

**Department of Instrumentation Science
(USIC)**

PROSPECTUS



**M. Sc. Instrumentation Science (Credit System)
(Two years master's course in Instrumentation Science)**

**University of Pune
Pune 411007.**

**M. Sc. Instrumentation Science (Credit System)
(Two years master's course in Instrumentation Science)**

BACKGROUND

All over the world the growth of an Industrial society in a Nation is measured by its use of Scientific Instruments. This is because the R & D achievements in research organizations and Industries depend on the availability of advanced instruments. Further the instruments can be utilized to its full capacity only if well trained manpower is available for design, development, its use and timely repair and maintenance. This is possible when the gap between Pure Sciences and Engineering; that is in effect the gap between Academic Society and Industrial Sector is bridged. This is a well-established fact today.

It is the requirement that has led to the emergence of Instrumentation Science – a new discipline of not only Science but technology as well and has become frontline area today. The discipline of Instrumentation Science necessarily needs the understanding of latest trends and achievements in the field of Physical, Chemical and Biological Sciences. The main objective of Instrumentation Science is to logically translate the proven research ideas into a reliable and effective but simple, elegant and handy instruments and gadgets. This will facilitate not only development of high tech products in diverse fields but also the teaching of advanced techniques in the frontline research.

To fulfill these goals, Pune University instituted Department of Instrumentation Science and introduced M. Sc. Instrumentation Science course. This is an industry / R & D oriented professional course. It incorporates compulsory 3 to 4 man month's practical training in an industry / R & D organization and a project therein of six man months. This gives exposure to the student to day-to-day life environment. The seminar course develops communication skill. Few expert lectures on industrial and financial management are organized. Practical in workshop techniques and skills are also arranged.

M. Sc. Instrumentation Science (Two Years Master's Course in Instrumentation Science)

1. ELIGIBILITY

B.Sc. with Physics / Electronics / Instrumentation Science / Computer Science / Vocational Physics / Electronics or B.E. (E & TC) / (Instrumentation)

2. DURATION: Two years (Four semester course)

Note: This is Industry oriented TWENTY-FOUR months professional course. There will be no vacation / holidays over this period.

3. COURSE STRUCTURE

SEMESTER - I: 4 Theory Courses 4 Credits each
2 Laboratory Courses 4 Credits each

SEMESTER - II: 4 Theory Courses 4 Credits each
Industrial Training 12 Credits

SEMESTER - III: 2 Theory Courses 4 Credits each
1 Departmental Course 4 Credits each
2 Laboratory Courses 4 Credits each

SEMESTER - IV: 2 Theory Courses 4 Credits each
1 Departmental Course 4 Credits each
Industrial Project 16 Credits

SEMESTER - I:

IS 1 UT 01 *	Sensors, Transducers and Actuators for Instrumentation
IS 1 UT 02 *	Signal conditioning, processing and interfacing techniques
IS 1 UT 03 *	Instrumentation components, devices and assemblies
IS 1 UT 04 *	Microprocessor based Instrumentation and System Design
IS 1 UP 01 *	Laboratory I
IS 1 UP 02 *	Laboratory II

SEMESTER - II:

IS 2 UT 05 *	Principles of Test and Measuring Instruments
IS 2 UT 06	Power Electronics
IS 2 UT 07 *	Process Control and Automation
IS 2 UT 08	Computer aided design techniques for Instrumentation
IS 2 UP 03 – 04 *	Industrial Training for duration of 2.5 - 3 months

SEMESTER - III:

IS 3 UT 09	Optical Instrumentation and Photonics
IS 3 UT 10*	Instrument Organization and Ergonomics
IS DT @	Departmental Course
IS 3 UP 05 *	Laboratory – V
IS 3 UP 07 *	Industrial Project Part I

SEMESTER – IV:

IS 4 UT 11	Advanced Fabrication Techniques and Materials
IS 4 UT 12 *	Seminar
IS DT @	Departmental Course
IS 4 UP 06 *	Laboratory – VI
IS 4 UP 08 *	Project Part II

** Core courses for M. Sc. Instrumentation Science.*

@ Any one of the theory courses mentioned in the list of Departmental (Specialization) courses. Any specialization course will be conducted provided adequate number of students opts for it.

DEPARTMENTAL COURSES:

IS DT 13	Optoelectronics
IS DT 14	Laser and Laser based Instruments, techniques
IS DT 15	Machine Tool Electronics
IS DT 16	Digital and Line Communication
IS DT 17	Analytical Instrumentation
IS DT 18	Biomedical Instrumentation
IS DT 19	Agro based Instrumentation
IS DT 20	PC based Instrumentation
IS DT 21	Robotics
IS DT 22	Cybernetics

CREDIT SYSTEM FOR M. Sc. (Instrumentation Science)

