# M Tech (Instrumentation and Control)
## Specialization: Biomedical Instrumentation

### Semester I

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course Code</th>
<th>Course Name</th>
<th>Teaching Scheme</th>
<th>Credits</th>
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### Semester II

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<th>Sr. No.</th>
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OR

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Semester-IV

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Transducers Design

**Teaching Scheme**
Lectures: 3 hrs/week

**Examination Scheme**
Mid-sem. Exam – 30 marks
End sem. Exam – 50 marks
Quizzes & Assignments – 20 Marks

Review of transducers for various parameters like temperature, pressure, flow, level, humidity, acceleration, vibration, density etc. Design considerations and selection criterion as per standards, Sensor fabrication techniques, process details, and latest trends in sensor fabrication, fiber optics sensors, electromechanical sensors, Solid state chemical sensors, Biosensors, Piezo-resistive sensors, characterization of sensors, effect of sensors on process identification, signal conditioning techniques.

**Reference Books**


**Instrument Design Engineering**

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<tbody>
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<td>Lectures: 3 hrs/week</td>
<td>Mid-sem. Exam – 30 marks</td>
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<tr>
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<td>End sem. Exam – 50 marks</td>
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<tr>
<td></td>
<td>Quizzes &amp; Assignments – 20 Marks</td>
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</table>

Electromagnetic Compatibility: Noise, Interference, Noise Coupling, cabling, grounding, ground loops, balancing and filtering
Shielding: Near field, far field, absorption losses, and reflection losses
Contact Protections: Arc discharge, Glow discharge, intrinsic noise sources, active device noise, digital circuit grounding
EMC Applications: Digital circuit power distribution, Digital circuit radiations, Conducted emissions, RF and transient immunity, electrostatic discharge, PCB layout and design, EMC measurements.
Automated Test equipment

**Reference Books**


**Modern Control Theory**

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<tbody>
<tr>
<td>Lectures: 3 hrs/week</td>
<td>Mid-sem Exam – 30 marks</td>
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<tr>
<td></td>
<td>End sem. Exam – 50 marks</td>
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<td>Quizzes &amp; Assignments – 20 Marks</td>
</tr>
</tbody>
</table>

State space analysis, eigen values and eigen vectors, feedback control system using state space, Controller and observer design, Design using Ackermann formula, Frequency domain controller, Introduction to discrete time control, Controller design in discrete domain

**Reference Books**

**Human Anatomy and Physiology**

**Teaching Scheme**
Lectures: 3 hrs/week

**Examination Scheme**
Mid-sem. Exam – 30 marks
End sem. Exam – 50 marks
Quizzes & Assignments – 20 Marks

Introduction to cell, Blood: Characteristics of blood, physiology of blood clotting.
Heart (Circulatory System)- Anatomy of heart and blood vessels, origin and conduction of heart beat, cardiac cycle, electrocardiogram, blood pressure, control of cardiac cycle.
Respiratory System- Anatomy of respiratory system, physiology of respiration in the alveolar and tissue capillaries, control of respiration.
Digestive system: Anatomy of digestive system, nerve and blood supply, physiology of digestion.
Kidney and Urinary system - Anatomy of urinary system and kidney, physiology of water and electrolyte balance, acid-base regulation.
Muscle Tissues - Anatomy, types of muscles, physiology of muscle contraction, generation of action potential, rhythmicity of cardiac muscle contraction, properties of skeletal and Cardiac muscles.
Nervous system - Neuron, anatomy and function of different parts of brain, spinal cord, autonomic nervous system, special sense organs for taste, smell, sight and hearing, Biological control and feed-back mechanism

**Reference Books**

3. C. C. Chatterjee, “Human Physiology”, Vol- I & II.

**Physiological Modeling**

**Teaching Scheme**
Lectures: 3 hrs/week

**Examination Scheme**
Mid-sem. Exam – 30 marks
End sem. Exam – 50 marks  
Quizzes & Assignments – 20 Marks

Approaches to modeling - The technique of mathematical modeling, classification of models, characteristics of models. Purpose of physiological modeling and signal, analysis, linearization of nonlinear models, Time invariant and time varying systems for physiological modeling
Equivalent circuit model - Electromotive, resistive and capacitive properties of cell membrane, change in membrane potential with distance, voltage clamp experiment and Hodgkin and Huxley’s model of action potential, the voltage dependent membrane constant and simulation of the model, model for strength-duration curve, model of the whole neuron. Huxley model of isotonic muscle contraction, modeling of EMG, motor unit firing: amplitude measurement, motor unit & frequency analysis.

Reference Books


Seminar

The students are required to search / gather the material / information on a specific a topic comprehend it and present / discuss in the class.

PG Laboratory I

The students are expected to do the following:

i. To get familiarize about the facilities available in the laboratory.

ii. To design, implement and verify the results of various experiments as per the suggestions of laboratory instructor.

iii. To devise, suggest and implement innovative experiments in the laboratory.
iv. To collaborate with other labs for implementing small projects.

v. To suggest and provide solutions for upgrading the laboratory facilities.

**Embedded Systems**

**Teaching Scheme**

- Lectures: 3 hrs/week

**Examination Scheme**

- Mid-sem. Exam – 30 marks
- End sem. Exam – 50 marks
- Quizzes & Assignments – 20 Marks

Introduction to Reconfigurable Computing, FPGA Architectures
FPGA Design Cycle, Technology-independent optimization, Technology Mapping, Placement and Routing, FPGA Vs ASIC design, Algorithm Prototyping and benchmarking, area, speed and power analysis for FPGA design, Floating Point Design (Implementing math functions), Reconfigurable Computing Applications – Bioinformatics, Process Automation, Image processing, Computational Fluid Dynamics, Power Electronics;
FPGAs vs. Multicore architectures
Advanced FPGA Design, Dynamic Reconfiguration, Partial Reconfiguration;

**Text Books**


**Reference Books**


**Advanced Control System**

**Teaching Scheme**

- Lectures : 3 hrs/week

**Examination Scheme**

- Mid-sem. Exam – 30 marks
- End sem. Exam – 50 marks
- Quizzes & Assignments – 20 Marks


**Reference Books**


**Robotics**

**Teaching Scheme**

Lectures : 3 hrs/week

**Examination Scheme**

Mid-sem. Exam – 30 marks
End sem. Exam – 50 marks
Quizzes & Assignments – 20 Marks

Introduction:- Basic Concepts such as Definition , three laws, DOF…..etc. , Robotics and automation, Robot anatomy, Classification, structure of robots, point to point and continuous path robotic systems. Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc..

Robot Grippers:- Types of Grippers , Design aspect for gripper, Force analysis for various basic gripper system

Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot

Drives:- Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems

Control Systems :- Types of Controllers, Introduction to closed loop control, second order linear systems and their control, control law partitioning, trajectory-following control, modelling and control of a single joint, Present industrial robot control systems and introduction to force control

Kinematics :- Transformation matrices and their arithmetic, link and joint description, Denavit - Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods

Velocities and Static forces in manipulators: Motion of the manipulator links, Jacobians, singularities, static forces, Jacobian in force domain
Dynamics :- Introduction to Dynamics, Trajectory generations, Manipulator Mechanism Design
Robot Programming : Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages : Introduction to various types such as RAIL and VAL II ... etc, Features of each type and development of languages for recent robot systems
Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI

Text Books


Reference Books


Fiber Optics and LASER Technology

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<td>End sem. Exam – 50 marks</td>
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<td>Quizzes &amp; Assignments – 20 Marks</td>
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</table>

Optical fiber: Light, waveguide, total internal reflection, NA, acceptance, critical angle
Optical fiber characteristics: attenuation, dispersion, refractive index profile, bending losses, polarization, optical amplifiers
Optical fiber sensors: different parameters such as light intensity, phase, etc to measure temperature, level, pressure, vibration
Optical sources: LED and LASERS, principle of LASERs, types of LASERs
LASERs application in biomedical: Endoscope, ophthalmic surgery, other surgical applications
LASER Applications: Holography, measurement of stain, stress, vibration, LASER gyroscope

Reference Books

Soft Computing

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Knowledge based methods
Expert systems (ES)
Fuzzy expert system (FES)
Analytical Hierarchical methods (AHP)
Data mining methods: Neural Networks (NN), Genetic Algorithms (GA), Support Vector machine (SVM)

Reference Books
1. S N Shivanandam, “Introduction to Neural Networks Using MATLAB 6.0”, TMH
2. Timothy Ross, “Fuzzy logic with application to engineering systems”, McGraw Hill

Biomedical Signal Processing

<table>
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Acquisition
Generation of Bio-signals,
Origin of bio-signals, Types of bio-signals, Study of diagnostically significant bio-signal parameters
Electrodes for bio-physiological sensing and conditioning, Electrode-electrolyte interface, polarization, The electrode skin interface and motion artefact, biomaterial used for electrode, Types of electrodes (body surface, internal, array of electrodes, microelectrodes), Practical aspects of using electrodes
Acquisition of bio-signals (signal conditioning) and Signal conversion (ADC’s DAC’s)
Processing
Digital filtering, Biomedical signal processing by Fourier analysis,Biomedical signal processing by wavelet (time-frequency) analysis
Analysis (Computation of signal parameters that are diagnostically significant),
Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and non-stationary signals, Principle component analysis, Correlation and regression, Analysis of chaotic signals
Application areas of Bio –Signals analysis
EEG- frequency component analysis, ECG- QRS detection, R amplitude, interval detection, Phonocardiogram- heart valve disorders etc, EMG- operant hand

Reference Books

Advanced Medical Instrumentation
Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Mid-sem. Exam – 30 marks
End sem. Exam – 50 marks
Quizzes & Assignments – 20 Marks

Computer based medical instrumentation - Computerised versions of ECG, EEG, EMG, Tread Mill Test ECG– Foetal monitor, cardiac arrhythmias and its monitoring through Holter monitor, Event monitors, Bispectral Index EEG for depth of anesthesia monitoring
Operation theatre equipment and Critical Care instrumentation - Patient monitors, pulse oximetry, ICU ventilators, suction apparatus, anesthesia equipment, electro surgery, operating microscopes, motorized operation table, infusion pumps and syringe pumps, nerve stimulator, defibrillators, Electrical Safety and other safety aspects of medical equipment.
Specialized Therapeutic and diagnostic equipment - Cardiac pacemakers, heart lung machines, Haemodialysis - design, clinical laboratory instrumentation, Audiometer, Phonocardiogram, Emerging trends in medical diagnostics and therapy
Clinical laboratory instrumentation - Blood cell counter and associated hematology system, blood gas analyzers
Instrumentation in Dental Chair & Hand piece control, Biomaterials, Medical expert system
Standards and practices for medical instruments / devices / equipment

Text Books

Reference Books
4. Rangaray M. Rangayyan, “Biomedical Signal Analysis – A Case Study Approach”, John Wiley and Sons Inc

Medical Imaging Techniques

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Mid-sem. Exam – 30 marks
End sem. Exam – 50 marks
Quizzes & Assignments – 20 Marks
The nature of Biomedical Images, Image quality and information content, Removal of artifacts, Image enhancement, Detection of region of interest, Analysis of shapes, Analysis of texture, Analysis of oriented patterns, Image reconstruction from projections, Deconvolution, Deblurring, and Restoration, Image coding and data compression, Pattern classification and diagnostic decision,
Basics physics of imaging systems, Theory and applications of optical, thermography, ultrasonic, radiography and computer tomography, single photon emission computer tomography, positron emission tomography, nuclear and magnetic resonant imaging.

**Text Books**

1. Rangaraj M. Rangayyan, “Biomedical Image Analysis” CRC Press, 2005

**Reference Books**


**Ultrasonic Application In Bioengineering**

**Teaching Scheme**
Lectures: 3 hrs/week

**Examination Scheme**
Mid sem. Exam – 30 marks
End sem. Exam – 50 marks
Quizzes & Assignments – 20 Marks

Piezoelectric ceramics: properties and applications, piezoelectric constants, depolarization : electrical, mechanical, thermal, Time of flight diffraction technique (transit time) measurement, testing of piezo crystal, bonding techniques
Transducers : dynamic behavior, power transducers, driver circuits, pulse generator circuit, piezo generator, piezo sensors, modeling techniques for piezoelectric transducer , Magnetostrictive Material: characteristics, dynamic behavior, modeling techniques, Data-acquisition techniques
Sonography and quantitative measurements such as tissue characterization and typing. Bioeffects and safety for ultrasound, therapeutic applications of high-intensity focused ultrasound
Reference Books

Clinical Engineering
Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Mid-sem. Exam – 30 marks
End sem. Exam – 50 marks
Quizzes & Assignments – 20 Marks


Text Books

Reference Books

PG Laboratory II
The students are expected to do the following:

i. To get familiarize about the facilities available in the laboratory.
ii. To design, implement and verify the results of various experiments as per the suggestions of laboratory instructor.
iii. To devise, suggest and implement innovative experiments in the laboratory.
iv. To collaborate with other labs for implementing small projects.
v. To suggest and provide solutions for upgrading the laboratory facilities.

**Dissertation Stage I**

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study.

The dissertation should have the following

i. Relevance to social needs of society  
ii. Relevance to value addition to existing facilities in the institute  
iii. Relevance to industry need / requirement  
iv. Problems of national importance  
v. Research and development in various domain

The student should complete the following:  
i. Literature survey  
ii. Problem Definition  
iii. Motivation for study and Objectives  
iv. Preliminary design / feasibility / modular approaches  
v. Implementation and Verification  
vi. Report and presentation

**Dissertation Stage II**

The dissertation stage II is based on a report prepared by the students on dissertation allotted to them.  
It may be based on:  
i. Entirely on study and analysis of typical Instrumentation and Control system, Biomedical Instrumentation / devices / instruments / related topic  
ii. Experimental verification / Proof of concept  
iii. Design, fabrication, testing, and calibration of an instrumentation system.  
iv. The viva-voce examination will be based on the above report and work.