B.Tech. DEGREE

INSTRUMENTATION AND CONTROL
ENGINEERING

SYLLABUS

FOR

CREDIT BASED
CURRICULUM

(For students admitted in 2005)

DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620 015
INDIA
### SEMESTER - III

<table>
<thead>
<tr>
<th>CODE</th>
<th>COURSE OF STUDY</th>
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*Department of Instrumentation and Control Engineering*
### SEMESTER - V

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### SEMESTER - VI

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*Department of Instrumentation and Control Engineering*
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Total 15 0 0 18

The total minimum credits required for completing the B.Tech. programme in Instrumentation and Control Engineering is $128 + 45 = 173$. 
## ELECTIVE LIST

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-> Any one elective from other department electives can be taken.

| Electives – 4 & 5:                         |                                             |   |   |   |    |
| IC 452 | Power Plant Instrumentation and Control       | 3 | 0 | 0 | 3  |
| IC 454 | Smart Materials                               | 3 | 0 | 0 | 3  |
| EC 356 | VLSI Systems                                  | 3 | 0 | 0 | 3  |
| EC 464 | Display Systems                               | 3 | 0 | 0 | 3  |
| CS 364 | Network Multimedia Systems                    | 3 | 0 | 0 | 3  |

-> Any one elective from other department electives can be taken.
# RESERVE ELECTIVE LIST

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Biotechnology 3 0 0 3

-> For VI, VII and VIII semester, electives given may be replaced by appropriate course depending on the student strength from the general electives.
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MA209 LINEAR ALGEBRA AND STATISTICS

Linear Algebra and Matrices – Vector spaces, Subspaces, Basis and Dimension - Systems of Linear Equations.

Linear Transformations - Kernel and Image - Geometric Ideas - Inner Product spaces - Orthogonality - Orthonormal basis - Reflections and Orthogonal maps of the plane - Orthogonal complements and Projections.

Bilinear, Quadratic, Hermitian, and Skew-Hermitian forms - Eigenvalues and Eigenvectors - Cayley-Hamilton theorem - Change of basis and diagonalization.

Binomial, Poisson and Normal distributions, Moment generating function, Characteristic function - Chebyshev’s inequality - Law of large numbers.

References.

1. HOFFMAN, K., and KUNZE, R., Linear Algebra, Prentice Hall of India.


IC 201 SENSORS AND TRANSDUCERS

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.

Elastic sensing elements: Diaphragms, bellows, bourdon tubes, beam and column type elements, ring type elements, their construction and design features. Variable resistance transducers: Potentiometers, metal and semiconductor strain gauges and their signal conditioning circuits, strain gauge applications: Load and torque measurement.

Inductive transducers: Transformer type, synchros and resolvers, eddy current transducers, electromagnetic sensors, Hall effect sensors, proximity detectors, magnetostrictive transducers and capacitive transducers, tacho generator, stroboscope.

Piezoelectric transducers and their signal conditioning, digital displacement sensors, electro-kinetic transducers, photoelectric transducers, basics of gyroscope, seismic instrument and accelerometers.

Semiconductor sensor: Introduction, classification, and basic fabrication techniques.

Text Books:

Reference Books:
IC 203 CIRCUIT THEORY


Text Books:

Reference Books:
IC 205 ELECTRON DEVICES


BJTs: Basic BJT theory, Different modes of operation and configurations. Transistor current components. Ebers – Moll model and Gummel – Poon model of BJTs. Transistor $\alpha$, Current amplification $\beta$. Bipolar transistor switch, SPICE BJT model, Punch through and other breakdown mechanisms, Photo-voltic effect, Photo-cell transistors.

MOSFETs: Device structure and physical operation, Current – voltage characteristics, MOSFET circuits at DC, MOSFET as an amplifier and as a switch, Small signal model, MOSFET internal capacitance and high frequency model, Depletion type MOSFET, SPICE MOSFET model, CMOS structure, operation, BiCMOS operation, CCDs.

Power devices: Thyristor family – UJT, SCR, TRIAC, DIAC – operation and VI characteristics. Triggering. Power diodes, power transistors, IGBTs and GTOs fabrication and V-I characteristics.

Text Books:

Reference Books:
CE 283 THERMO DYNAMICS AND FLUID MECHANICS

**Basic concepts:** 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. 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 motion, stream function and potential function, Eulers equations of motion, Bernoulli’s equation and its application. Classification of open channel flows – measurement of discharge using rectangular and V notches.


**Reference Books:**
MT 211 MATERIAL SCIENCE

Introduction to crystal structure of materials: Miller indices, X-ray diffraction techniques, mechanical properties of materials, elastic, viscoelastic and plastic behaviour, stress-strain relationship, relaxation creep, strengthening mechanisms and fracture.

Defects in solids: Point, line and planar defects and their effect on different planar properties of materials, phase diagram, mono component and binary systems, non-equilibrium phase diagrams and their applications.

Properties of materials: Thermal properties, specific heat, expansion, conductivity and application of these properties in selection of materials. Electrical properties, free electron theory, conductors and insulators, superconductors.


Optical properties of materials: Absorption and emission, losses, environmental effect on materials. Synthesis and growth of Group III - V compounds and their applications. Selection of specific materials required for instrumentation devices, valves, pipelines and coatings.