1. M. Sc. Instrumentation science course has average 6 modular courses per semester.
2. For earning the degree of M. Sc. Instrumentation Science, every student will have to obtain 100 credits of which a minimum of 75% of the credits will have to be earned from the core / compulsory courses from the syllabi as defined by the Department of Instrumentation Science.
3. A student can opt for remaining 25% of the credits from the courses offered by other departments with proper cross matching. This cross matching can be carried out in consultation with the Departmental committee and concerned Head of Departments.
4. Assessment for each theory course is divided into two parts, Internal examination and External term end examination in the ratio of 40:60. Teacher may select any / combinations of the following methods for internal assessment.
 - a. Series of internal tests
 - b. Seminar presentation
 - c. Home assignments
 - d. Survey – Excursion work
5. Internal assessment for each laboratory course will be carried out on the basis of completion of Journal including viva-voce for each experiment and the internal practical examination.
6. Rules for granting term for theory / practical course consists of minimum 75 % attendance for the theory course and completion of Laboratory Journal for at least 75% practicals in all respect.
7. Internal assessment for each Seminar course will be carried out on the basis of minimum 5 (five) seminars, presented by the student in periodic manner with relevant technical coverage in each seminar. Granting the term for seminar course will be decided on the overall performance of the student.
8. Internal assessment for Industrial Training and Project will be carried out on the basis of assessment by the internal guide / staff during the visits, periodic reporting, presentations by the student and the confidential report from the Industry.
9. Granting of term for Industrial Training and Project will be decided on the basis of attendance, actual work carried out by the student, assessment by the internal guide / staff and confidential report from the Industry.

10. The external term end examination consists of

a) Theory course	Written examination
b) Practical course	Practical examination and viva-voce
c) Seminar course	Oral presentation followed by the question answers
d) Industrial Training	Oral presentation followed by the question answers
e) Project	Oral presentation followed by the question answers
11. For getting a credit for a particular course, student must obtain minimum 40% marks in the External Term End Examination and in total both for the course. For each course grade and grade points would be awarded as shown in the following table.

Marks Obtained %	Grade	Grade Points
100 – 90	A+	10
89 – 80	A	9
79 – 70	A-	8
69 – 60	B+	7
59 – 55	B	6
54 – 45	B-	5
44 – 40	C+	4
39 and less	C	0

C grade would be treated as disqualification for getting a credit for the respective course.

Award of the final grade will be decided on the basis of all the grade points obtained by the student for all 100 credits. The grade point average (GPA) will be calculated as mentioned below.

$$\text{GPA} = \frac{\text{Total Grade points Earned}}{\text{Total Grade Points}} \times 10$$

GPA	Final Grade
10.0 – 7.5	O
7.4 – 6.0	A
5.9 – 5.5	B
5.4 – 5.0	C
4.9 – 4.5	D
4.4 – 4.0	E
3.9 – 0.0	F

INDUSTRIAL TRAINING: Industrial training is for the period of 2½ – 3 months, in an Industry / R & D organization nearby Pune (within PMC and PCMC limits).

PROJECT: The Project work must be carried out in an industry / R & D organization for a period of Six months.

DEGREE AND CERTIFICATE

A detailed Statement of Cumulative Grade point shall be provided as per the University procedure. The successful candidates will be awarded with the degree certificate as per the University rules.

DETAILED SYLLABUS

NOTE:

- 1) The theory courses may be changed, and / or replaced by special topics to keep the pace with advances in instrumentation and technology.
- 2) Numbers in the bracket indicate tentative number of lectures

IS1UT01: SENSORS, TRANSDUCERS AND ACTUATORS FOR INSTRUMENTATION

Transducer Fundamentals: (2)

Transducer terminology, Transducer classification, Performance Characteristics, Criteria for transducer selection

Principles of operation, specification and construction of following Transducers (4)

Displacement: Potentiometer, Capacitive, Inductive, Optical encoders – Linear and Rotary, Inductosyn, Tachometers

Level: Mechanical, Capacitive, Ultrasonic, Radioactive, Microwave, Conductive, Heat transfer (4)

Pressure: Bourdon Tube, Differential pressure measurement, Strain gauges, Inductive, Capacitive, Piezoelectric Transducers, Vacuum – Pirani and Penning gauges (6)

Flow: Differential Pressure type, Variable area type, Rotameters, Electromagnetic, Mass flow, Turbine, Anemometer, ultrasonic (6)

Temperature: RTD, Thermocouple, Thermistors, Semiconductor Sensors, Pyrometry (6)

Chemical sensors: Measurement of Conductivity, pH and Humidity, (6)

Optical sensors: PMT, Photodiodes, CCD, LDR,

Advanced sensors: Optical fiber sensors for temperature, image, displacement, pressure, flow, and liquid level sensors, biosensors and smart sensors (4)

Actuators: (6)

Principles and applications of mechanical, electrical, hydraulic, pneumatic actuators, valves, relays, solenoids, annunciator, motorized valves, fluidic gates etc

Transducer Performance: (4)

Electrical tests, measurement units, measurement of voltage, current, frequency, impedance, noise, loading errors, resolution, threshold, calibration, dynamic, environmental and life test.

