COURSE CONTENTS FOR M.TECH (INSTRUMENTATION)

SEMESTER – I

Signal Processing-I, Ins 61.01

Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours : 45

Unit-I (11 hours)

Classification of discrete time signal and systems, Mathematical operations on discrete time signals. Sampling and aliasing, Linear, Circular & Sectioned convolution, Inverse system and Deconvolution, Correlation, Cross correlation and Auto correlation.

Unit-II(12 hours)


Unit-III(11 hours)


Unit-IV(11 hours)


Books suggested :

Essential Books:

Reference Books:

**Analog and digital electronics Ins 61.02**

**Time : 3 Hours**
**Max. Marks: 75(Exam)+25(Internal)**
**Hours : 45**

**Unit-I (11 hours)**
Amplifiers for instrumentation applications, their design and characterization, analog multiplexers.

**Unit-II (11 hours)**
Analog filter design, power supplies; [Regulated power supply, stabilization, voltage regulator & op-amp based regulated power supply, an overview of SMPS and UPS], oscillators and waveform generators.

**Unit-III (12 hours)**
Combinational circuit design, sequential circuit design, digital filters, multiplexers.

**Unit-IV (11 hours)**
A/D and D/A converters, memories, computer circuits, an overview of Micro-processors and Micro-controller.

**Books suggested:**

**Essential Books:**

**Reference Books:**
3. Digital Logic Application and Design by John M. Yarbrough, CL Engineering, 2006

Transducers-I,Ins 61.03:  
Time : 3 Hours  
Max. Marks: 75(Exam)+25(Internal)  
Hours : 45

Unit-I(11 hours)
Transducer classification and its characteristics.  
Displacement Transducer : Resistive, capacitive and inductive.  
Thickness Transducer : Capacitive, Inductive.  
Pressure Transducer : Resistive, Capacitive.  
Moisture transducer: Inductive, capacitive and load cell.

Unit-II(12 hours)
Thermoelectric Transducer : RTD, PRT and its calibration,  
Thermistor, Thermocouple transducers, Integrated circuit temperature and Pyroelectric transducers.  
Photoelectric Transducer : Photoconductive, Photovoltaic and Photo emissive based transducers.

Unit-III(12 hours)
Galvanomagnetic Transducer : Hall effect Transducer, Magneto resistance Magnetostri ction & Magnetoelastic based transducers.  
Piezoelectric Transducer : Force, Torque, Pressure and Acceleration transducer.

Unit-IV(10 hours)
Electromagnetic Acoustic Transducer (EMAT).  

Books suggested:

Essentials Books:

Reference Books:

**Foundations Of Measurement - Ins 61.04**

*Time: 3 Hours*

*Max. Marks: 100 (Exam) + 50 (Internal)*

*Hours: 45*

**Unit-I (07 hours)**

Theory of Measurement, Introduction to probability and random variables.

**Unit-II (10 hours)**

Random processes and their characterization.

**Unit-III (08 hours)**


**Unit-IV (15 hours)**


**Books Suggested:**

**Essential Books:**

Unit-I (11 hours)

Unit-II (11 hours)

Unit-III (12 hours)
Fibre optics: optical fibre principle and structure, Critical angle, Numerical aperture, classification of fibres and materials used, losses, applications, Fibre optic sensors
Detection of light: Thermal detectors, photon detectors, optical materials used for different detectors, Characteristics

Unit-IV (11 hours)
Representative devices based on electro-optics and acoustooptics, principles of photometry and instrumental aspects, design concepts of UV-Visible and IR spectrometer.

Books Suggested:

Essential Books:

Reference Books:
Design of mechanical elements INS 61.06:  Time : 3 Hours
Max. Marks: 100(Exam)+50(Internal)
Hours : 45

Unit-I(10 hours)


Unit-II(11 hours)

Linkages: Four-Bar Linkages and Typical Industrial Applications, design of Four-Bar Linkages for Angular Motion, Design of Slider-Crank Mechanisms, Design of Crank and Rocker Mechanism.

Gears and Gearing: Gear Classification and Terminology, Simple Gear Trains, Compound Gear Trains, Planetary Gears, Design of Spur and Bevel Gears.