Text Books:

Reference Books:
CE 285 THERMO DYNAMICS AND FLUID MECHANICS LABORATORY

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
IC 207 CIRCUITS AND DEVICES LABORATORY

1. Verification of Circuit theorems.
3. Frequency response of a second order circuit
4. Resonance.
5. Currents and voltages in unbalanced and balanced star and delta circuits.
6. Transfer function of simple R, L, C circuits from frequency response characteristics.
7. Determination of Z, Y and h parameters of a two port network.
8. Volt-ampere characteristics of semiconductor diode and zener diodes.
9. Transistor characteristics – CE.
10. Transistor characteristics – CB.
11. Characteristics of FET.
12. Characteristics of UJT.
MA202 NUMERICAL TECHNIQUES

Solution of linear system - Gaussian elimination and Gauss-Jordan methods - LU - decomposition methods - Crout's method - Jacobi and Gauss-Seidel iterative methods - sufficient conditions for convergence - Power method to find the dominant eigenvalue and eigenvector.

Solution of nonlinear equation - Bisection method - Secant method - Regula falsi method - Newton-Raphson method for \( f(x) = 0 \) and for \( f(x,y) = 0, g(x,y) = 0 \) - Order of convergence - Horner's method - Graeffe's method - Bairstow's method.


Numerical solution of Laplace equation and Poisson equation by Liebmann's method - solution of one dimensional heat flow equation - Bender - Schmidt recurrence relation - Crank - Nicolson method - Solution of one dimensional wave equation.

References.

1. GERALD, C.F., and WHEATLEY, P.O., Applied Numerical Analysis, Addison Wesley.
IC 202 SIGNALS AND SYSTEMS

Introduction to signals and systems: Introduction to signals, classification of signals, basic continuous- time and discrete- time signals, step and impulse functions, transformation of independent variable. Introduction to systems, properties of systems, classification of systems, mathematical model for systems, normal form of system equations, initial conditions.

Impulse response of a physical system, introduction to convolution, system impulse response and convolution integral, numerical convolution. Sampling theorem, Z-transform, convergence of Z-transform, properties of Z-transform, inversion of Z-transform, evaluation of system frequency response, applications of Z-transform.

Representation of signals in terms of elementary signals, condition for orthogonality, representation of signals by elementary sinusoids, Fourier series representation, power spectrum, Fourier Transform, system function, energy spectrum. Calculation of simple transforms, Discrete Fourier Transform (DFT), properties of Discrete Fourier Transform.

Statistical Signal Analysis: Classification of random signals, auto correlation function, properties of auto correlation function, measurement of auto correlation function, application of autocorrelation functions, cross correlation functions, properties of cross correlation functions, sum of random processes.

Spectral density, relation of spectral density to autocorrelation function. Auto correlation function of system output, cross- correlation between input and output, white noise, generation of pseudo-random binary noise, analysis of linear systems in time domain using white noise, mean and mean square value of system output, analysis in the frequency domain.

Text Books:

Reference Books:
IC 204 INDUSTRIAL INSTRUMENTATION


Introduction, differential pressure type flowmeters, variable area flowmeters, positive displacement flowmeters for liquids and gas services, Hot wire Anemometers, EM flowmeter and turbine flowmeter.

Ultrasonic flowmeter, Vortex flowmeter, Cross correlation flowmeter, Mass flowmeter: Direct and Indirect methods.

Pressure measurement: Introduction, Mechanical, Electromechanical and Electrical methods of measurement. Low pressure measurement.

Level measurement: Introduction, mechanical, electromechanical and electrical type. Viscosity and density measurement.

Text Books:

Reference Books:
IC 206 ANALOG ELECTRONIC CIRCUITS


Output stages and power amplifiers: Class A, class B, class AB output stages. Biasing class AB circuits. Power BJTs, MOS power transistor. Variations on the class AB configuration. IC power amplifiers. Class AB operation.

Text Books:

Reference Books:
Number systems & Boolean algebra: Number systems and data representation, Binary, Octal, Hexadecimal representations and their conversions, Signed numbers and floating point number representation. Codes, Basic logic operations, Boolean algebra, De-Morgan theorems, Algebraic reductions, NAND and NOR based logic, Digital logic gates.

Combinational Logic and circuits: Canonical logic forms, Extracting canonical forms, Karnaugh maps and Tabular methods, Don’t care conditions, minimisation of multiple output functions.

Synthesis of combinational functions: Arithmetic circuits-Adder, carry look-ahead adder, number complements subtraction using adders, signed number addition and subtraction, BCD adders. IC adders. Multiplexers, implementation of combinational functions using multiplexers, de-multiplexers, decoders, code converters, Combinational logic with MSI and LSI. Programmable logic devices.


Digital Hardware: Logic levels, Digital integrated circuits, Logic delay times, Fan-Out and Fan-In, Logic families, Interfacing between different families.

CMOS Electronics: CMOS electronics & Electronic logic gates, The CMOS inverter, Logic formation using MOSFETs, CMOS memories. Design and analysis procedures, Logic arrays.

Text Books:

Reference Books:
IC 210 DATA STRUCTURES & ALGORITHMS

Development of algorithm, notation analysis. Sorting and searching algorithms and their implementation under C/C++.