Reference Books:

1. Rangan, Mani, Sharma: Instrumentation devices and systems.
2. Nakara, Chaudhari: Instrumentation, Measurement and Analysis.
3. E. O. Doebelin: Measurement systems.
4. B. G. Liptak: Instrumentation and process control Handbook.
5. H. N. Norton: Handbook of Transducers
6. C. D. Johnson: Process Control Instrumentation Technology

IS 1 UT 02: SIGNAL CONDITIONING PROCESSING AND INTERFACING TECHNIQUES:

Signal conditioning elements: *Bridges:* Basic circuit theorems, DC bridge concept, (6) Whetstone's bridge, Kelvin's double bridge, DC bridge design considerations, AC bridges, concept of impedances and their representations, Maxwell's bridge, Anderson's bridge, Wein Bridge etc. Problems on bridge circuits: analysis and design.

Analog signal conditioning: Basics of operational amplifier, ideal and practical (16) characteristics, specifications, data sheet referencing, Input and output impedances, offset voltage and current, bias current, slew rate, CMRR, gain-bandwidth product, concept of positive feed back and negative feed back, basic amplifier configurations and applications: inverting and non-inverting amplifier, summing amplifier, subtractor etc. Single ended and differential signals, instrumentation amplifiers, precision rectifiers, active filters, Log - antilog amplifiers, peak detector, differentiator, integrator, Schmitt trigger wave shaping circuits, linearization circuits, milli-volt to current converter, F to V and V to F conversion, phase lock loop etc. problems on analysis and designing, AC carrier systems, phase sensitive Modulator, Demodulator, Chopper stabilized Amplifier.

Analog and Digital Interface: *System – module interfacing considerations:* Analog (14) and digital representation of data, comparisons and relative merits, sampling and quantisation, sample and hold circuits, *Analog to digital converters:* Flash, Counter type, Tracking, Successive approximation, Single Slope and Dual slope ADC, Sigma Delta ADC, Study of typical ADC ICs, specifications, merits and demerits, Problems on analysis and designing. *Digital to analog converters:* Binary weighted and R – 2R type, specifications, merits and demerits, Applications of DACs like Programmable power supplies, waveform generation and synthesis, Study of typical DAC ICs Problems on analysis and designing. *Digital data transmission:* Advantages of digital communication, need of multiplexing, SDM, FDM, TDM, PCM etc

Digital Signal Processing: Concept of signals and systems, time domain and frequency (8) domain signal representation, impulse response, linearly time invariant (LTI) system, Fourier transform, convolution, output of an LTI system, Case study: Digital filter design

Analog and digital system co-housing: EMI effects and EMC measures, Analog and (4) Digital PCB design guidelines, Shielding and grounding techniques, Enclosure design guidelines, Isolation and interference filtering

Reference Books:

1. Gaikwad: Op-amps and linear ICS
2. G. B. Clayton: Operational amplifiers
3. Millman and Halkias: Integrated electronics
4. Horowitz and Hill: Art of electronics
5. R. F. Coughline: Op-amps and linear ICs

IS 1 UT 03: INSTRUMENTATION COMPONENTS, DEVICES AND ASSEMBLIES

Prerequisites: Knowledge of basic circuit theorems, Study of data sheets.

Electronic Components and Devices: *Passive and Active devices:* Resistors, (10) Capacitors, Inductors, Transformers, Relays, Switches, wires and cables etc. specifications, data sheets referencing, testing, Diodes, Zener diodes, Light emitting diodes, BJTs, FETs, MOSFETs specifications, data sheets referencing, characteristics and testing, Class A, Class B, Class AB, Push pull and Class C amplifiers, Transistor as a switch etc.

Linear regulated power supplies: Power supply basics, rectifiers, filters, Simple Zener (6) regulator, Zener regulator with series pass transistors, Voltage regulator IC 723, Three terminal regulators, testing of power supplies, specifications, line, load regulation, efficiency of power supplies, stability etc.

Digital Electronics: Logic gates, Boolean algebra, combinational logic, K-maps, half (12) adder, full adder, digital comparator, decoders, encoders, mux – demux, sequential logic, Flip-flops – RS, JK, JK/MS, D, T, Latches, Counters – asynchronous, synchronous, up-down, pre settable, shift registers, memories, PAL, PLDs, FPGA, Logic families – TTL, CMOS, study of specifications and applications.

Fundamental of geometrical optics: Reflection, refraction, refractive index, sign (6) convention, total internal reflection, Optical Components and devices - Lens, prism, mirrors, slit, aperture, Fresnel lens, collimators, beam expanders, optical bench, basic principles and applications, aberrations: monochromatic and chromatic.

Mechanical Components: Screws, Power Screws, Bolts, Nuts, Washers, Foundation (10) Bolts, Locking Arrangements, Forms of Threads, Thread Nomenclature, Thread Representations, Various types of springs, Pulleys, levers, gears; belts and gears; belts and chain drives – basic structures and applications, Shafts, Keys, Couplings, Joints, Bearings, Brackets, Boxes, Hangers, Flat tables, Fixture clamps, V blocks, Vices, Indexing mechanisms, Indexing heads and Tools and Machine tools, *Types of rivets:* Bolted, riveted, and welded joints, welding processes and equipments, *Mechanisms for motion conversions:* Cam and followers, Materials and Material properties, Instrument Assembly: Reading drawing, working layout of instrument, assembly of joints detachable, permanent, semi permanent etc.

