

## B. Sc. Instrumentation Course Detail

Semester-wise : 2012 onward

S. No.	Paper Code	B.Sc. (Instrumentation) Paper Name	Periods per Week	Credit
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### Semester - I

1.	INST--1T1	Instrument Mechanisms	4	4
2.	INST--1T2	Electronics	4	4
3.	INST--1P1	Electronics & Computer Lab. I	4	2

### Semester - II

1.	INST--2T1	Digital Electronics	4	4
2.	INST--2T2	Metrology	4	4
3.	INST--2P1	Mechanical Instrumentation Lab.	4	2

### Semester - III

1.	INST--3T1	Optical Instrumentation	4	4
2.	INST--3T2	Vacuum Measurement Techniques	4	4
3.	INST--3P1	Optics & Vacuum Instrumentation Lab.	4	2

### Semester - IV

1.	INST--4T1	Signal Conditioning, Operational Amplifiers & Applications	4	4
2.	INST--4T2	Microprocessors	4	4
3.	INST--4P1	Microprocessors & Computer Lab. II	4	2

### Semester - V

1.	INST--5T1	Transducers	4	4
2.	INST--5T2	Instrumentation Systems	4	4
3.	INST--5P1	Transducers Lab.	4	2

### Semester - VI

1.	INST--6T1	Industrial Instrumentation	4	4
2.	INST--6T2	Entrepreneurship	4	4
3.	INST--6P1	Project Work	4	2

# **B.Sc. INSTRUMENTATION SYLLABUS**

**Semester-wise : 2012 onward**

**Semester - I**

## **INST-ITI INSTRUMENTATION MECHANISM**

**Unit 1. Introduction :** Material for instruments, bearings, machine, bearings vs instrument bearings. Different type of bearings and guides. Locks and stops Locks, unidirectional locks, stops for linear motion, switching motion, switching stops, stops for rotary motion.

**Unit 2. Couplings :** Rigid couplings, couplings for shafts with longitudinal shift coupling for shafts with off-set of centers, coupling for shafts overrunning clutches single revolution clutches with permanent magnets. Energy storing elements : Mass Springs, leaf Springs, spiral springs, torsion springs, conical disc, springs

**Unit 3. Joining :** Adhesive and cemented joints, joints by elastic deformation, joints by wedge effect, screw joints, press fitted joints, joints by plastic deformation, beaded joints, folded joints, lapped joints, crimped joints, embossed joints, spreaded joints, joints by embedding.

**Unit 4. Functional Mechanism :** Gear Mechanism, friction wheel mechanisms, wedge and screw mechanisms, Linkage mechanisms, integrating mechanisms, differential quantity integrator, rate quantity integrator. Elements in high speed mechanisms Inertia, friction and energy.

**Unit 5. Elements of workshop Technology :** Covering fundamentals of simple manufacturing process machine tools like lathes drilling machine milling machines shaping machines metal framing and casting.

### **Books :**

1. Elements of Precise Engineering by R. Roman
2. The Design and Use Of Instruments and Accurate Mechanism by White

## **INST-IT2 BASIC ELECTRONICS AND INSTRUMENTATION**

**Unit 1. A.C Fundamentals :** (Frequency, Period, Phase concepts), Average and Effective Values, Fm Factor, Phasor Representation, Vector addition/ Subtraction, Polar Notation, Complex Notation. *Resisters :* General Information: Symbol, color code, Types such as Carbon, Metal Film, thin film, Thick film, wire wound, variable Potentiometers, Logarithmic, Linear multi-turn. *Their Physical Properties :* Temperature Dependence (Thermistor), Light Dependent (LDR), voltage dependent (VDR). Technical specification: wattage, working voltage. *Methods of Measurements:* very low and very High Resistance, Wheatstone Bridge, Its merit. *Inductors :* *General Information:* Symbol, type (air core, iron core, Ferrite core) choke, frequency response, methods of measurements. *Capacitors :* *General Information:* symbol, color code, types ( air, paper, electrolytic, mica, tantalum, polystyrene) Fixed and Variable Capacitors. *Specification:* Power Factor, working voltage, measurement of capacitance.