Stacks, queues, linked lists and their implementation under C/C++


Formal definition of an algorithm in terms of turing machines.

Introduction to the class P and NP.

Text Books:

Reference Books:
IC 212 SENSORS AND TRANSDUCERS LABORATORY

1. Measurement of strain using strain gauges
2. Measurement of torque using strain gauges
3. Measurement of speed using Electro magnetic transducer
4. Measurement of speed using photoelectric transducers
5. Measurement of speed using stroboscope
6. Measurement of sound level
7. Measurement of natural frequency using Accelerometer
8. Measurement using proximity sensors
9. Measurement of angular displacement using Potentiometer
10. Design of opto coupler using photoelectric transducers
11. Measurement of displacement using LVDT
12. Measurement using load cells
13. Characteristics of Hall effect sensor
14. Measurement using capacitive transducer
15. Measurement using inductive transducer
IC 214 ELECTRONIC CIRCUITS LABORATORY

1. Clipping and Clamping circuits.
2. Half wave and Full wave rectifiers.
   1. Bridge Rectifiers.
4. Single-stage Amplifiers
5. Multistage Amplifiers
6. Feedback Topologies
7. Frequency Response of Amplifiers
8. PSPICE Simulations
IC 301 ELECTRICAL AND ELECTRONIC MEASUREMENTS

Electro mechanical instruments: Moving coil, moving iron, dynamometer type, rectifier type, thermal instruments. Application of PMMC meter. Current transformer and potential transformer.

Power and Energy Measurements: Electrodynamic wattmeters, Hall effect wattmeter, thermal type wattmeter, compensated wattmeter, single and three phase power measurement, calibration of wattmeter. Energy measurement, maximum demand meter, P.F meter, Megger.


Waveform analysing instruments: Distortion meter, Analog and digital spectrum analyzer, additional waveform analysing instruments. Oscilloscopes: General purpose oscilloscopes, special oscilloscopes.

Text Books:

Reference Books:
EC 317 PRINCIPLES OF COMMUNICATION SYSTEMS

Amplitude modulation: AM, generation of AM waves, demodulation, DSBSC, SSB, VSB, FDM, AM 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:

Reference Books:
**IC 303 MICROPROCESSORS AND MICROCONTROLLERS**

Introduction to computer architecture and organisation: Architecture of 8-bit microprocessors, bus configurations, CPU module, introduction to assembly language and machine language programming, instruction set of a typical 8-bit microprocessor, subroutines and stacks, programming exercises.

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

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

Architectures of 8051 Microcontroller: Bus configuration, instruction sets, programming exercises.

Microcontroller system software and hardware design, development and trouble shooting tools.

**Text Books:**

**Reference Books:**
IC 305 LINEAR INTEGRATED CIRCUITS


Dynamic Feedback: The integrator and the differentiator circuits, Transfer function H(jω), First-order circuits and some applications, Second-order circuits, KRC filters, Multiple feedback filters, State-variable and Biquad filters, Switched-capacitor filters.


Comparators & Signal Generators: Voltage comparators, Schmitt triggers, Precision rectifiers, Peak detectors, Sample-and-hold amplifiers, Multivibrators and IC 555, Waveform generators, V/F and F/V converters, Voltage references, Linear regulators, D-to-A and A-to-D converters and ICs.

Other Op-Amp Circuits: Log/Antilog amplifiers, Analog multipliers, Transconductance Amplifiers, Voltage Controlled Oscillators, Phase detectors, Phase-Locked Loops, PLL ICs, PLL applications.

Text Books:

Reference Books:
**IC 307 PROGRAMMING TOOLS & TECHNIQUES**

Introduction to scripting languages. Study of any one scripting language in depth.

Introduction to program generation using lex and yacc.

Introduction to GUI development under Windows and Linux.

Introduction to STL.

Introduction to UML tools such as umbrello, reverse engineering dissemblers and document generation tools for reverse engineering.

(The evaluation will be assignment based and testing will be based on proficiency in tool usage.)

**References:**

1. The documentation associated with the tools should be adequate.
IC 309 CONTROL SYSTEMS

Systems and their representation: Terminology and basic structure of control system, Open loop and Closed loop systems, servomechanism, regulatory system, analogous systems, electrical analogy of physical systems, Physical Systems and their models, transfer function, Block diagram representation of physical systems, Block diagram algebra, Signal Flow graph and Mason’s formula.

Time response: Time response analysis and design: Types of test inputs, Response of first and second order system, Time domain specifications, Error coefficients, generalised error series, Response with rate, reset and PID controllers.

Root Loci: Effect of pole zero addition, desired closed loop pole location, Root locus plot, Properties of Root loci and applications, Stability range from the loci. Determination of roots of the closed loop system, transient response and stability from root locus.


Control system design: Performance criteria, selection of controller modes, compensators- – lag, lead, and lag-lead networks, – compensator design for desired response.