References Books:

1. Malvino: Electronic Principles
2. Malvino and Leach: Digital principles
3. Millman and Halkins: Integrated Electronics
4. Jenkins and White: Fundamentals of Optics
5. Chaudhari: Workshop technology I & II

IS 1 UT 04: MICROPROCESSOR BASED INSTRUMENTATION AND SYSTEM DESIGN

Embedded Instrumentation: *Need and advantages of using Microprocessors in Instrumentation:* Basic concepts of embedded instrumentation, features, specifications and differences; different blocks of embedded instruments, ideal microprocessor / microcontroller based Instrument, case study; Basics of processor / controller, hardware resources, comparison of 8085 and 8051 and other processors / controllers, architectural details of microprocessor 8085 and microcontroller 8051, introduction to other microcontrollers viz. eZ80, PIC, AVR and latest controllers; comparative study of different controllers like 89C51AC2/RB2/RC2/RD2, 68HC11, eZ80, MSP430X11, AVR, 80C552, 80C535 etc. (8)

Microprocessor support devices: *Memories:* Latches, Shift registers, RAM, NVRAM, ROM, PROM, UVPRM, EAPROM, FLASH, SRAM and DRAM, Serial EEPROMS, Serial RAM, Differences and general specifications, various memory devices, interfacing of memory devices with microprocessor / microcontroller. Memory mapping scheme for microprocessor 8085, memory decoders, folded memory, external memory interfacing for microcontroller 8051, internal memory map for 8051, details of various SFR's and BIT addressable memory, *Input output devices:* I / O mapping, I / O mapped I / Os, Memory mapped I / Os, advantages and disadvantages, non programmable I / O devices, Programmable peripheral interface 8255, Programmable timer counter 8253, Keyboard and Display interface device 8279, study and interfacing techniques for 8085 and 8051; (14)

Programming techniques: Addressing modes and study of instruction set, Stack pointer, stack memory and stack operation; introduction to assembly language programming, simple programs; extensive programming exercises with using assembly language for 8085 and 8051 Use of Integrated development environment (IDE), *Keil, Tasking and SC-51* cross C compilers, simulator and debuggers for system integration (10)

Modular development of embedded system: Interfacing of switches and LEDs, Rotary switches and related programming, interfacing of matrix type keyboard, lookup table searching, Error detection programs, Interfacing of seven segment displays and alpha numeric LCD modules, Interfacing of ADC and DAC, I / O Expansion for 8051 using serial interface, Timers and counters in 8051, various modes of operation, generation of PWM signal, Interrupts in 8085 and 8051, priority of interrupts, vectored interrupts Implementation and applications of serial interface RS 232 using 8051 UART, Study of Parallel Interface, extensive programming exercises using assembly and C language. Power down and Idle mode of operation in 8051, Program securities (16)

References Books:

1. Gaonkar: Microprocessor Architecture, programming and Applications.
2. K. J. Ayala: The 8051 Microcontroller
3. Atmel: Microcontroller Handbook

IS IUP 01: LABORATORY FOR SENSORS AND TRANSDUCERS INTERFACING TECHNIQUES

Note: Each experiment is of four Hours duration.

List of Experiments:

1. Study of electronic and electrical components. (active and passive devices)
2. Study of active filters using operational amplifier IC 741.
3. Study of digital ICs, and digital frequency counter. (Digital ICs TTL and CMOS family – MSI / LSI type)
4. Study of linear displacement transducer and precision rectifier using operational amplifier IC 741
5. Study and characterization of Instrumentation amplifier using quad opamp IC 324 and study of Schmitt trigger / comparator circuit
6. Mechanical workshop practices
7. Study and calibration of temperature sensor: Pt – 100
8. Comparative study of various types of regulated power supplies
9. Study of capacitive level sensor
10. Study of optical sensors: LDR and photo diode
11. Study of R – 2R ladder network DAC and DAC IC1408
12. Study of single slope ADC
13. And or experiments of similar kind

IS IUP 02: LABORATORY FOR COMPUTATIONAL TECHNIQUES FOR INSTRUMENTATION AND MICROPROCESSORS / MICROCONTROLLERS

Note: Each experiment is of four Hours duration.

List of Experiments:

1. Sorting of array using switch and case statement
2. Multiplication of multi dimensional matrices
3. To change the case of the string using pointers
4. Writing user defined functions for complex calculations
5. To perform various manipulations on a string using functions
6. To perform encryption and decryption of data stored in file
7. To create a data base using structures and files
8. Assembly Language Programming and simulation for microprocessor 8085
9. Assembly Language Programming – simple programming and simulation for 8051
10. Assembly Language Programming – I / O ports and simulation for 8051
11. Assembly Language Programming – Timer-counters / Interrupts and simulation for 8051
12. Schematic drawing and PCB designing using EAGLE software
13. And or experiments of similar kind

IS 2 UT 05: PRINCIPLES OF TEST AND MEASURING INSTRUMENTS

Multimeters: Analog multimeters: Basic permanent magnet moving coil movement (12) construction and working, Sensitivity of PMMC meters and their loading effects, Study of specifications and data sheets, Need of universal shunt, Multi range Ammeters, Voltmeters Ohmmeters, A.C. voltmeters, true – rms A.C. voltmeters, Micro-voltmeters, Tong testers, Study of specifications for analog multimeters from various manufacturers' catalogs and Demo; Digital Multimeters: Block diagram and Working of DMM, types of ADCs used, Auto Zeroing and Auto - ranging concepts, various circuit details of DMM, Study of specifications for digital multimeters from various manufacturers' catalogs and Demo.