**Unit 2. Circuit theory** : Resistors in series and parallel, Star-Delta Transformation, Kirchoffs current and voltage law. simple exercises, *Networks Theorem* : Superposition, Maximum Power Transfer, Thevenins Theorem, Norton's theorem, source Information, Millman's Theorem (simple Exercise), Two Port Network.

**Unit 3. A.C Circuits** : Resistance-Inductance-Energy Stored in capacitance-series circuits, RL, RC and RLC circuit. Power Triangle, Series Parallel circuits, Admittance (Exercise).  
*Resonance In A.C Circuits* : Series Resistance, Frequency variation, Selectivity, Q Factor, Half Power Frequency- Band Width- Parallel Resistance- Two Branch Parallel Circuits- Resistance Variation – Resistance at all frequencies, Tunnel circuit.

**Unit 4. Diodes, BJT and FET** : Linear diodes, Zener Diodes, Varactor Diodes, Photo Diodes, Light Emitting Diodes, Optical Isolator, *Power Supplies* : Transformer, ratings, specifications,  $V1/V2= I2/I1= N1/N2$ . Efficiency and Losses. Rectifiers (Full wave, Half Wave Filters) Regulation (Line & Regulation). Zener diode as Voltage Regulator, Three pin Regulators and black box. Ideal constant Voltage source, Ideal constant current source concept. Construction and working of BJT and FET, BJT transistor amplifier circuit biasing in CB, CC and CE configuration, FET amplifier circuit, frequency response of 1 and 2 stage BJT amplifier circuit.

**Unit 5. Cathode Ray Oscilloscope** : General constructional details of C.R.O. Classification of C.R.O. C.R.T with Reference to the controls provided on the C.R.O panel, time base generators, synchronization and sweep circuits, Dual Trace C.R.O, Application of C.R.O.

**Books :**

1. Basic Electronics by Bernard Grob
2. Basic Electronics By Malvino
3. Electrical Measurement by Golding

**INST-1P1 ELECTRONICS AND COMPUTER LAB ( I )**

*Electronics:*

To design a variable potentiometer, determination of internal resistance of a battery, use of SPDT and DPDT switches with LED, To study the temperature dependence characteristics of thermistors, To study the LDR and LED characteristics, I-V characteristics of P-N and Zener Diodes, Half wave and full wave rectifiers with filter circuits( ripple factors), Three PIN (IC) regulator, To find the operating point of NPN and PNP transistors (DC Load Line analysis) Characteristics of JFET, Impedance of LCR circuit.

*Computer:*

DOS, Windows, MS office ( MS word, MS excel, Power point), Programming in Fortran and C languages ( tutorials)

**Semester - II**

**INST-2T1 DIGITAL ELECTRONICS**

**Unit 1. Number Systems** : Introduction to decimal, binary, octal hexadecimal number system, BCD codes, Introversion of binary decimal, BCD, Octal, Hex. Parity Excess 3 Gray and Johnson

code, simple binary Arithmetic, Introduction to Excess 3 Arithmetic.

**Unit 2. Logic Gate :** Positive and negative Logic. Different Logic Gates such as AND, OR, NOT, NOR, NAND, EXOR, EXNOR, symbols and truth table. Introduction to different Logic Families (ERTL, DTL, TTL, ECL, CMOS) merits and demerits. *Case study of TTL NAND Gates :* Multimeter Input Transistor phase Splitter, Totem pole and open collector output concepts. Basic concepts of Fan In and Fan Out sinking and sourcing of Current.

**Unit 3. Boolean Algebra and Combinational Logic :** Boolean Axioms, D Morgans Theorem: Statement verification and application Simple combinational logic implementations. C-Mappings up to four variable (SOP and POS). Ones compliment half adder full adder interpretation of full adder as subtractor. Universal gates (NOR and NAND) its importance. Prove that any logic gate can be implemented by use of universal gates only, Introduction MEP (Map Entered Variables ).