Text Books:

Reference Books:
IC 311 LINEAR INTEGRATED CIRCUITS LABORATORY

1. Op-Amp circuits with resistive feedback
2. Instrumentation Amplifier
3. Op-Amp filters
4. Waveform generators
5. Schmitt trigger & Precision rectifiers
6. Multivibrators
7. PLLs
8. Combinatorial & Sequential circuits
9. Multiplexers & Demultiplexers
10. A/D and D/A converters
11. TTL and other logic gates
12. PSPICE simulations
IC 313 MICROPROCESSOR AND MICROCONTROLLERS LABORATORY

1. Familiarisation with 8085 microprocessor kit and its keyboard.
2. Exercises with entry and manipulation of data (Different addressing modes).
4. Programming exercises to programmable peripheral interface.
5. Programming exercises using interrupts.
6. Programming an EPROM for a specific application.
7. Programming exercises to programmable timer
8. Familiarisation 8051 Microcontroller kit and its assembler
10. Mini project using closed loop control using 8085 microprocessor or 8051 Microcontroller
IC 302 MODERN CONTROL THEORY

Systems in state space: Concept of states and state model, State equation from transfer function, Modeling of dynamical systems, State space representation of multivariable systems, Building blocks of state space models. Modeling through energy approach of electrical, mechanical and electromechanical systems.

Canonical forms, Solution to state-space equations, state transition matrix, properties of state transition matrix, computation of state transition matrix.

Equilibrium points and stability concepts, stability definitions, Modeling energy of the system in terms of quadratic functions, Direct method of Lyapunov criterion for LTI systems.

Definition of controllability, observability, stabilizability and detectability. State feedback control for controllable canonical form, State feedback control in general

Output feedback control. Full-order and reduced-order observers, Use of Lyapunov’s method in feedback design – Linear Quadratic problems.

Text Books:

Reference Books:
IC 304 PROCESS CONTROL


Dead-time estimation and compensation: Cascade control, ratio control, feed forward control. Over-ride, split range and selective control. Multivariable process control, interaction of control loops. Examples - Distillation column, boiler drum level control and chemical reactor control.

Text Books:

Reference Books:
IC 306 PRODUCT DESIGN AND DEVELOPMENT

Course Aim: The course is intended to provide the students with:
1. Competence in a set of tools and methods for product design and development.
2. Confidence in their own abilities to create a new product.
3. Exposure to the role of different functions in creating a new product.
4. Capability to coordinate different, interdisciplinary tasks in order to achieve the objective of creating a new product.
5. Ability to consolidate and build on specific knowledge from other courses through practice and reflection in a realistic and result – oriented setting.

Expected outcome of the course: The students are expected to have a realistic team project. The project may preferably have a specific instrumentation and / or control engineering content to it. The initial classes will be towards familiarizing the students in the various aspects of the product design and development cycle. During the practical hours of the course the students may work in the appropriate labs or work-shops. The students are expected to work as a team. At the end of the course the students are required to come out with a working and marketable model of the product.

Evaluation of the course: The students will be evaluated on their specific knowledge of industrial design, engineering, production and economics during the cycle tests. The final evaluation will be done only after the final working model is completed. In case the students did not complete the prototype during the semester period, they will have to complete it during the summer vacation to earn the credits. To pass this course, the team must submit at least the alpha prototype of the product.

Project material and expenses: The students are required to choose a reasonably inexpensive project. The material and facilities provided by the Institute will be restricted to what is available in the Institute at that time. The overall team budget is Rs. 2000/- for a team of five students. Any expenditure beyond this amount must be borne by the team. If the team has any intention of developing a product with a aim of marketing it, they may do so. But the expenses should be born by the team beyond the stipulated limit.

Intellectual property rights: The teams will generally retain the Intellectual Property Rights of the inventions they develop during the course. They may even patent it themselves.

CLASS SCHEDULE

<table>
<thead>
<tr>
<th>Class – 1</th>
<th>Introduction</th>
<th>Class – 2</th>
<th>Class Planning</th>
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<tr>
<td>Class – 3</td>
<td>Identifying Customer Needs</td>
<td>Class – 4</td>
<td>Project Selection</td>
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<tr>
<td></td>
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<td>Project Proposal must be submitted</td>
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<tr>
<td>Class – 5</td>
<td>Product Specification</td>
<td>Class – 6</td>
<td>Concept Generation</td>
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<td>Mission statement and customer needs must be submitted</td>
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<tr>
<td>Class – 7</td>
<td>Industrial Design</td>
<td>Class – 8</td>
<td>Concept Selection</td>
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<td>Concepts sketched and target specification must be done</td>
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<tr>
<td>Class – 9</td>
<td>Prototyping</td>
<td>Class – 10</td>
<td>Product Architecture</td>
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<tr>
<td>Class – 11</td>
<td>Preliminary concept selection must be done</td>
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<tr>
<td>Lecture by a Project Consultant</td>
<td>Class – 12</td>
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<td>Peer Concept Review</td>
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<td>Class – 13</td>
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<tr>
<td>Product Development Economics</td>
<td>Class – 14</td>
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<td>Design for Manufacturing</td>
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<td>Class – 15</td>
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<td>Robust Design</td>
<td>Class – 16</td>
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<td>Lecture by a Project Consultant</td>
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<tr>
<td>Drawings, plans and revised schedule must be submitted</td>
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<td>Class – 17</td>
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<td>Intellectual Property</td>
<td>Class – 18</td>
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<td>Concept Testing</td>
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<td>Financial model and patent review must be submitted.</td>
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<td>Class – 19</td>
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<tr>
<td>Case Study</td>
<td>Class – 20</td>
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<td>Design for Environment</td>
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<td>Class – 21</td>
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<td>Organizing Concurrent Engineering</td>
<td>Class – 22</td>
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<td>Supply Chain Design</td>
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<td>After one week:</td>
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<tr>
<td>Alpha prototype must be submitted</td>
<td>After one week:</td>
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<td>The report on alpha prototype testing and evaluation and the beta prototype must be submitted.</td>
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<td>After one week:</td>
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<td>The report on beta prototype testing and customer evaluation must be submitted along with final market ready model.</td>
<td>After three days:</td>
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<td>Final Presentation.</td>
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<td></td>
<td>Demonstration of the working model.</td>
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</tbody>
</table>