Unit-III(09 hours)

Shafts and Couplings: Shaft Materials, Design Considerations, Critical Speeds of Rotating Shafts, Design of Shafts subjected to Static Loads, Classification of Couplings, Design Considerations in Rigid and Flexible Couplings.

Unit-IV(15 hours)


Essential Books:

Process dynamics and control INS 61.07: Time : 3 Hours
Max. Marks: 100 (Exam) + 50 (Internal)
Hours : 45

Unit-I (08 hours)


Unit-II (14 hours)


Unit-III (11 hours)

Controller characteristics: Characteristics of on-off, proportional, integral, derivative modes and their combinations.


Unit-IV (12 hours)

Controllers: Electronics, pneumatic, hydraulic controllers implementing. Single and composite mode of controllers. Latest trends in industrial controllers employing PLCs & other logic devices such as DCS & Computer based systems etc.

Final control elements: Types & function of Control valves. Electrical, Pneumatic, hydraulic actuators.

Books recommended:

Essential Books:


Reference Books:
2. Industrial Instrumentation; D.P. Eckman; CBS, Publisher 2015
5. Programmable logic controllers; John W. Webb, Ronald A. Reis; Prentice Hall, Principles and Applications

**Ins 61.52 SIGNAL PROCESSING (Practical)**

L T P - - 2

Max. Marks: 30(Exam)+20(Internal)

Practicals based on the contents given above in theory.

**INS 61.51 Analog And Digital Electronics (Practical)**

L T P - - 2

Max. Marks: 30(Exam)+20(Internal)

Practicals based on the contents given above in theory.

**INS 61.53 TRANSDUCER (Practical)**

L T P - - 2

Max. Marks: 30(Exam)+20(Internal)

Practicals based on the contents given above in theory.

**INS 61.54 PHOTONICS (Practical)**

L T P - - 2

Max. Marks: 30(Exam)+20(Internal)

Practicals based on following topics spectral attenuation of optical fibre, Numerical aperture of optical fibres, Audio, video and data transmission through optical fibres, thin film deposition.
SEMESTER-II

MICROPROCESSORS IN INSTRUMENTATION  INS 62.01:

Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours : 45

Unit-I(11 hours)

Numbering and coding system. Overview of microprocessor family. Introduction to 8051 Assembly programming. 8051 addressing modes, 8051 Hardware. Date types and time delay in 8051, I/O programming Logic operations and Data conversion programs in 8051C.

Unit-II(12 hours)

8051 Timer and counter programming in C. 8051-Serial port programming in C/ 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communications, interrupts LCD and keyboard interfacing.

Unit-III(12 hours)

ADC, DAC and sensor interfacing, Semiconductor memory. Memory addresses decoding. 8051 interface with external memory, Accessing external data memory in 8051/8951 interfacing and programming with 8255.

Unit-IV(10 hours)

DS12887 RTC interfacing and programming. Stepper motor and DC motor using C. An overview of Arduino programming and its applications.

Books recommended:

Essential Books:

4. Beginning Arduino Programming (Technology in Action); Brian Evans;
AUTOMATIC CONTROL SYSTEM INS 62.02: Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours : 45

Unit-I (10 hours)
An overview of Laplace Transform, Mathematical Modeling of physical systems, Linear systems, Equations and transfer functions of control system.

Unit-II (12 hours)
Time domain analysis of control systems, stability of linear control systems, Root locus technique.

Unit-III (12 hours)
Frequency response of control systems. Sample-data control systems.

Unit-IV (11 hours)
State-space methods, Nonlinear control systems, Computers in control.

Books suggested:

Essential Books:

Reference Books:


ANALYTICAL INSTRUMENTATION INS 62.03. Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours : 45

Unit-I (11 hours)
Basics of Physical methods of chemical analysis, spectral methods of analysis, basic techniques, terminology, units. Interaction of e.m. radiations with matter, emission, absorption & scattering techniques. Analytical data presentation.
Unit-II (12 hours)

Instrumentation of X-Ray, UV-Visible and infrared techniques. Various light sources, spectrometers, detectors, data processing comparison of various spectral analytical techniques.

