7. Observer design - full order and reduced order.

Reference Books:

1. *Dorf, R.C., & Bishop, R.H., Modern Control Systems, 12th edition, Prentice Hall, 2010.*
2. *Daniel H. Sheingold, Transducer Interfacing Handbook – A Guide to Analog Signal Conditioning, Analog Devices Inc. 1980.*

Course Outcomes:

1. Develop an ability to design control systems.
2. Students can design and implement controller designs to regulate and control various processes and systems.



ICLR17 – INDUSTRIAL AUTOMATION AND PROCESS CONTROL LABORATORY

Course Type: Essential Laboratory Requirement (ELR)

No. of Credits: 2

Course Learning Objectives:

The course aims to give the students

1. Practical experience in PC based data acquisition, analysis and control of different process trainers.
2. To understand the industrial automation concept and programming techniques.

List of Experiments:

1. Identification of FOPDT and SOPDT process using time domain and frequency domain techniques.
2. Design of different PID controller for FOPDT and SOPDT process using different standard technique and evaluate qualitative & quantitative performance.
3. Study of Different Process trainers.
4. Design and Verification of Combinational & Sequential Circuits Using PLC.
5. Design of PID Controller for a Level Process/Temperature/Flow/Pressure process stations and evaluate servo/regulatory responses.
6. Study the effect of different PID Controller Parameters using real time process trainer.
7. Pressure to Current & Current to Pressure Convertor using real time process trainer.
8. Design of Timer and Counter Using PLC.
9. Design of PLC programming for practical applications.
10. Design of Cascade and Feed forward-feedback Controller using simulation software.
11. Verification of Control Valve Characteristics using pneumatic and electronic control value trainer.
12. Development of P&I design using Distributed control system (DCS).

Reference Books:

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, 2nd Edition, 1991.*
3. *B.W. Bequette, Process Control Modeling, Design and Simulation, Prentice Hall of India, New Delhi, 2004.*

Course Outcomes:

After completing this course, the student can gain practical knowledge on Industrial automation concepts using PC, PLC and DCS techniques.