**Text Books:**


**Web Resources:**

1. www.ocw.mit.edu
2. www.uspto.gov
3. www.businessweek.com
4. www.epa.gov
5. www.hbsp.harvard.edu
6. www.patent.gov.uk
**IC 308 PERSONAL COMPUTERS AND INTERFACING**

**Review of microprocessors:** Advanced microprocessor architectures. Introduction to Intel and Motorola families. Introduction to the Power PC processors.

**Overview of the PC architecture:** Introduction to synchronous and asynchronous buses. Overview of various PC buses: Evaluation, PCI bus and its features. Introduction to Plug and Play architecture.

**Fundamental concepts of operating systems:** Introduction to operating systems. Input/output, processes, inter process communication and synchronization, memory management, file management, ROM-BIOS services. Case study of various personal computer based operating systems. Relevance of the above operating systems to process control applications.

**Hardware Interfacing:** Peripheral devices, graphics device interface, introduction to device drivers. Anatomy of a device driver under atleast two operating systems.

**Recent trends in interfaces:** Introduction to the Universal Serial Bus (USB). Overview of standards (such as IEEE1394, etc.)

**Text Books:**

**Reference Books:**
IC 310 COMPUTER NETWORKS


Local area networks: Objectives and advantages of PC LANs, topologies for LANs, media for LANs, medium access control techniques: CSMA, CSMA/CD, Token bus and token ring, performance analysis for LANs.

Internetworking: Basic principles, bridges and routers, connection oriented and connectionless internetworking. Introduction to the protocols in the TCP/IP protocol suite.

ISDN and B – ISDN, frame relay and asynchronous transfer mode. Data compression. Data security and authentication techniques.

Network management, electronic mail, network security, other internet applications. Test techniques for data networks: Basic tests, transmission impairment measurement tests, Time Domain Reflectometry (TDR). Line monitors and protocol analyzers.

Text Books:

Reference Books:
IC 312 PERSONAL COMPUTERS & INTERFACING LABORATORY

1. Data acquisition using PC-add on cards under different operating systems.
2. Data transfer via Modem under various operating systems.
3. Installation of device drivers under various operating systems. e.g. mouse, CD-ROM, scanner, process controller.
1. Setting up a PC based LAN network, System integration with various operating systems.
2. Development of simple database applications.
3. Development of a virtual instrument using GUI and Sub VIs.
5. Measurement of vibration of a given structure and analyzing the data.
6. Measurement of strain of a given structure and publishing it in the web.
7. Control of temperature using Multifunction RT Data Acquisition card
8. Control of a given process using Real Time Embedded controller
9. Control of temperature using Distributed input/output modules.
IC 314 CONTROL ENGINEERING LABORATORY

1. Frequency response characteristics of a second order system.
2. Time 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
6. Design of state feedback.
7. Observer design.
8. Study of PD, PI, PID controller (Electronic Version and Process Simulator)
9. Microprocessor based servo system.
10. Speed Control system (Open loop & closed loop).
11. Real time control of Inverted Pendulum.
12. Real time control of Gyroscope.
IC 401 LOGIC AND DISTRIBUTED CONTROL SYSTEMS


Programmable logic controller (PLC) basics: Definition, overview of PLC systems, input/output modules, power supplies and isolators. General PLC programming procedures, programming on-off inputs/outputs. Auxiliary commands and functions, PLC Basic Functions, register basics, timer functions, counter functions.

PLC intermediate functions: Arithmetic functions, number comparison functions, Skip and MCR functions, data move systems. PLC Advanced intermediate functions: Utilising digital bits, sequencer functions, matrix functions. PLC Advanced functions: Alternate programming languages, analog PLC operation, networking of PLC, PLC-PID functions, PLC installation, troubleshooting and maintenance. Design of interlocks and alarms using PLC, creating ladder diagrams from process control descriptions.

Distributed Control Systems (DCS): Definition, Local Control Unit (LCU) architecture, LCU languages, LCU - Process interfacing issues, communication facilities, configuration of DCS, displays, redundancy concept - case studies in DCS.


Text Books:

Reference Books:
IC 403 ANALYTICAL INSTRUMENTATION

Electromagnetic radiation and its interaction with matter: Spectral methods of analysis, absorption spectroscopy, Beer’s law, radiation sources, monochromators, flitters, prisms, diffraction grating, ultraviolet spectrometer, single beam and double beam instruments, detectors, choice of solvent.