Unit-III (11 hours)


Unit-IV (11 hours)


BOOKS SUGGESTED:

Essential Books:

Reference Books:

ROBOTICS INS 62.04:

Time : 3 Hours
Max. Marks: 100(Exam)+50(Internal)
Hours : 45

Unit-I (08 hours)

Introduction: Robot technology and terms related to robot. Robot physical configurations, Joints and Links, Industrial Applications of Robotic Manipulators

Unit-II (08 hours)

Unit-III(09 hours)

Sensors: Purpose of sensors, internal and external sensors, common sensors – Accelerometers, gyros, encoders, tachometers, strain gauge based force-torque sensors. Tactile, Proximity and Range sensors in robots – Infrared, Sonar, Laser; Velocity sensors.

Unit-IV(15 hours)


Essential BOOKS:


MEDICAL INSTRUMENTS INS 62.05:

Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours : 45

Unit-I(10 hours)

Introduction to biomedical engineering, Biometrics, Man-Instrumentation System, Physiological Systems of Body, Constrains in measuring a living system.

Sensor and transducers for biological applications-specify Types, properties and selection of transducers for biological instrumentation applications. Electrical safety from medical equipment, shock hazards from electrical equipment, Methods of prevention from accident.

Unit-II(08 hours)

Sources of Bioelectric signals. Anatomy and physiology of the organs resulting in generation of bioelectric signals. Measurement of bioelectric signals such as ECG, EEG, EMG, EOG, ERG.

Instrumentation for measurement of Physiological signals such as blood pressure, temperature, oxygen saturation, blood flow, patient monitoring system and telemetry etc.
Unit-III (12 hours)

Modern Imaging Systems such as X-Ray machines, X-Ray Computer Tomography, Magnetic Resonance Imaging, Ultrasound Imaging, Nuclear Medical Imaging: Emission Computed Tomography ECT, Single Photon Emission Computed Tomography SPECT, Positron Emission Tomography PET.

Unit-IV (08 hours)

Working Principle and Instrumentation of Therapeutic equipments like Pacemakers, Defibrillators, Physiotherapy Equipments, Haemodialysis, Ventilators and Lasers in Biomedical Field.

BOOKS SUGGESTED:

**Essential Books:**

2. Biomedical Instrumentation & Measurements; Leslie Cromwel, Fred J. Weibell, Erich A. Pfeiffer; 2nd Edn; Pearson Education; 2015.

**Reference Books:**


**Signal Processing-II, INS 62.06**

Time : 3 Hours

Max. Marks: 75 (Exam) + 25 (Internal)

Hours : 45

Unit-I (12)

Model of a Neurons—Non-Linear models and Stochastic model. Neural network architecture—Single layer feed forward network, multiplayer feed forward architectures. Recurrent network, knowledge representation.

Unit-II (11)

Unit-III(12)
Fuzzy control basics, Fuzzy system design, Fuzzyfications, Inference Mechanism Defuzification methods, Tuning of Fuzzy control system.

Unit-IV(10)
Coherent and incoherent optical processing – optical correlators, time integrating and space integrating correlator, incoherent matrix vector multiplier, Holographic memories.

BOOKS SUGGESTED:

Essential Books:
1. ‘Neural Networks and Fuzzy systems’ Bart Kosko, Prentice Hall of India, 2001

Reference Books:
1. ‘Neural Networks’ a comprehensive Foundation Simon Haykin 2nd Ed. Pearson Education Asia (LPE) 2013.
3. ‘Fuzzy sets and Fuzzy logic; Theory and application George J.Klir/Bo Yuan, Prentice Hall of India (EEE) 2001

Transducers-II, INS 62.07:

Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours: 45

Unit-I(11 hours)
Electrochemical transducer, Electrochemical cell, Electrode potential, Nernst theory of solution pressure, Reference electrode, Indicator electrode., calomel electrode, Ag/AgCl electrode, Classification of membrane indicator electrode. Glass Electrode, Liquid membrane electrode, Measurement of pH

Unit-II(11 hours)

Chemical Sensors:
Thermal Sensors, Lambda sensor, Hydrogen sensor (PEMFC)
Unit-III(11 hours)

**Biosensors:**
Introduction, Immobilisation of the Biosensing using Physical Methods and Chemical Methods, Amperometric Biosensors; Mediated Amperometric Biosensors, Potentiometric Biosensors; Ion Selective Electrodes (ISEs), Enzyme electrode, Photometric Biosensors, Biomimetic Sensors, Glucose Sensors

Unit-IV(12 hours)

**Sensor Materials and Technologies:**
Materials; semiconductor as a Sensing Material,
Surface Processing: Deposition of Thin and Thick Films, Spin-Coating, Vacuum Deposition, Sputtering, Chemical Vapor Deposition, e-beam evaporation.