Oscilloscopes: Working principle of general purpose (Real Time) Oscilloscope with (16) block diagram, circuit diagrams and timing diagrams, Details of Y amplifier, X amplifier, CRT section, Details of stability of waveform, triggering modes and facilities, multi trace operation, delayed time base operation, delay line, X-Y mode, Study of specifications of different CROs and Demo; Oscilloscope probes: Specifications characteristics and probe tuning; Storage oscilloscope: Working principle of Storage Oscilloscopes, Digital Storage Oscilloscope block diagram, Sampling techniques, Merits and demerits of DSO and Demonstration

Other Test and Measuring Instruments: Recorders: Block schematic and working of (14) strip chart, potentiometric, galvanometric, X – Y – t recorders and plotters, Study of specifications of recorders and Demo; Frequency Counters: Working principles, Study of block diagrams and timing diagrams for Frequency Counters / Universal Counters, applications, measurements, Study of Specifications for Frequency Counters and Demo; Special purpose Instruments: Signal / Function Generators, LCR meters, Lock in amplifiers, Working principles and applications

Reliability Engineering: Concept of Reliability, quality, failures and causes of failures, (6) Maintainability, designing for higher redundancy, system reliability modes, reliability management, reliability and cost, economics and mathematics of reliability engineering

Instrument Performance Characteristics: Accuracy, precision, tolerance, range, bias, (8) sensitivity, hysteresis, resolution, repeatability, reliability, loading effect and other parameters, calibration of instruments, Errors in Measurements and statistical data analysis: Types and sources of errors, error reduction techniques, Graphical representation of data, curve fitting, Statistical concepts, mean and median values, standard deviation, frequency distribution, normal and Gaussian distribution, confidence level, chi-square method,

Reference Books:

1. Oliver and Cage: Electronic Measurements and Instrumentation
2. W. Cooper: Electronic Instrumentation and measuring techniques
3. Phillips Oscilloscope Manual
4. Reliability Handbook: Balguruswamy

IS 2 UT 06: POWER ELECTRONICS

Power Semiconductor devices: Diodes, Transistors, MOSFETs, IGBTs and Thyristors, (8) Switching characteristics, specifications and performance comparison of power devices

Power Circuits: Thyristor turn on and turn off methods, Controlled Rectification: (12) Effect of Resistive / Resistive- Inductive / Inductive load on performance, Inverters: Transistors and Thyristorised inverters; Applications of Invertors, Choppers: Four-Quadrant operation of Choppers, Applications of Choppers, Cyclo converters: Principle of operation and applications

Power supplies: Uninterrupted Power Supplies: ON LINE and OFF LINE UPS, (12) Specifications, testing and applications
Alternative solutions for Linear Power supplies like Low Drop Out (LDO) regulators, Switch Mode Power Supplies (SMPS): Need and Concept of SMPS, principle of operation, specifications, integrated solutions for LDOs and SMPS
HV power supply: Pulsed power supply, Specifications, Designing concepts, Protections and Applications

Motors and Motor Drives: Types of Motors: DC Motors, AC Motors, Induction (12) Motors, Single and Three Phase Motors, Synchronous Motors, Stepper Motors, Servo Motors etc. Constructional details, Specifications, Characteristics of motors, Motor Driving circuits and their applications

AC power transmission and distribution: Single phase, three phase systems (10) Transmission line constants, single phase, three phase transformers and power factor calculation, load distribution.
Circuit analysis and design: Vector algebra and complex algebra with graphical representation with reference to Power electronics.

Reference Books:

1. P. C. Sen: Power Electronics
2. M. H. Rashid: Power Electronics – Circuits, Devices and Applications
3. M. S. Barde: Thyristor Engineering
4. Cyrill W. Lender: Power Electronics
5. A. K. Jain: Power Electronics

IS 2 UT 07: PROCESS CONTROL AND AUTOMATION

Fundamentals of process control: Introduction to process control, open loop and closed loop systems, Process parameters, Control systems parameters, Different controller modes, Composite controllers (8)

Discontinuous and continuous controllers: Study of On - off controller, Proportional controller, PI controller, PID controller, Study of electronic and pneumatic controllers, control loop characteristics, control system configuration, single variable, multi variable, cascade controllers, feedback and feed forward controller. (14)

Laplace transforms: Step function, Ramp function, and Sinusoidal function, Inverse Laplace transform, solving differential equations using Laplace transform. Transfer function, Open loop transfer function, Close loop transfer function, Block diagram reduction, and Signal flow diagrams. Review of signals and systems in time and frequency domain (14)

Process stability: Routh's stability criteria, Nyquist criteria, Process loop tuning, Open loop transient response method, Ziegler Nichols method, Frequency response method, Auto tuning PID. (8)

Discrete state process control: Discrete state system characteristics, process specifications, sequential control, Programmable Logic Controllers, Ladder diagrams, PLC programming and operation, Computer in process control, Data logging, Supervisory controllers, Factory automation (12)

Reference Books:

1. C. D. Johnson: Process control Instrumentation Technology.
2. N. A. Anderson: Instrumentation for process measurement and control.
3. D. P. Eckman: Automatic process control.
4. K. Ogata: Modern Control Engineering
5. Kuo: Automatic Control Systems.

IS 2 UT 08: COMPUTER AIDED DESIGN TECHNIQUES FOR INSTRUMENTATION

Computer graphic fundamentals: Points and Lines, Orthographic and Isometric projections, Three dimensional transformations and projections, Plane curves, Surface disruption and generation, Line generation algorithm, Hidden line algorithms for Wire frame Modeling, Surface Modeling, Solid modeling, Representation of 3 - D objects (16)

Principles of computer-aided design: Computer configuration for CAD applications, Computer peripherals for CAD, Concept of Physical and engineering modeling (8)

3 - D solid modelers and constructive solid geometry: CAD system utilization and application, Hidden surface algorithms and shading, Finite element systems, Computer aided drafting systems. (10)

Computer Aided Design (CAD) Soft wares: *AutoCAD*: Commands for creation of entities like line, pline, polygon, circle, arc, ellipse, point, donut, text, and boundary hatch. Editing commands like erase, move, copy, offset, trim, break, rotate, scale, divide, measure, mirror, array, stretch, chamfer, fillet. Creating and handling blocks, layers, dimensions, Slides, script files, Automated drafting using script files Use of script file for animations (16)

Auto LISP: Basic arithmetic functions, advanced mathematical functions, various get functions, decision making, looping functions, handling system variables, file handling.

Reference Books:

1. D. Bowman: Understanding CAD / CAM
2. D. Raker and H. Rice: Inside Auto CAD.
3. Bolan: Mastering C.
4. Schlieve: Illustrated Auto CAD
5. Barry Hawkes: The CAD/CAM process
6. Kumar and Zha: Technology of CAD & Manufacturing
7. C. B. Basat and C.W.K. Liu: Computer aided design and manufacturing
8. Rogers and Adams: Mathematical elements of computer graphics.
9. Zimmer and Groover: CAD-CAM
10. William Oliver: Illustrated Auto lisp
11. N. D. Bhatt: Engineering Drawing

IS 3 UT 09: OPTICAL INSTRUMENTATION AND PHOTONICS

Confining Ray bundle in Optical System: Aperture, field of view, entrance / exit window effects of Aperture, Energy flow in optical instrumentation: Light flux, Radiometry and Photometry, Radiative transfer in optical system, heterodyne and phase shifting interferometry, Types of Optical filters, specifications, interference, diffraction, polarization, and types of gratings (12)

Optical Photoelectric System: Types of optical detectors, characteristics, effect of spectral characteristics, Optical materials for UV, visible and IR regions; (12)

Introduction to Optical Systems in LASER: Properties of Laser, Basics of Laser Principles: active medium, laser pumping, optical feedback, laser output: line shape broadening, laser modes: optical resonance, pump rate, power output; (14)

Laser Exposition: Working principle and construction of Gas lasers, Solid-state lasers, Semiconductor lasers, and Dye lasers, Applications of lasers (10)

Optical Fiber: Introduction to Optical fiber, principle in optical fiber, numerical aperture, multimode and single mode fibers, losses in fiber: dispersion, absorption, scattering losses, types of couplers and connectors, losses due to couplers, splicing techniques, fabrication techniques, Applications of optical fiber viz. Fiber Optic sensors, Communication System etc. (12)

Reference Books:

1. Jenkins and White: Optics
2. Ghatak: Instrumental methods of analysis
3. Khandpur, Kaiser, Zanger and Zanger: Optical fiber communications
4. B. N. Begunov, S. I. Kiryushin, V. I. Kyzichev: Optical Instrumentation: Theory and design.
5. R. Sirohi, M. P. Kothiyal: Optical Components, Systems and Measurement techniques
6. W. T. Silfvast: Laser Fundamentals
7. R. Papannareddy: Light wave Communication Systems: A Practical Perspective

IS 3 UT 10: INSTRUMENT ORGANIZATION AND ERGONOMICS

Introduction to Ergonomics: Management of Technology, Need analysis and product specification, Solution search, product planning and system breakup, sub-system interaction, environmental factors for successful operation, Anthropology and Anthropometry principles and applications (8)

Classification of tasks of Instruments: Activity analysis in terms of man machine tasks, Identification of constraints on instrument design arising out of Scientific, Technical, Production, Environmental and Maintenance replacement consideration. (10)

Design of configuration /options: Design of controls, Displays and graphics, Aesthetics of colour and form, Value engineering and Value analysis, Creativity tools like brainstorming, Vicarious imagination, Lateral thinking and Spatial management. (4)

Design of manuals: Job-aids and training aids, Cultural parameters of design. Concepts of drawing and various types of drawing, Creative thinking, free hand sketching, presentation drawings, engineering drawings, exploded views and enlarged details, Installation and performance charts (8)

The design cycle: Need analysis, Formulation of design problem, Product planning, Product conceptualization, Design methods for divergent, transformation and convergent thinking, Instrument aesthetics, Instrument ergonomics, Model making, Product life cycle (12)

Design consideration for reliability: Calibration and testing standards, Environmental testing of Instruments, Certification of performance (6)

Reference Books:

1. C. S. Rangan, G. R. Sarma and V. S. Mani: Instrumentation Devices and Systems
2. David B. Osborne: Ergonomics at work

IS 3 DT 20: PC BASED INSTRUMENTATION

(Prior knowledge of 8 bit microprocessors and “C” programming is essential for the course. Old PC motherboard and non functional add on cards will be made available to students to understand plugging of add on card, base address importance etc.)

PC based Instrumentation: Need of PC based Instrumentation. Comparison between (6) embedded instrumentation and PC based instrumentation, Introduction to 8086 microprocessor

Personal Computer: Evolution of PC, Introduction to PC motherboard and other (12) components of PC, Overview of chips and their functions on motherboard with reference to first 8086 motherboard, BIOS, POST, Bootstrap loader, BIOS - DOS interaction, DMA controller, Interrupt Controller, CMOS setup, Memory map and I/O map of PC

PC add on cards: Different bus architectures on PC motherboard for add on card / (14) prototype functions i.e. ISA, VESA, PCI, PCI express bus, Control through PC add on card, Data acquisition concept by study of AD / DA card in detail for ISA slot card, Study of AD574 ADC chip, Introduction to digital input output card, Timer card, Frame grabber card, Ethernet card

PC communication ports: Introduction to CENTRONICS parallel port, Serial COM1 / (10) COM2 ports, RS232 standard, USB communication, Importance of GPIB / IEEE488 interface for PC based instrumentation for scientific applications

BIOS Services: Need of BIOS services, different categories, detailing with respect to (6) BIOS services for keyboard, mouse, and video categories

Lab VIEW based Instrumentation: Introduction to Windows API, Introduction to Lab (4) VIEW, “G” language concept, Introduction to VI, Sample VI – making and execution on PC

Reference books:

1. IBM PC and Clones – B. Govindarajalu
2. Hardware Bible – Winn L. Rosch
3. The Indispensable PC hardware book – Hans Peter Messmer
4. Microprocessor interfacing – programming and hardware – Douglas Hall
5. Using assembly language – Allen Wyatt
6. Troubleshooting, maintenance & repairing of PC – Bigelow

IS 3 UP 05: LABORATORY FOR MICROCONTROLLER INTERFACING AND PC BASED INSTRUMENTATION

Note: Each experiment is of four Hours duration

- 1) Interfacing of mouse using DOS interrupts to PC
- 2) Interfacing of PCL207 - AD / DA card to PC
- 3) Visual Basic Programming – Standard Calculator.
- 4) Schematic drawing, PCB layout and Artwork using “ORCAD”
- 5) Microcontroller interfacing – Switches and LEDs
- 6) Microcontroller interfacing – Timer / Counter and Interrupt based applications
- 7) Microcontroller interfacing – Serial Interface
- 8) Microcontroller interfacing – 8 - bit ADC and 16 X 2 dot matrix Liquid Crystal Display Interfacing
- 9) Microcontroller interfacing – Interfacing of Serial EEPROM using I²C protocol
- 10) Microcontroller software development using Cross C compiler
- 11) AutoCAD drawing – Electromechanical System drawing
- 12) Study, application and analysis using MATLAB
- 13) Study, application and analysis using Virtual Instrumentation (NI)
- 14) And or Experiments of similar kind

IS 4 UT 11: ADVANCED FABRICATION TECHNIQUES AND MATERIALS

Manufacturing techniques for Instrument components: Injection and compression (8) molding of plastics, Mould design considerations, Common defects in molded parts and remedies, Vacuum forming practices, Former design, manufacturing and applications, Fiber molding techniques, Selection and use of raw material. Pressure die casting of non-ferrous Instrument parts, Die design considerations, Press working of sheet metal components, Behavior of common engineering material under press working, Die design considerations.

Surface Treatment Techniques: Vacuum deposition, Electro-deposition, Hard facing. (6) Electroplating and Anodizing of surfaces, Surface preparation and control of parameters for surface treatment Metallizing, Decorative finishing and their applications, Painting techniques, like electrostatic painting, powder coating. Heat treatment like Annealing, Hardening, Tempering and Stress relieving.

Machining Techniques: Lathe Machines, Slotting machine, Milling machine, Drilling (6) machine, Joining processes, Welding processes like Spot welding, Arc welding, Gas welding etc.

NC CNC Machine tools: Principles of machine tools, Control of machine tools, (10) Construction of machine tools, Modes of operation of NC-CNC machines, Input output transducers for NC-CNC machines, Principles of operation of NC machine tools

Part programming for CNC machine: Structure of part program, various commands, (6) Simple programming exercise, Simulation of CNC part program using PC.

Vacuum systems: Vacuum pumps and Vacuum gauges. Vacuum deposition system, (6) Thin film deposition methods like Thermal evaporation, DC and RF Sputtering, Chemical vapor deposition etc

Thin films and Hybrid technology: Properties of thin films, Structure dependence, (8) Effects of substrate temperature and rate of deposition, Electrical properties of thin films, experimental methods for measurements of various thin film parameters. Photolithography Processes

Advanced methods of manufacturing: EDM, ECM, and LASER machining and (4) Photo fabrication techniques for fine and intricate components

Reference Books:

1. W. J. Patton: Materials in Industries
2. Edi. Dekker Inc., N.Y. Series of Advances: Optical Materials Vol. A.
3. Meissel and Glang: Vacuum Systems and Thin films.

IS 3 UP 06: LABORATORY FOR ADVANCED PROCESS CONTROL AND AUTOMATION

Note: Each experiment is of four Hours duration

- 1) Study of and tuning of PID controller for Oven
- 2) Study of and application development using Programmable Logic Controller
- 3) Part program development for CNC machine and Simulation
- 4) Study of and application development using pneumatic trainer system
- 5) Study of and application development using SCADA trainer system
- 6) Study of He-Ne LASER characteristics and application for contact less diameter measurement
- 7) Study of optical fiber characteristics and application for digital communication
- 8) Study of and application development using Mentor Robot manipulator
- 9) Study of Vacuum system, thin film deposition and film thickness measurement
- 10) Project Like Experiment (to be performed in a group of 3 - 4 students. Equivalent to 4 laboratory experiments)
- 11) And or Experiments of similar kind

IS 4 UT 12: SEMINAR

- 1) Topic for seminar is to be decided in consultation with the teacher guide
- 2) Total 6 (six) seminars are to be delivered by the student during the semester on the approved topic, each of minimum duration of 45 minutes.
- 3) Minimum gap between two seminars would be 8 – 10 days.
- 4) As a part of Internal assessment each student is to attend all the seminars delivered by the students in his / her group and appear for the written examination on any two topics in addition to his own topic.
- 5) Internal assessment will be carried out on the basis of
 - a) Seminar contents
 - b) Presentation skills
 - c) Understanding of the topic
 - d) Report writing and
 - e) Written examination
- 6) During the external examination student will be assessed on the basis of Seminar contents, Presentation skills, Understanding of the topic and Report writing.

IS 4 DT 21: ROBOTICS

Introduction: Need for automation, Robotics fundamentals, Classification of Robots (6)
based on co-ordinate system, Method of control, Major components of Robotics system,
Fixed and flexible automation, Application of Robotics

Mechanical system: Components of Robot - Manipulator, Controller, Sensors, Power (8)
conversion unit, Fundamentals of Pneumatic, Hydraulic and Electrical actuators used in
Robots, Vision systems for Robot.

Motion conversion: Rotary to rotary, Rotary to Linear, Linkages, Modeling of (6)
Mechanical systems - Translational, Rotational, Kinematics' chain, Lagrangian analysis of
manipulator, End effectors, Control of Robotic joints.

Transformation and Kinematics: Homogeneous co-ordinates, Vector operations, (12)
Matrix operations, Co-ordinate reference frames, Homogeneous transformation and
manipulator orientation, Relative points reference frames forward solutions - Link
co-ordinate frames, Denavit Hartenberg (D-H) Matrix.

Inverse or back solution: Problem of obtaining inverse solution, Techniques using (8)
direct and geometric approach. Motion generation - On and off line trajectory, Velocity
profile, Acceleration profile, Cartesian motion of manipulator, Joint interpolated control,
Jacobian in terms of D-H matrix.

Computer consideration for Robot system: Robot programming - Fixed instruction (4)
sequence control, General programming language, Specific programming languages.

Artificial intelligence and Robotics: Artificial intelligence, Real time considerations, (6)
Event driven processes and Sensor information processes. Path Planning - Co-ordination
motion, Automatic programming

Reference Books:

1. R.J. Schilling: Fundamental of Robotics - Analysis and control
2. R. Jain, R. Kasturi and B. J. Shunck: Machine Vision
3. M. P. Groover: Automation, production systems and computer integrated manufacturing

IS DT: DEPARTMENTAL COURSES

List of other departmental courses available:

Important Note: Following, other departmental, courses will be offered depending upon availability of the staff and facilities. The detailed syllabi can be made available if required / asked for.

IS DT 13: OPTOELECTRONICS

IS DT 14: LASER AND LASER BASED INSTRUMENTS TECHNIQUES

IS DT 15: MACHINE TOOL ELECTRONICS

IS DT 16: DIGITAL AND LINE COMMUNICATION

IS DT 17: ANALYTICAL INSTRUMENTATION

IS DT 18: BIOMEDICAL INSTRUMENTATION

IS DT 19: AGROBASED INSTRUMENTATION