Sampling: Sample collection for gas, liquid and solid analysis, pH measurement: Basic principles, ion selective electrodes, glass and reference electrodes, measuring circuit. Electrical conductivity measurement: Measuring circuit, water and steam purity measurement. Oxygen measurement: Paramagnetic oxygen analysers, ceramic electrode for high temperature oxygen measurement and dissolved oxygen measurement.


Text Books:

Reference Books:
HM 401 INDUSTRIAL ECONOMICS


Reference Books:
IC 405 BIOMEDICAL INSTRUMENTATION

Electro physiology: Review of physiology and anatomy, resting potential, action potential, bioelectric potentials, cardiovascular dynamics, electrode theory, bipolar and uni-polar electrodes, surface electrodes, physiological transducers. Systems approach to biological systems.

Bioelectric potential and cardiovascular measurements: EMG - Evoked potential response, EEG, foetal monitor. ECG phonocardiography, vector cardiograph, BP, blood flow cardiac output, plethysmography, impedance cardiology, cardiac arrhythmia’s, pace makers, defibrillators.

Respirator and pulmonary measurements and rehabilitation: Physiology of respiratory system, respiratory rate measurement, artificial respirator, oximeter, hearing aids, functional neuromuscular simulation, physiotherapy, diathermy, nerve stimulator, artificial kidney machine.

Patient monitoring systems: Intensive cardiac care, bedside and central monitoring systems, patient monitoring through bio-telemetry, implanted transmitters, telemetering multiple information. Sources of electrical hazards and safety techniques.

Recent trends: Medical imaging, X-rays, laser applications, ultrasound scanner, echo cardiography, CT Scan MRI/NMR, cine angiogram, colour doppler systems, Holter monitoring, endoscopy.

Text Books:

Reference Books:
IC 407 INSTRUMENTATION LABORATORY

1. Design of temperature transmitter using RTD.
2. Design of cold junction compensation circuit.
3. Design of IC temperature transmitter.
5. Design of pressure transmitter.
6. Performance evaluation of pressure gauges using Dead weight tester.
8. Design of alarms and annunciators.
10. PC based respiratory analyser.
11. PC based ECG, pulse analyser.
14. Characteristics of I/P and P/I.
15. Measurement of flow using orifice, electro magnetic and positive displacement flowmeters.
IC 409 PROCESS CONTROL LABORATORY

1. Experimental study of PID controller response on a level loop.
2. Experimental study of ON-OFF and Proportional controller responses on temperature loop.
3. Tuning of controllers on a pressure loop.
4. Control valve characteristics with and without positioner.
5. Modeling of flow process.
6. Study of complex control systems (Ratio, Feedforward, and Cascade).
7. Study of Distillation column.
8. Study of basic logic operations, timer, counter, arithmetic operations in PLC.
9. Study of analog operations in PLC.
10. Problem solving in PLC.

The following experiments will be conducted on virtual DCS.

11. Three – element boiler control
12. Binary distillation column control
13. Level control in coupled tanks
14. Pressure control in different sized vessels
15. Heat exchanger control
16. Control of rotary dryer
IC 402 OPTO-ELECTRONICS AND LASER BASED INSTRUMENTATION

Introduction: Characteristics of optical radiation, electro - luminescence. Light emitting diode, heterojunction diode, internal and external photo effects.

Optical Sources: Photo diode, PIN diode, schottky, barrier diode, heterojunction diode, APD, photo-transistor, photo-thyristor, photo- thermistor.

Charge couples devices: Opto-couplers and their application in analogue and digital devices. Optical fibre fundamentals, modes, types of optical fibres, fibre coupling.

Characteristics of LASERS: Laser rate equation, properties, modes, two, three and four level system, Resonator configuration, Q switching and mode locking, cavity dumping, simple frequency operation.

Types of Lasers.

Industrial applications of LASERS: Lasers for measurement of distance and length, velocity, acceleration, atmospheric effects, sonic boom, pollutants, current and voltage. Material processing: Laser heating, melting, scribing, splicing, welding and trimming of materials, removal and vaporisation, calculation of power requirements.

Text Books:

Reference Books:
MB 790 MANAGEMENT CONCEPTS AND PRACTICES


Reference Books:
ELECTIVES

IC 352 POWER ELECTRONICS

Power semiconductor switches: Power diodes, Power transistors, Triac-GTOs-power MOSFETs, IGBTs, MCTs, SCRs - series and parallel connections, driver circuits, turn-on characteristics, turn off characteristics.

AC to DC converters: Natural commutation, single phase and three phase bridge rectifiers, semi controlled and fully controlled rectifiers, dual converters, inverter operation.

DC to DC converters: Voltage, Current, load commutation, thyristor choppers, design of commutation elements, MOSFET/IGBT choppers, AC choppers.

DC to AC converters: Thyristor inverters, McMurray-Mc Murray Bedford inverter, current source inverter, voltage control, inverters using devices other than thyristors, vector control of induction motors.

AC to AC converters: Single phase and three phase AC voltage controllers, integral cycle control, single phase cyclo-converters - effect of harmonics and Electro Magnetic Interference (EMI).