**Essential Books:**

**Additional reference:**
INS 62.51 MICROPROCESSOR IN INSTRUMENTATION (Practical)  

- 2  
Max. Marks: 30(Exam)+20(Internal)  

Practical based on the contents given above in Theory.

INS 62.52 AUTOMATIC CONTROL SYSTEM (Practical)  

- 2  
Max. Marks: 30(Exam)+20(Internal)  

Practical based on the contents given above in Theory.

INS 62.53 ANALYTICAL INSTRUMENTATION (Practicals)  

- 2  
Max. Marks: 30(Exam)+20(Internal)  

Practical based on the topics given above in Theory.

INS 62.54 : MEDICAL INSTRUMENTS (Practical)  

- 2  
Max. Marks: 30(Exam)+20(Internal)  

Practical related to the theory topics given above.

INS 62.55 : SIGNAL PROCESSING - II (Practical)  

- 2  
Max. Marks: 30(Exam)+20(Internal)  

Practical related to the theory topics given above.

INS 62.56 Transducers - II (Practical)  

- 2  
Max. Marks: 30(Exam)+20(Internal)  

Practical related to the theory topics given above.
SEMESTER - III

COMPUTER AIDED DESIGN & COMPUTER AIDED MANUFACTURING

INS 71.01: Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours : 45

Unit-I(07 hours)
Hardware requirements for CAD designing such as computer, input/output devices - data gloves, mice, joystick, force ball, Biological input sensors, voice recognition systems etc. CRTs, storage CRTs, digital storage devices etc. Data representation, operating system. Eye coordination system. Introduction to CAD/CAM, Product design cycle, Automation and CAD/CAM.

Unit-II(09 hours)
Computer aided design system software, operating system, graphics system. The overlay system, graphics data base structure and handling, operating features, symbols, Macros, editing facility, data selection, graphics transformation and plotting. Transformation system, windowing and clipping, two and three dimensional transformation, Linear transformations, display files for three dimensional data, visuals of three dimensional data.

Unit-III(12 hours)
Geometric modelling dimensions of models, types of models, construction of solid models. Draughting for mechanical systems, annotation, arrows and pointers, dimensioning, text, cross-hatching, draughting examples.

Unit-IV(17 hours)
CAD for electronic circuits, fundamentals, design tables, general circuit analysis programme, circuit simulation, PC layout examples using SMARTWORK/similar software. Digital system checkout, levels of tests, field testing, production testing. Detailed flow, Input unit, output unit, memory unit, instruction register, computer cycle, programme counter and index register. Test methods, maintenance panel, computer testing and computer trouble shooting.

Essential Books:

1. CAD/CAM Computer Aided Design & Manufacturing
INSTRUMENTATION FOR SPECIAL APPLICATIONS (INS 71.02)

Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours : 45

Design concept, signal sensing, resultant output, analytical standards, calibration and applications of:

Unit-I (12 hours)

i) Miniaturised analytical systems

Unit-II (11 hours)

ii) Total analysis systems : hyphenated Techniques

Unit-III (12 hours)

iii) Biosensing and chemical detectors biological elements and immobilisation of biological component.

Unit-IV (10 hours)

A perspective for the State-of-the-art instrumentation, one instrument each, for the following areas:

Environmental Sciences
Life Sciences
Analytical Sciences

Essential Books:


Reference Books:


SELECTED TOPICS : INS 71.03:

Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours : 45

Unit-I

Shape Memory Alloys (NiTiNOL), Applications of shape memory Alloys: Properties of Shape Memory Alloys. SMA Hybrid composites.
Unit-II
Electrorheological and Magnetorheological fluids mechanism and properties and applications. Smart structures – Actuators piezoceramic based, electrostrictive (Lead – Magnesium – Niobate) PMN based actuators, Electroceramic composite actuators, polyvinylidene Fluoride (PVDF) actuators, Magnetostrictive actuators (Terfenol-D)

Unit-III
Molecular Electronics Devices –, Organic rectifiers, Molecular switching in Neuromal Membrane

Unit-IV
Integrated, smart and intelligent sensors, principles of intelligent sensor, applications of intelligent sensors.

Essential Books:


Virtual Instrumentation 71.04:
Time : 3 Hours
Max. Marks: 75(Exam)+25(Internal)
Hours : 45

Unit-I (06 hours)
Introduction to Virtual Instrumentation, Historical Perspective, Advantages, Basic Representations, Conventional vs. Virtual instrumentation, System Hardware requirements for the Virtual Instrumentation set-up: Input devices like data gloves, mice, joystick etc. Output devices like various graphical displays & CRTs etc. Data acquisition cards and terminal blocks like SCXI-1120, 1121,1125,1530,1540 SCXI-1327, 1520, 1315.

Unit-II(12 hours)
Introduction to LabVIEW, Front Panel, and Block diagram Pallets, Knowledge of various controls and indicators of front panel. Block diagrams-Vis & Express Vis, Nodes, Terminals, and Wires. Creating and using VIs, Sub-VIs, Editing and debugging tools.

Unit-III(15 hours)
Details of LabVIEW Programming techniques- Structures, Arrays, Clusters, Charts and Graphs, Signal Processing examples.
Unit-IV (12 hours)
Components of Data acquisition, DAQ Hardware configuration using DAQ assistant for Input & output mode. Applications of VIs in various fields like Industrial applications, defense, Medical.

BOOKS SUGGESTED:

Essential Books:
1. Learning with LabVIEW 7 Express; Robert H. Bishop; Pearson Education; 2005

Reference Books:
4. www.ni.com
5. www.natinst.com

INS 71.51 COMPUTER AIDED DESIGN AND COMPUTER AIDED MANUFACTURING (Practical)

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Max. Marks: 30(Exam)+20(Internal)

Practicals related to the topics given in above Theory.

INS 71.52: INSTRUMENTATION FOR SPECIAL APPLICATIONS (Practical)

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Max. Marks: 30(Exam)+20(Internal)

Practical based on the topics given above in Theory.

INS 71.53 SELECTED TOPICS (Practical)

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Max. Marks: 30(Exam)+20(Internal)

Practicals based on the contents given above in Theory.

INS 71.54 Virtual Instrumentation (Practical):

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Max. Marks: 30(Exam)+20(Internal)

The practical based on the above mentioned theory.
Each student will be required to work on the major project approved by the department faculty. The project work will span over IIIrd and IVth semesters during which periodic progress reports will be monitored. At the end of the IIIrd semester, the project progress will be evaluated by the departmental faculty. At the end of IV semester, the student will submit the thesis based on his project research work conducted in the Department on the approved topic under the supervision of a faculty member of the Department. Students would be required to present one seminar on the thesis topic. These would be presented before the Department faculty and students of the Department. The evaluation will be done by a Board consisting of Supervisor, Chairman or his nominee and a member of Faculty to be nominated by Board of Studies out of a panel of three Examiners suggested by the supervisor.
Each student will be required to work on the major project approved by department faculty that will span III and IV semesters during which periodic progress reports will be monitored. At the end of III semester, project progress will be evaluated by the departmental faculty.

At the end of IV semester, the student will submit the thesis based on his project work.

The student will conclude his project work and submit the thesis as detailed under INS 71.55 (Major Project).

No Numerical marks will be assigned to thesis work. It will be either accepted or rejected. However, the quality of the work reported in the thesis can be graded in terms of marks/grades. The criteria for evaluation of thesis to award marks/grades for thesis will be as under:

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<th>Grade</th>
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<td>1.</td>
<td>A'</td>
<td>Publication from Thesis in SCI indexed journal.</td>
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<td>3.</td>
<td>B'</td>
<td>Publication from Thesis in proceedings of Conferences which is Scopus indexed.</td>
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