**Unit 4. Sequential Logic :** Differential Flip Flops such as RS, clocked RS, JK ( Race condition ). Master Slave J.K. D type and T Type Flip Flops. Explain D type as a delay element. *Shift Registers* Type of Shift Registers SI SO SI PO PISO shift right and shift left. Applications; Ring counter and Johnson's counter (Twisted Ring) multiple cycle delay element.

**Unit 5. Counters :** Asynchronous counter and synchronous counters (UP and Down) Module N counter. Concepts of counters as frequency dividers. BCD counters. *Data Routing Elements :* Multiplexer, De-multiplexers, Decoders, Encoders, Tri-state, Buffer, Priority Encoder. Display and display Drivers.

**Books :**

1. Digital Electronics by Merlin And Leach
2. Digital Principle And Application Malvino and Leach
3. Digital Electronics by V.K.Jain
4. Digital System Principles And Applications by R.J. Tocci
5. Digital Computer Fundamentals by T.C. Bartee

**INST-2T2 METROLOGY:**

**Unit 1. Measuring Systems And Precision Instruments :** Measuring with rules. Mathematical Concepts. Limiting Mean, range, variance, standard deviation, normal distribution, confidence intervals, Principle of Sampling.

**Unit 2. Standards Of Measurements :** Standards of length end standards. Vernier calipers fixed Gauges inside depth and height gauges, Gauge block surface plate micrometers, Angular measurements. sine-bars angle gauges levels clinometers auto collimators taper gauges. Direct measuring tools and instruments. Optical projectors and microscopes. Horizontal vertical and cabinet profile Projectors. Tool makers and workshop microscopes. End standards end bars slip gauges.

**Unit 3. Comparison Measurements :** Compactors Pneumatic electric and electronic compactors. Limits Fits and Tolerances. Interchangeability types of fits geometric dimensioning tolerance.

Interferences. Surface Characteristics. Evaluation and symbology. Surface roughness measurements profilometers.

**Unit 4. Alignment Testing :** Machine tools alignment machine beds. Alignment of axis (Spindle axis and bed spindle axis and line of centers) axial slip calibrator of lead screw alignment of telescopes. Interferometers Ultrasonic Pulse Echo and Resonance Gauging optical alignment. Equipment and Methods.

**Unit 5. Surface Texture Measurements and Gauging :** Testing of screw threads. Pitch and angle error. External and Internal thread gauges. Testing of gears involute geometry runout pitch profile lead backlash tooth thickness, roundness measurements lobing of cylinders. Measurements of inspection and quality control. Automatic Dimensional Controls, manufacturing processes.

**Books :**

1. Engineering Metrology by R.K Jain

**INST-2P1 MECHANICAL INSTRUMENTATION LAB**

*Instrumentation :* Drawing, Conventional Representation of common elements of instruments. External and internal Threads, slotted head, square and flat, radial fins, splined shaft, chain wheel, (sprocket wheel) ratchet and pinion, bearing (ball and rollers), Knurling, helical springs, compression springs with square and circular sections, tension spring, torsion springs.

Gears : Spur/Helical Gears, screw gears, rack and pinion, bevel gear (assembly), worm and worm wheel. Geometric Drawing. Orthographic Projections, sections, pictorial drawings. Proportionate Sketch and Isometric views of following Instruments: Voltmeters, single phase energy meters, ammeters and wattmeters, pressure gauge and Tachometers. Draft and pressure measuring devices, flow meters, pyrometer, control valves and actuator. I.S.A for instrumentation flow plan. *Experiments in Metrology :* 8 experiments to familiarize the use of instruments and techniques for measurement double ended plug gauge, micrometer calibration, plain ring gauge, taper plug gauge, straight edge, plug gauge on a comparator, sine bar.

*Mechanical Measurements :* 6 experiments to familiarize the use of instruments and techniques for measurement of temperature, flow, pressure, torque, strain, vibration and noise.

**Semester – III**

**INST-3T1 OPTICAL INSTRUMENTATION**

**Unit 1. Optical components and their characteristics :** Plane Mirrors, Achromatic Prisms, Direct Vision Prisms, Right angle prisms, Roof Prisms, Erecting prism systems, cube corner prisms, beam splitter cubes, curved mirrors, lenses, ophthalmic lenses. *Optical Instruments ;* Compound Microscopes, Projection Microscope, Binoculars, Telescopes - Terrestrial and astronomic, profile projectors, theodolites. 5hrs.

**Unit 2. Laser Instrumentation :** Principle of laser construction of the laser, application in distance measurements, interferometry and Holography.

**Unit 3. Testing Optical Components :** Newtons Interferoscope, Fizeau Interferometer, Tyman Green Interferometer, Mach-Zehnder Interferometer. Multiple beam Interferometer, Fabry Perot Interferometer Polarization interferometer, shearing interferometer. Autocollimator's, Rochi grating test, Focault Knife edge test. Haitmann and other Screen tests. Distance Measuring Interferometers. Bull testing Comparators.

**Unit 4. Fiber Optics :** Principles of Optical Fibers. Materials for optical fibers, production for optical fibers, sources detectors , couplings Application of Fibre Optics- illuminator's, imaging bundle, endoscopy, communications , fiber optic sensors.

**Unit 5. Optical Materials and fabrication techniques :** Optical glassed and their characteristics, crystalline materials. Optical Machinery Grinding Polishing Drilling Trepanning Spherical Curve Generator, Optical Tools, abrasive and materials. Making Optical Instrumentation Flats, mirrors, parallel plates, mirrors ,lenses, prisms, polishing crystals.

**Books :**

1. Fundamentals of Optics by Jenkins and white, McGraw Hill
2. Optics and optical instruments by Johnson, Dover, N.Y
3. Optical Glass Working by Twyman Felger and Watts, London
4. Optical Shop Testing by Daniel Malacara, John Wiley and Sons N.Y.
5. Optics and Atomic Physics by Satyaprakash

### **INST-3T2 VACUUM MEASUREMENT TECHNIQUES**

**Unit 1. Introduction to Vacuums – Fundamentals**

Gas flow mechanisms, conductance calculations, concept of throughput and pumping speed. Rotary, roots and oil free pumps. Diffusion and Sorption pumps. Turbomolecular, cyro and ion pumps.

**Unit 2. Pressure Measurement :** by hydrostatics, thermal conductivity and ionization gauges. Gauge calibration using spinning rotor, diaphragm and mcleod gauges. vacuum components- traps baffles, valves seals and feed through's.

**Unit 3. Vacuum materials and fabrication techniques :** Leak detection techniques, Mass Spectrometer and Residual gas analysis.

**Unit 4. High vacuum system design :** Thin film deposition techniques ( Thermal evaporation and modification)

**Unit 5. Vacuum Applications :** Freeze Drying, Food Processing industry, lamp industry, vacuum metallurgy, vacuum impregnation.

**Books :**

1. Introduction to the theory and Practice of High Vacuum Technology by L.Ward and J.P. Bunn, Butterworths London
2. Vacuum Technology by A. Guthrie, John Wiley and Sons.
3. Vacuum Deposition of Thin Films, L. Holland, Chapman and Hall.
4. Modern Vacuum Practice, Nigel Harris, McGraw Hill

**INST-3P1 OPTICS AND VACCUUM LAB***Optics Experiments*

Image formation using lenses and lens combinations, Testing the angles of prisms using a mechanical level protector and auto collimator's, Testing the radius of curvature of spherical components and tools using a ring spherometer., Testing concave mirrors using a Renchi Grating, Testing a concave Mirrors using the Focault Knife edge test., Abbe Refractometer, Measurement of Refractive Index., Interference Fringes Young's Double Slit Experiment and Fresnel's Bi prism, Testing the Flatness of Plates Using Newtons Interfero-scope., Experiments with Michelson Interferometer, Experiments with a Laser Power Beam Diameter and Divergence, Familiarization of Holograms.

*Vacuum Experiment*

Service of the Rotary Pump, Conductance and speed of the Rotary Pump at the vessel, Working of Bourdan Guage barometers U Tube Manometers and MacLeod Guage, Secondary Guages like Pirani Penning and callibration of Guages, High vacuum Pumps and Measurement of High Vacuum, Study of Flanges feedthroughs valves, Design of High vacuum System a case study, Vacuum evaporation and preparation of mirror, Vacuum Degassing of material and selection of material for vacuum system, Leak detection techniques.

**Semester - IV****INST-4T1 SIGNAL CONDITIONING, OPERATIONAL AMPLIFIERS & APPLICATIONS**

**Unit 1. Signal Generation and Processing :** Sine wave Generation ( Using OP-Amp also ) and amplitude stability, linear frequency control and quadrature output. sawtooth wave (Linear) square wave (Schmitt trigger circuit ), triangular wave generators, pulse, step and stair case generators. The 555 timer.

**Unit 2. Signal Conditioner :** Instrumentation amplifier, programmable amplifier, (OTA based) characteristic, linearization, D.C Emphasis on Phase sensitive detectors and their importance in extracting signals "Lock In amplifier " burried under noise. Precision Rectifiers 723, 7105, 7965, peak detectors, sample and hold Circuits, (aperture time , acquisition time etc) comparators and qualitative importance of Logarithmic amplifiers, isolation amplifier, Optical Isolator,

Reference voltage and current reference.

**Unit 3. Operational Amplifiers :** Op-amp parameters, ideal op-amp, open loop op-amp configuration differential amplifier, inverting amplifier, non inverting amplifier, equivalent circuit of an op-amp., Op-amp linear application-dc amplifier, ac amplifier, summing amplifier, scaling amplifier, averaging amplifier, precision rectifier, instrumentation amplifier, integrator, differentiator.

**Unit 4.** Active filters-low pass high pass,band reject,all pass filter, Wave form generators-square wave,triangular,saw tooth, voltage controlled oscillator

**Unit 5.** Comparators : Basic Comparator types, characteristics,applications,zero crossing detector, Schmidt trigger,voltage limiters

**Books For Signal Conditioning :**

1. Instrumentation Devices and Systems by Ranger , Mani and Sharma.
2. Electronic Measurements and Instrumentation by Olive and Cage.
3. Electronic Instrumentation and measuring techniques by Cooper.
4. Principle of Active Network Synthesis and Design by G. Daryanari, John Wiley and Sons
5. Filter Theory and Design by Sedra and Bracket, Active and Matrix Publisher

**Books For Operational Amplifier :**

1. Op-amps and linear integrated circuits by E.A. Gayakwad, Prentice Hall India.
2. Operational Amplifiers and Applications by Subirkumar Sarkar, S. Chand & Co.
3. Operational Amplifiers and Linear Integrated Circuits by Robert F. Coughlin and Frederick F. Driscoll, Prentice Hall India, New Delhi
4. Digital Principles and Applications by Malvino and Leach 4th Ed. TMH
5. Digital Fundamentals by Thomas L Floyd, Merril Publishing Co, US

## INST-4T2 MICROPROCESSOR

**Unit 1. Microprocessor Architecture :** Memory organization: Type of memories ( RAM, EPROM, ROM, PROM, DRAM ), basic concepts of memory organization (Number of address line required arrangement of memory cells, control line memory extension), concepts of control lines such as Read/Write chip enable. Register to register transfer via data bus. Arithmetic and Logic Unit (ALU) , detail design of of a small 'ALU'. an ALU which performs four basic functions ( ADD , SUBTTY, OR, AND ), Need for decoder integration of ID with "ALU" to form an ALU with Control signals. Control and timing unit: Need for this ninth , concept of sequence of execution of and instruction, integration of all three (i,ii,iii) to form C.P.U.

*Introduction to 8085 Architecture :* Block Diagram, Address Bus, Control Bus, Data Bus, Need to multiplex address and data bus, Memory organization( with emphasis on demultiplexing address and data bus during memory read and memory write. Control and timing unit.. ALU details. Registers, Flags

**Unit 2. Instruction Set :** Introduction, classification of instruction set, opcode format some



basic instructions. (i) Data Transfer instructions, this must include (a) immediate addressing, Register addressing, Direct addressing, Indirect addressing, Arithmetic and Logic Instructions. ADD, Sub, AND ,OR, XOR, CMP.

*Control and Timing* : Sequence of execution of instruction. Concept of Instruction Cycle and Machine Cycle. Various types of machine cycle along with associated control and status signals (Op Code Fetch, memory Read ,Memory Write. I/O Read, I/O write, IO/M, SO, SI, MR, MW/Detail timing diagram of some instructions.

**Unit 3. Advanced Instructions** : Branching conditional and unconditional subroutines, concept of stack, need for stack pointer

**Unit 4. Interfacing** : Concept of Interrupts, classification of interrupts, various types of interrupts (5,5,6,5,7,5) TRAP, Hardware : Software Interrupts RST0, to RST7 instruction associated with interrupts (RIM, SIM, EI, D10 Typical examples illustrating usage.

**Unit 5. Interfacing with peripherals** : Concept of Input and Output ports of 8255, 8279, 8253 (General description, how to programme, usage). Interfacing of A/D and D/A Converters.

**Books :**

1. Microprocessor Architecture, Programme and Applications by Gaonkar.
2. Digital Computer Electronics by Albert Paul Malvino (TMH) 1st edition.
3. Microprocessors and Application by Mathur.

**INST- 4P1 MICROPROCESSOR AND COMPUTER LAB-II**

*Microprocessors*

Addition, Subtraction, Multiplication, Average, Delay generation, clock using delay, key board recognition routines, display of items,, interfacing of keyboard modules, interfacing of A/D and D/A converter, stepper motor control using microprocessor.

Computer

Exercise in DOS, Exercise in UNIX, C Programming in DOS, C Programming in UNIX, Assembly Language programming In DOS, Circuit Design and Simulation Using Electronic Work Bench, Microprocessor

**Semester - V**

**INST-5T1 TRANSDUCERS**

**Unit 1. Philosophy of Measurement and Error Analysis** : Units and Standards calibration Techniques Classification of errors – classification of errors- error analysis- Statistical Methods, MTBF, MTTR.

**Unit 2. Static and Dynamic Characteristics** : Accuracy, Repeatability, hysteresis, etc Characteristics of Transducers - Static Calibrations Mathematical Model of Transducers-0, 1st, 2<sup>nd</sup> order Transducers - Response to Ramp and Sinusoidal inputs.

**Unit 3. Variable Resistance Transducers** : Principle of operational details characteristic and applications of potentiometric - Hot wire anemometer - RTD - Thermistor -Humidity sensors.

**Unit4. Variable Inductance and Variable Capacitance Transducers** :Inductive Transducers - LVDT-E.I Pick Up - Capacitive Transducers of different types. Capacitor Microphone-Floating Cell.

**Unit 5. Other Transducers** : Piezo Electric Transducers - Hall Effect - Ionization Transducers -Magneto restrictive Fiber Optic Transducers- Eddy Currents-Semiconductor Transducers-Electro - Optic Transducers-IC Sensors - Shaft angle Encoder, Digital Transducer-Smart Transducers-Their salient features.

**Books For Transducers :**

1. Measurement System Application and Design by E.O. Doebelin, Mc Graw Hill Book Co, IV edition 1990.
2. Instrumentation Devices and Systems by C.S. Rangan, V.S.V. Mani and G.R. Sarma, Tata McGraw Hill.
3. Instrument Transducers by H.K.P. Neubert, Clarendon Press, Oxford.
4. Electrical and Electronic Measurements and Instrumentation by A.K. Sawhney, Dhanpat Rai and Sons.
5. Transducers and Instrumentation by D.V.S. Murthy, Prentice Hall of India Pvt. Ltd.

**INST-5T2 INSTRUMENTATION SYSTEM**

**Unit 1. Analytical Instrumentation** : Introduction to instrumentation System need for an Integral approach. *Analytical Instruments* : Working Principles Operation and data analysis of the following instruments Spectro-photometers atomic AAS electron Microscope.

**Unit 2. Nuclear Magnetic Resonance Spectrometer** : Principle of Operation Sample Preparation and data analysis. Stability of magnetic Fields and electronics. *Mass Spectrometer* : Application areas working principles of static and dynamic instruments analysis of data, *Mossbauer Spectrometers* : Principles of operation measurement of Radioactivity analysis of data.

**Unit 3. X-Ray** : Techniques and Their application to Radiography Fluorescence and Diffractometry, interpretation of data.

**Unit 4. Biomedical Instrumentation** : Introduction to Transducers and their Application Recording Electrodes, EEG, ECG and Other Potentials : Working Principles and precautions Blood Pressure Measurements : Introduction to Hemodynamics, Introduction to Ultrasound and Topographic Techniques : Interpretation of Data and Precautions for measurements Introduction

to Working Principles and operation of Pacemakers : Defibrillators Heart lung and Other ICU Instrumentation.

**Unit 5. Environmental Instrumentation :**

General Introduction To Physical Environment : Physical aspects like Pressure temperature humidity noise visibility air quality and water quality, Humid atmosphere Hygrometers and dew point instruments controlled humidity environment. Thermal Comfort meter Heat Stress Monitor and temperature Monitors, Hot wire anemometer lidar and velocity and effect on dispersion of pollutants. Cup anemometer, Sound level meters tape recorders noise dosimeters sound level monitors and acoustical calibrators, Solar Flux Pyranometers pyrhemometers, Water Quantity by Turbidity Meter calorimeter pH meter microscopes atomic absorption spectroscopy. Air Quality measurement using gas chromatography High pressure Liquid Chromatography gas Chromatography mass spectrometry conductivity meter, Particulate meter in air soiling index and visibility, Congenial environment for work, artificial lightings, acoustic consideration and air conditioning.

**Books For Instrumentation System :**

1. Air Pollution Physical and Chemical fundamentals by J.H.Seinfeld McGraw-Hill NY.
2. Meteorological Instruments by W.E Knowles Middleton and A.F Spilhans, University Toronto Press.
3. Instrumental Methods of Analysis 6th Ed. By H. Willard, L.L. Merrit, J.A. Dean and F.A. Settle.
4. Environmental Instrumentation by L.J. Frichtschen, and L.W. Gay.

**INST-5P1 TRANSDUCERS LAB**

Practicals in Op-Amp., Inverting, Non -inverting, Buffer, Offset Balance, Sine Wave and Square wave Generators (Amplitude Stability), Filters: Low Pass, High Pass, Band Pass, All Pass Filters, Transducers : (Exp, Set Up), Strain Guage, LVDT, Load Cell, Thermistor or Diode as Temp.Sensor, Hall Effect Transducer.

**Semester - VI**

**INST-6T1 INDUSTRIAL INSTRUMENTATION**

**Unit 1. General Techniques :** Measurement of industrial parameters : Discussion of load cells, torque meter and various velocity pick-ups, Exposure to various accelerometer pick-ups, Vibrometers, density and viscosity pick-ups, Pressure Transducers, Temperature standards, calibration and signal conditioning used in RTD's, Thermocouples and Pyrometry techniques, *Miscellaneous Measurements* : Time Frequency, phase angle, vibration instruments, noise measurements, liquid level, humidity, chemical composition.

*Measurement of force, torque and velocity* : Electric balance – Different types of load cells – Magnets – Elastic load cells - Strain gauge load cell – Different methods of torque measurement – Strain gauge, relative regular twist – Speed measurement – Revolution counter – Capacitive tacho-drag cup type tacho – D.C and A.C tacho generators – Stroboscope.

**Unit 2. Measurement of acceleration, vibration, density, viscosity and Liquid Level :** Accelerometers – LVDT, piezoelectric, strain gauge and variable reluctance type accelerometers – Mechanical type vibration instruments – Seismic instrument as an accelerometer and vibrometer – Calibration of vibration pick-ups – Units of density, specific gravity and viscosity used in industries – Baume scale, API scale – Pressure head type densitometer – Float type densitometer – Ultrasonic densitometer – Bridge type gas densitometer – Viscosity terms – Saybolt viscometer – Rotameter type, liquid level measurements.

**Unit 3. Pressure Measurements :** Units of pressure - Manometers – Different types – Elastic type pressure gauges – Bourdon type bellows – Diaphragms – Electrical methods – Elastic elements with LVDT and strain gauges – Capacitive type pressure gauge – Piezo resistive pressure sensor – Resonator pressure sensor – Measurement of vacuum – McLeod gauge – Thermal conductivity gauges – Ionization gauge, cold cathode and hot cathode types – Testing and calibration of pressure gauges – Dead weight tester.

**Unit 4. Temperature Measurements :** Definitions and standards – Primary and secondary fixed points – Calibration of thermometer, different types of filled in system thermometer – Sources of errors in filled in systems and their compensation – Bimetallic thermometers – Electrical methods of temperature measurement – Signal conditioning of industrial RTDs and their characteristics – Three lead and four lead RTDs. Radiation method of temperature measurement, Total radiation and Selective radiation Pyrometer, Optical Pyrometer, Thermocouples, Laws of Thermocouple, Fabrication of industrial thermo-couples , Signal conditioning of thermocouples output.

**Unit 5. Flow Measurements :** Bernoulli Theorem, Pitot-static tube, Venturi-meter, Orifice Meter and Nozel Meter, Ultrasonic Flow Meter, Hot-wire Anemometer, Electromagnetic Flow Meter and Laser Doppler Anemometer.

**Books :**

1. Measurement Systems – Application and Design by E.O. Doebelin, Tata McGraw Hill Publishing Company
2. Mechanical and Industrial Measurements by R.K. Jain, Khanna Publishers, New Delhi
3. Principles of Industrial Instrumentation by D. Patranabis, Tata McGraw Hill Pub. Co.
4. A Course on Mechanical Measurements - Instrumentation and Control by A.K. Sawhney and P. Sawhney, Dhanpath Rai and Co.
5. Instrumentation Measurement & Analysis by B.C. Nakra & K.K. Chaudary, Tata McGraw Hill Co. Publishing Ltd.
6. Industrial Instrumentation and Control by S.K. Singh, Tata McGraw Hill, 2003
7. Industrial Instrumentation by D.P. Eckman, Wiley Eastern Ltd.,

**INST-6T2 ENTREPRENEURSHIP**

**Unit 1. Entrepreneur :** Type of Entrepreneurs, Qualities of a successful Entrepreneur, Functions of an entrepreneur, Entrepreneurship, barriers to entrepreneurship, environmental factors influencing entrepreneurship, Entrepreneurial motivation, industry and its classification.

**Unit 2. Project Management :** Meaning of a project , Project Identification Project Report, Network Planning techniques, Basic concept in network analysis, construction of network diagram. CPM 4 PERT , concept of project appraisal. Project appraisal methods. cash flow as cost and benefits play back period, Average rate of return. Discounted cash flow techniques. concept of factory design. type of factory buildings factory layout objectives and types.

**Unit 3.** Method of estimating cost, performa balance sheet and profit and loss account, project appraisal in public enterprise, public investment decision making in India. Privatization sources of finance cost of capital, project finance term loans, lease finance sources of short term finance financial institutions institutions assisting entrepreneurs.

**Unit 4.** Concept of marketing channel, selecting channel members, alternative channels of distribution Mercantile agents Merchant middle men Wholesalers Retailers Phases of Entrepreneurial development program, concepts of training programme for ED, Special agencies and schemes.

**Unit 5.** Steps to be taken for small industries, preparation of project report guidelines. Sole proprietorship partnership, joint stock company, factors effecting the choice of organization. meaning of incentives and subsidies. Needs and Problems Schemes of incentives in operation, Machinery on hire purchase Transport subsidy. Taxation benefits to SSL. Exports and Imports.

**Books :**

1. Developing Entrepreneurship- A Hand Book by T. Venkateswara Rao, Eureka Marketing Group
2. Entrepreneurship and Entrepreneurship Development and Planning in India by D.N. Mishra, Chugh Publications
3. Development Bank and New Entrepreneurship in India by P.N. Mishra, National Publishing House
4. Entrepreneurship in Small Scale Industries by M.C. Gupta, Anmol Publications
5. How to Start Your Own Small Scale Industry by G.D. Sharma, Vision Books

**INST-6P1 PROJECT**

The project work is to be undertaken in consultation with the concerned teachers.