Text Books:

Reference Books:
IC 354 MICRO ELECTRO MECHANICAL SYSTEMS

Introduction, emergence, devices and application: market, challenges and technology trend and scaling issues.

Materials for MEMS, Surface and Bulk micromachining.

Microsterolithography, LIGA process.

Devices and applications. Electronic interfaces.

Design, Simulation & Layout of MEMS devices using CAD tools.

Books:
IC 451 EMBEDDED SYSTEMS AND RTOS

Embedded Software - Real time and Non Real time - Introduction to Real-time Systems and Embedded Real-time Systems - Linking - Compiling – Locators - Development Tools - operating system structures– Scheduling Algorithms - Inter task communication and Synchronization – Inter-process Communication – Signals

RTOS kernel – real time programming – RTOS multitasking – RT Scheduling – Co-operative /Non cooperative processing – Synchronization – Inter task communication and Event group - RTOS kernel System calls

RTOS porting to a target – comparison and study of various RTOS like VxWorks – pSOS – C Executive - Emulator – Simulator - Debugging techniques.


Case Studies, examples of complete embedded systems using mc68 HC11, mc8051, PIC series of microcontroller - IEEE1451.1 and IEEE1451.2 plug and play standard – RTOS for Image processing – Embedded RTOS for voice over IP – RTOS for fault tolerant applications – RTOS for control systems.

Reference Books:
Virtual Instrumentation: Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, graphical programming in data flow, comparison with conventional programming. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming.

VI programming techniques: VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O, Instrument Drivers, Publishing measurement data in the web.

Data acquisition basics: Introduction to data acquisition on PC, Sampling fundamentals, Input/Output techniques and buses. ADC, DAC, Digital I/O, counters and timers, DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements.

VI Chassis requirements. Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.

VI toolsets, Distributed I/O modules. Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control.

Text Books:

Reference Books:

Web Resources:
1. www.ni.com
2. www.ltrpub.com
IC 452 POWER PLANT INSTRUMENTATION AND CONTROL


Measurement in boiler and turbine: Metal temperature measurement in boilers, piping system for pressure measuring devices, smoke and dust monitor, flame monitoring. Introduction to turbine supervising system, pedestal vibration, shaft vibration, eccentricity measurement. Installation of non-contracting transducers for speed measurement, rotor and casing movement and expansion measurement.

Controls in boiler: Problems associated with control of multiple pulverizers. Draught plant: Introduction, natural draught, forced draught, induced draught, power requirements for draught systems. Fan drives and control, control of air flow. Combustion control: Fuel/Air ratio, oxygen, CO and CO$_2$ trimming, combustion efficiency, excess air, parallel and cross limited combustion control, control of large systems.

Controls in boiler: Boiler drum level measurement methods, feedwater control, soot-blowing operation, steam temperature control, Coordinated control, boiler following mode operation, turbine following mode operation, sliding pressure mode operation, selection between boiler and turbine following modes. Distributed control system in power plants-interlocks in boiler operation. Turbine control: Shell temperature control-steam pressure control – lubricant oil temperature control – cooling system.

Nuclear power plant instrumentation: Piping and instrumentation diagram of different types of nuclear power plant, Nuclear reactor control loops, reactor dynamics, excess reactivity, pulse channel and logarithmic instrumentation, control and safety instrumentation, reliability aspects.

Text Books:

Reference Books:
IC 454 SMART MATERIALS

Review of engineering materials, Different classes of materials: metals, ceramics, polymers and composites, engineering properties, micro structures, structure property correlations, recent development towards novel materials.

Piezoelectric materials: Background, piezoelectricity, industrial piezoelectric materials, smart materials featuring piezoelectric elements.

Shape-memory materials: Background on shape-memory-alloys, continuum applications: structures and machine systems, applications of shape-memory-alloys.

Electro-Rheological (ER) fluids: Suspensions and ER fluids, ER phenomenon, charge migration mechanism, ER fluid actuators, applications of ER fluids.

Magneto-Rheological(MR) fluids: Composition of MR fluid, applications of MR fluids.

Books:
RESERVE ELECTIVES

IC 455 OPTIMIZATION TECHNIQUE

Introduction to optimization, Engineering applications, Classical optimization techniques, multivariable optimization with and without equalities, Linear programming – Simplex method, Duality, Karmankar’s method, Non linear programming – one dimensional minimization, Geometric programming, Dynamic programming, Queuing theory, Game theory.

Text Books:
IC 457 DIGITAL CONTROL SYSTEMS

Introduction to Discrete time systems, analogies with continuous-time systems, mathematical models for LTI discrete-time systems, convolution representation and difference equations in advanced and delayed form, Z-transformation of difference equations, analysis of first, second, and higher order systems, stability of discrete-time systems, the Jury’s criterion.

State space modeling of discrete-time dynamical systems, canonical forms, solution to state space equations, properties of the state transition matrix, analysis of discrete-time state equations.

Equilibrium points and stability definitions, direct method of Lyapunov, definitions of controllability and observability, equivalent controllability/observability conditions. Design of state feedback and output feedback control. Design of observers.

Numerical Computations, digital simulation of state-space models, QR decomposition, singular value decomposition, digital control using digital signal processors.

Introduction to Optimal Control, statement of the optimal control problem, dynamic programming, general introduction to the principle of optimality, application to DTS, discrete-time linear quadratic problem, Riccati equation and its solution, optimal state feedback solution.

Text Books:

Reference Books:
IC 459 ROBOTICS

Introduction: Basic concepts, definition and origin of robotics, different types of robots, robot classification, applications, robot specifications.

Introduction to automation: Components and subsystems, basic building block of automation, manipulator arms, wrists and end-effectors. Transmission elements: Hydraulic, pneumatic and electric drives. Gears, sensors, materials, user interface, machine vision, implications for robot design, controllers.

Kinematics, dynamics and control: Object location, three dimensional transformation matrices, inverse transformation, kinematics and path planning, Jacobian work envelope, manipulator dynamics, dynamic stabilization, position control and force control, present industrial robot control schemes.

Robot programming: Robot programming languages and systems, levels of programming robots, problems peculiar to robot programming, control of industrial robots using PLCs.

Automation and robots: Case studies, multiple robots, machine interface, robots in manufacturing and non-manufacturing applications, robot cell design, selection of a robot.

Text Books:

Reference Books:
IC 461 NANO TECHNOLOGY

Background to Nanotechnology, Scientific revolutions, types of nanotechnology and nanomachines, Nano Materials – Atomic structure surfaces and dimensional space. Molecular Nanotechnology.

Nanopowders and Nanomaterials: Introduction, preparation and applications.

CNT: Types, formation / synthesis of nano tubes, applications.

Nanoelectronics: Introduction, tools for nano fabrication, Quantum electronics devices, quantum computers.

Optics and nanotechnology, Nanoholes and photons. Nanoparticles based solar absorbers. Optically useful nanostructured polymers, Nanomechanics, Nanoelasticity and Nanomedicine.

Books:

1. Michael Wilson, Kamali Kannangara, Geoff Smith, Michelk Simon, “Nanotechnology: Basic science and Emerging technologies”.
IC 456 FAULT DETECTION AND DIAGNOSIS

Introduction to Fault Detection and Diagnosis: Scope of FDD: Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances - Different issues involved in FDD - Typical applications.


Text Books:

Reference Books:
IC 458 AUTOMOTIVE CONTROL SYSTEMS

Thermodynamic engine cycles, ideal combustion engines, comparison of different engine concepts, potential of different fuels and propulsion systems.

Basic engine operation, fuel control, ignition control, lambda control, idle-speed control, knock control, combustion torque estimation.

Basic driveline equations, Modeling of neutral gear, State-space formulation, Driveline speed control, Driveline control for gear shifting.

Vehicle modeling, wheel model, tyre characteristics, complete vehicle model, validation of the model, velocity estimation.

Vehicle control system, Antilock Braking Systems (ABS), control cycles of ABS, road model, PID driver model, hybrid driver model, model of human information acquisition, complete driver model.

Text Books:

Reference Books:
Introduction to neural networks, different architectures of neural networks, Rosenblatt’s perceptrons, multi layer perceptrons, back propagation algorithm, Hopfield’s networks, Kohonen’s self organising maps, adaptive resonance theory.

Neural networks for control systems: Schemes of neuro-control, identification and control of dynamical systems, case studies.

Introduction to fuzzy logic: Fuzzy sets, fuzzy relations, fuzzy conditional statements, fuzzy rules, fuzzy learning algorithms.

Fuzzy logic for control systems: Fuzzy logic controllers, fuzzification interface, knowledge/rule base, decision making logic, defuzzification interface, design of fuzzy logic controllers, case studies.


Text Books:
1. Bose and Liang, “Artificial Neural Networks”, Tata Mcgraw Hill, New Delhi, 1996

Reference Books:
IC 462 PIPING & INSTRUMENTATION DIAGRAMS

Flow sheet design: Types of flowsheets, flow sheet presentation, flow sheet symbols, line symbols and designation, process flow diagram, synthesis of steady state flowsheet, flowsheeting software.

Piping and instrumentation diagram evaluation and preparation: P & I D Symbols, line numbering, line schedule, P & I D development, various stages of P & ID-P& ID for pumps, compressors process vessels, absorber, evaporator.

Control systems and interlocks for process operation: Introduction and description, need of interlock, types of interlocks, interlock for pumps, compressor, heater-control system for heater, distillation column, expander.

Instrument line diagram: Line diagram symbols, logic gates, representation of line diagram.

Application of P& ID’s: Applications of P& ID in design state, construction stage, commissioning state, operating stage revamping state, applications of P&ID in HAZAPS and risk analysis.

Text Books:

Reference Books:
IC 464 RELIABILITY AND SAFETY ENGINEERING


Use of redundancy and system reliability improvement methods.

Maintenance: Objectives, types of maintenance, preventive, condition-based and reliability centered maintenance. Terotechnology, Total Productive Maintenance (TPM).

Maintainability: Definition, basic concepts, relationship between reliability, maintainability and availability, corrective maintenance time distributions and maintainability demonstration. Design considerations for maintainability.

Introduction to life-testing, destructive and non-destructive tests, estimation of parameters for exponential and Weibull distributions, component reliability and MIL standards.


Text Books:

Reference Books: