College of Engineering, Pune
(An Autonomous Institute of Govt. of Maharashtra, Permanently Affiliated to S.P. Pune University)

Department of Instrumentation and Control Engineering

Curriculum Structure & Detailed Syllabus (PG Program)

M. Tech (Biomedical Instrumentation)
(Revision: A.Y. 2019-2023, Effective from: A.Y. 2019-20)

Department Vision:

To lead the field of Instrumentation and Control towards **inclusive excellence** through integration of **teaching and learning**, advancement of the knowledge base by **research, innovations, scholarships** and **services to the society.**

Department Mission:

- **Set-up** a mechanism for creating high quality undergraduate and post graduate programs in Instrumentation and Control Engineering.
- **Adapt** systems and methods for meaningful collaboration with stakeholders.
- **Take-up** socially relevant and nationally important issues and problems as project assignments.
- **Inculcate** creativity, entrepreneurial attitude and values amongst Learners.

Program Education Objectives (PEOs):

Program Educational Objectives for M Tech (Biomedical Instrumentation) are as follows:

- **PEO1:** Practice the knowledge of Instrumentation and Control Engineering and allied /related fields

- **PEO2:** Demonstrate technical, communication skills and team spirit along with leadership qualities to pursue career in broad areas of Instrumentation and Control Engineering, Biomedical Instrumentation

- **PEO3:** Engage in life-long learning through independent study and research

- **PEO4:** Undertake responsibilities for societal, environmental and ethical causes

Program Outcomes (POs):

On successful completion of the Program, engineering graduates will able to:

PO1: **Engineering Knowledge of subject**: An ability to independently carry out research /investigation and development work to solve practical problems in the area of Medical Instrumentation.

PO2:Technical Writing: Ability to write and present a substantial technical report/document

PO3: **Problem Analysis**: Students should be able to demonstrate a degree of mastery over the area of Biomedical Instrumentation

PO4:Engineering and Society: Learn and use a variety of medical sensors, data acquisition systems, physiological models and telemedicine to readily provide innovative solutions to the day-to-day problems related to medical field.

PO5: Leadership: To function efficiently in various capacities as members, leaders, and decision makers in multi-disciplinary teams to accomplish projects of different magnitudes.

PO6: **Life-long learning**: Would have recognized the need for engaging themselves in independent and life-long learning in the broadest context of technological change.

Correlation between the PEOs and the POs

PO→ PEO↓	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	✓		✓	✓		
PEO2		✓		✓	✓	
PEO3	✓					✓
PEO4		✓		✓		

List of Abbreviations

Sr. No.	Abbreviation	Stands for:
1	PSMC	Program Specific Mathematics Course
2	PSBC	Program Specific Bridge Course
3	DEC	Department Elective Course
4	MLC	Mandatory Learning Course
5	PCC	Program Core Course
6	LC	Laboratory Course
7	IOC	Interdisciplinary Open Course
8	LLC	Liberal Learning Course
9	SLC	Self Learning Course
10	SBC	Skill Based Course

Title	No of courses	Credits	% of Credits
Program Core Course (PCC)	6	18	26.4%
Department Elective Course (DEC)	3	09	13.2%
Open Electives (OE)	1	03	4.4%
Major Project: Skill Base Course (SBC)	1	18	26.4%
Any other (MOOC) Self Learning Course (SLC)	2	06	8.8%
Laboratory Course (LC)	6	06	8.8%
Program specific Mathematics course (PSMC)	1	04	5.9%
Program Specific Bridge Course (PSBC)	1	03	4.4%
Liberal Learning Course (LLC)	1	01	1.7%
Total	**21**	**68**	**100%**

CURRICULUM STRUCTURE OF M. TECH. BIOMEDICAL INSTRUMENTATION
(Effective from A. Y. 2020-2021)

Semester I

Sr. No.	Course Type/ Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	PSMC/IBI-19001	Statistics	3	1	0	4
2.	PSBC/IBI-19002	Anatomy & Physiology for Engineers	3	0	0	3
3.	DEC IBI(DE)-19001 IBI(DE)-19002 IBI(DE)-19003 IBI(DE)-19004	**Department Elective –I** 1. Embedded Systems- I 2. Industrial Internet of Things 3. Modern Control Theory 4. Automotive Embedded Product Development	3	0	0	3
4.	MLC/ML-19011	Research Methodology and Intellectual Property Rights (Audit)	2	0	0	0
5.	MLC/ML-19012	Effective Technical Communication	1	0	0	0
6.	PCC/IBI-19003	Medical Sensors and Biomaterials	3	0	2	4
7.	PCC/IBI-19004	Instrument Design Engineering	3	0	2	4
8.	PCC/IBI-19005	Physiological Modeling	3	0	2	4
	Total		**21**	**1**	**6**	**22**
	Total Academic Engagement and Credits		**28**			**22**

Semester II

Sr. No.	Course Type/ Code	Course Name	Teaching Scheme			Credits
			L	**T**	**P**	
1.	IOC/ ICE-19001	Interdisciplinary Open Course	3	0	0	3
2.	DEC	**Department Elective –II**	3	0	0	3
	IBI(DE)-19005	1. Ultrasonic Applications in				
	IBI(DE)-19006	Bioengineering				
	IBI(DE)-19007	2. Hospital Management				
	IBI(DE)-19008	3. Biomechanics				
		4. Clinical Engineering				
	IBI(DE)-190010	5. Automotive Electronics Hardware Development				
3.	DEC	**Department Elective –III**	3	0	0	3
	IBI(DE)-19011	1. Embedded Systems-II				
	IBI(DE)-19012	2. Soft Computing				
	IBI(DE)-19013	3. Optical Instrumentation				
	IBI(DE)-19014	4. Artificial Intelligence and Machine Learning				
	IBI(DE)-19015	5. Automotive Electronics Software Development				
4.	LLC/ LLC-19001	Liberal Learning Course	1	0	0	1
5.	PCC/ IBI-19006	Advanced Medical Instrumentation	3	0	2	4
6.	PCC/ IBI-19007	Biomedical Signal Processing	3	0	2	4
7.	PCC/ IBI-19008	Medical Imaging	3	0	2	4
	Total		**19**	**0**	**6**	**22**
	Total Academic Engagement and Credits		**25**			**22**

Interdisciplinary Open Course: **Smart Sensors** offered to other departments.

Semester-III

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	SBC/IBI-20001	Dissertation Phase – I	0	0	18	9
2.	SLC/IBI(OC)-2001	Massive Open Online Course -I	3	0	0	3
	Total		**3**	**0**	**18**	**12**
	Total Academic Engagement and Credits		**21**			**12**

Semester-IV

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	SBC/IBI-20002	Dissertation Phase – I	0	0	18	9
2.	SLC/IBI(OC)-2002	Massive Open Online Course -I	3	0	0	3
	Total		**3**	**0**	**18**	**12**
	Total Academic Engagement and Credits		**21**			**12**

IBI-19001 Statistics

Teaching Scheme:
Lectures: 3 hours/week

Examination Scheme:
Test 1: 20 Marks
Test 2: 20 Marks
End-Sem Exam: 60 Marks:

Course Outcomes
1. Understand the basic concepts of statistics for engineering. [PEO1][PO1]
2. Appreciate the use and importance of statistics in Engineering. [PEO1] [PO4]
3. Apply the techniques learnt in the course for problem solving and analysis. [PEO1] [PO3]
4. Apply knowledge of statistics to solve engineering problems. [PEO4] [PO4]

Course Contents

Probability and Probability Distributions: Brief history of Probability and Statistics, Wrong idea of Probability and statistics, Notion of Probability, Random Variables, Conditional Probability and Independence, , Rules of Probability, Joint Distributions, Mathematical Expectation, Bayes' Theorem with engineering application, Naïve Bays classifier

Discrete Distribution: Bernoulli, Binomial, Geometric, Poisson, Multinomial Distributions etc.,

Continuous Distributions: Uniform, Exponential, Gamma, Normal, Weibull, Beta, Distribution of function of Random variables.

Statistics, Descriptive Statistics: Plotting Data, Population and Sample, Uncertainty measures

Measure of Central Tendency (mean, mode median), Measure of Location (percentile, range, sample standard deviation, variance) , Measure of Dispersion and Variability   (Spread). Measure of association (co variation, covariance, correlation coefficient), Pearson rank order correlation, Accuracy, Box =Whisker Plot, Outliers, Dickson test.

Distributions arising from Normal or Gaussian distribution: Chi Square Distribution, t distribution and F Distribution, Distributions of Sampling Statistics: The Sample Mean, Central Limit Theorem

Parameter Estimation: Maximum Likelihood Estimator, Hypothesis testing, t test, Chi-square tests, Goodness of fit test, non-parametric tests, Wilcoxon rank sum and sign rank tests, Rank correlation coefficient.ANOVA: One Way and Two-Way ANOVA

An Overview: Quality Control and Life Testing, Control charts for Average values-case of known and unknown mean and standard deviation, Hazard rate, Exponential distribution in life testing, reliability estimation

Reference Books:

- RonaldE,Walpole,SharonL.Myers,KeyingYe,ProbabilityandStatisticsforEngineersand Scientists (8th Edition), Pearson Prentice Hall,2007.
- Douglas C. Montgomery, Design and Analysis of Experiments (7th Edition), Wiley Student Edition, 2009.
- S. P. Gupta, Statistical Methods, S. Chand & Sons, 37th revised edition,2008.
- William W. Hines, Douglas C. Montgomery, David M. Goldsman, Probability and Statistics for Engineering, (4th Edition), Willey Student edition,2006.

[IBI-19002] Anatomy and Physiology for Engineers

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Able to describe human body structure[PEO1] [PO3]
2. Understand working of different physiological systems of human body[PEO1] [PO3]
3. Ability to explain the functioning of the human body system[PEO1] [PO3]
4. Understand biological control and feedback mechanism[PEO1] [PO3]
5. Able to apply knowledge of human anatomy and physiology to solve different biomedical research problems[PEO3] [PO1]

Course Contents
Introduction to cell, Blood: Characteristics of blood, physiology of blood clotting, biochemical cycle Heart (Circulatory System)- Anatomy of heart and blood vessels, origin and conduction of heartbeat, 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,

Sensory system - Visual, auditory, Vestibular

Endocrine system- pituitary, thyroid, parathyroid, adrenal, pancreas

Biological control and feed-back mechanism, clinical and technological implications

Reference Books:
- Anne Waugh and Allison Grant, Ross and Wilson Anatomy and Physiology in Health and Illness, Elsevier Health Sciences, 11th edition, 2010.
- Guyton & Hall, "Textbook of Medical Physiology", 12th edition, Elsevier publication.
- Wilson and Wangh, "Anatomy and Physiology", 11th edition, Elsevier publication.
- C. C. Chatterjee, "Human Physiology", Vol- I & II.
- A. V. James & D. L. Sherman, "Human Physiology", 9th edition, McGraw Hill publication.

[IBI(DE)-19001] Embedded Systems-I

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. To understand the scientific principles and concepts behind small scale embedded systems. [PEO1][PO1]
2. To have a direct hands-on experience on both hardware and software elements commonly used in small scale embedded system design. [PEO2][PO4]
3. To have knowledge of hardware/software co-design.[PEO2][PO3]
4. Understanding the applications and role of microcontrollers for embedded systems design.[PEO3][PO6]

Course Contents

Embedded Systems: Definition, classification, examples and broad overview. Embedded system design criterions, architectural design aspects, embedded programming and tools for building embedded systems, memory types- organization and interfacing.

Small scale embedded system design: Architecture of small scale microcontroller (PIC18F4550), I/O programming, Interrupt driven programming, digital and analog sensor interfacing, actuator interfacing, Programming with: Timers, Counters, PWM, Enhanced PWM, CCP Module, On chip communication protocols: UART and USART (I2C, SPI).

Case studies and applications: DC Motor control, Control of conveyer belt, etc.

Reference Books:

- Mazidi, PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC 18 series, Pearson, January 2008 edition.
- John B. Peatman-- Design with PIC Microcontrollers, Pearson, 2009 Edition.
- Raj Kamal, ―Embedded Systems – Architecture: Programming and Design, Tata McGraw-Hill Education, 3rded.,2003.
- Frank Vahid, Tony Givargis-- "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002.

[IBI(DE)-19002]   Industrial Internet of Things

Teaching Scheme: **Examination Scheme:**
Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcome
1. Understand, design and develop the real life IoT applications using off the shelf hardware and software. [PEO4][PO4]
2. Knowledge of Key components in the field of IIoT, Architectures and its pros and cons [PEO1][PO1]
3. Interpret the various IoT Layers and their relative importance in Business Models [PEO3][PO6]
4. Use various IoT platforms and security for solving social and industrial problems [PEO4][PO4]

Course Contents
Introduction to IIoT&IIoT Architectures, Overview of Components of IIoT – Sensors, Networks, Characteristic of IIoT System, Architectures for IIoT, Types of Architectures, Components of IIoT – Field Devices (Sensors /Actuators) & Field Networks - Sensors, Applicability of Sensors in different Industries, Design of sensors, Special requirements for IIoT sensors, Sensor architecture, Actuators basics, Types of Actuators, Introduction to wired and wireless technologies, Topologies of Networks, Overview of Protocols such as ZIGBEE, ZWAVE, MBUS, etc. Different IIoT networks & connectivity, Modes of communications, Overview of various IIoT protocols like - COAP, 6LoWPAN, LWM2M, MQTT, AMPQ etc., Comparison of Industrial devices vs. Prototype devices (Arduino, Mega, Pi, Galileo), Software Architecture of Edge/FOG devices
IOT Platform Architecture, Overview & Understanding of COTS cloud platforms like Predix, Watson, Thingworks, Azure etc. , Basic understanding of various business models like SaaS, PaaS & IaaS and pros & cons
IoT Privacy, Security & Governance - Security Basics - Risk, Threat & Vulnerability, Risk Assessment, IIoT Security Framework based on IIC , Basic understanding of various IIoT security standards like NIST 82, IEC 62443, NERC, NIC etc., Hardware based Security, Overview of Data analytics, Cloud services, IIoT Use cases& Recent Trends in IOT - Data Analytics Basics, various techniques – Machine Learning , Deep learning, AI, Overview of IOT Cloud Services, classification and machine learning algorithms extract useful information from aggregated data, Recent Trends in IIOTs

Reference Books:
- Industrial Internet Vocabulary - IIC
- The Industrial Internet of Things Volume G1: Reference Architecture – IIC
- Industrial Internet of Things Volume G4: Security Framework – IIC
- The Industrial Internet of Things, Volume B01: Business Strategy and Innovation Framework – IIC
- Industrial Analytics: The Engine Driving the IIoT Revolution
- Karen Rose, Scott Eldridge, Lyman Chapin, "The Internet of Things: An Overview Understanding the Issues and Challenges of a More Connected World" Internet Society
- Bahga – Madisetti, "Internet of things Book – A hands on Approach"
- Olivier Hersent, "The Internet of Things: Key Applications and Protocols", 2nd Edition

- Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", 1st ed. Edition
- Industrial Automation and Control System Security Principles: Protecting the Critical
- Ronald L. Krutz, PhD, PE, "Infrastructure", Second Edition

[IBI(DE)-19003] Modern Control Theory

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. An ability to design a continuous state feedback controller and observer in state space. [PEO1],[PO4]
2. An ability to design discrete state feedback controller and observer for the continuous system. [PEO1],[PO4]
3. To carry out analysis of multivariable systems using the concept of controllability, observability and stability. [PEO1],[PO3]
4. Ability to design compensators in continuous and discrete domain [PEO1],[[PO3]

Course Contents

State variable representation of linear and nonlinear systems, comparison with transfer function representation, standard forms of representation.

Time and frequency domain specifications, Pole placement by state feedback, controllability and observability, design of observers, separation principle. Controller design using transfer function approach. Introduction to discrete time control, z transforms, difference equations, analysis of discrete time systems, controller design in discrete domain

Reference Books:

- H. Nijmeijer and AVD Schaft, "Nonlinear Dynamical Control Systems", Springer Verlag, New York, 1990.
- JJE Slotine and W. Li, "Applied Nonlinear Control", Prentice Hall, New Jersey, 1991.
- B. Friedland, "Advanced Control System Design", Prentice Hall, New Jersey, 1996.
- HK Khalil, "Nonlinear Systems", Prentice Hall, New Jersey, 2002.

[IBI(DE)-19004] Automotive Embedded Product Development

Teaching Scheme: **Examination Scheme:**
Lectures: 3 hrs/week   T1, T2 – 30 marks each, End-Sem Exam - 40

Course Outcome
1. Acquire knowledge of automotive embedded product development and illustrate their operation. [PEO1],[PO4]
2. Design and assemble automotive embedded products in appropriate project planning and scheduling. [PEO1],[PO3]
3. Apply processes, methods and tools to demonstrate learning. [PEO4],[PO4]
4. Develop, evaluate, and distribute stand-alone automotive applications. [PEO1],[PO3]

Course Contents
Automotive system overview & product development: Major Automotive trends (e-mobility, Autonomous Driving, Comfort & Connected Cars), Vehicle EE architecture, Products. Integration of Mechanical, Software, Hardware domains and their interdependences, Design for Abilities(manufacturability, testability, serviceability, maintainability), Overview of Design guidelines.

Process, methods & tools: Requirement Engineering and version control tools: DOORs, PTC, V model, Product Engineering Process, Automotive Spice, TS 16949, Key Performance Indicators for development.

Product reliability, safety & quality:DFMEA, PFMEA, Warranty, Design Validations, Process Validations, Customer Line Return, Non-Quality Expenses, First Pass Yield, Statistical tools, ASIL levels, Safety Goals, Safety Measures, HARA, FMEDA, ISO 26262.

Project Management & Organization: Matrix Organization, Line responsibilities, Functional responsibility, Teamwork, Leadership, Scope management, Scheduling, Cost, Monitoring & Tracking, Engineering Change Management, Milestones.

[ML-19011] Research Methodology and Intellectual Property Rights

Teaching Scheme:
Lectures: 2hrs/week

Examination Scheme:
Continuous evaluation
Assignments/Presentation/Quiz/Test

Course Outcomes
1. Define research problem formulation and approaches of investigation of solutions for research problems [PEO1],[PO4]
2. Learn and use ethical practices to be followed in research and apply research methodology in case studies and acquire skills required for presentation of research outcomes [PEO2],[PO2]
3. Analyze IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario [PEO2],[PO5]
4. Summarize that it is an incentive for further research work and investment in R & D, leading to creation of new and better products and generation of economic and social benefits [PEO3],[PO6]

Course Contents
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

Effective literature studies approaches, analysis, Use Design of Experiments /Taguchi Method to plan a set of experiments or simulations or build prototype, Analyze your results and draw conclusions or Build Prototype, Test and Redesign, Plagiarism, Research ethics, Effective technical writing, how to write report, Paper.

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights

Understanding the types of Intellectual Property Rights: -Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act, Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non-Provisional Patent Application and Specification, Plant Patenting, Idea Patenting, Integrated Circuits, Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies

New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Patenting under PCT

Reference Books:
- Aswani Kumar Bansal : Law of Trademarks in India
- B L Wadehra : Law Relating to Patents, Trademarks, Copyright,Designs and Geographical Indications.
- G.V.G Krishnamurthy : The Law of Trademarks, Copyright, Patents andDesign.
- SatyawratPonkse: The Management of Intellectual Property.

- S K Roy Chaudhary & H K Saharay: The Law of Trademarks, Copyright, Patents
- Intellectual Property Rights under WTO by T. Ramappa, S. Chand.
- Manual of Patent Office Practice and Procedure
- WIPO: WIPO Guide to Using Patent Information
- Resisting Intellectual Property by Halbert,Taylor & Francis
- Industrial Design by Mayall, Mc Graw Hill
- Product Design by Niebel, Mc Graw Hill
- Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemle

[ML-19012] MLC-Effective Technical Communication

Teaching Scheme: **Evaluation Scheme:**

Lectures: 1hr / week   100M: 4 Assignments (25M each)

Course Outcomes
Student will be able to
1. Produce effective dialogue for business related situations [PEO2],[PO5]
2. Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively [PEO2],[PO2]
3. Analyze critically different concepts / principles of communication skills [PEO3],[PO6]
4. Appreciate, analyze, evaluate business reports and research papers [PEO2],[PO2]

Course Contents
Fundamentals of Communication: 7 Cs of communication, common errors in English, enriching vocabulary, styles and registers

Aural-Oral Communication: The art of listening, stress and intonation, group discussion, oral presentation skills

Reading and Writing: Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers

Reference Books:

- Raman Sharma, "Technical Communication", Oxford University Press.
- Raymond Murphy "Essential English Grammar" (Elementary & Intermediate) Cambridge University Press.
- Mark Hancock "English Pronunciation in Use" Cambridge University Press.
- Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh edition), Prentise Hall
- Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Non-native speakers of English", McGraw Hill.

[IBI-19003] Medical Sensors and Bio-Materials

Teaching Scheme:
Lectures: 3 hrs/week
Course Project:2 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Appreciate the role of transducers for medical applications[PEO1] [PO3]
2. Classify the biomaterials and recognize their production and properties [PEO1] [PO3]
3. Recognize the importance of relationships between living tissues and biomaterials[PEO1] [PO3]
4. Understand application areas of biomaterials [PEO1] [PO1]

Course Contents
Basic transduction principles, Transducers for biomedical applications: Force and pressure transducers: such as piezoelectric, strain gauge, Displacement transducers, Bio potential Electrodes, list different bio potential signals generated in human body, Transducers for cardiovascular measurement, Transducers for heart sound measurement, Transducers for Noninvasive diagnostic measurements, Introduction to biomaterials engineering and processing, Properties of materials, Application of materials in medicine, biology, and artificial organs

Reference Books:
- Biomedical Instrumentation and Measurements Cromwell Leslie, Fred J. Weibell and Erich A. Pfeiffer PHI Learning, New Delhi, 2010
- Medical Instrumentation Application and Design Webster John G., Editor WILEY India
- Addington, M., Schodek, Daniel L.: Smart materials and new technologies, Architectural Press, 2005.
- Brain Culshaw – Smart Structure and Materials Artech House – Borton. London-1996..
- Srinivasan A.V., Michael McFarland D., Smart Structure analysis and design, Cambridge University Press

[IBI-19004]Instrument Design Engineering

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course Project:2 hrs/week

Course Outcomes
1. Analyze and justify the requirement of Instrument and systems. [PEO1],[PO1]
2. Design various electronic circuits and measurement systems, noises identification and appropriate elimination methods related to instrument and system. [PEO1],[PO3]
3. Select, design appropriate enclosure, cables, PCB. [PEO1],[PO3]
4. Estimate, analyze, improve the reliability of instrument and system. [PEO1],[PO4]

Course Contents
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, and 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. Standards, reliability, automated test equipment.

Reference Books:
- Henry W Ott, "Electromagnetic Compatibility Engineering", John Wiley and Sons Inc. Publication, 2009
- W. C. Bossshart , "PCB Design and Technology" Tata McGraw Hill, 1987.
- Clyde F. Coombs, "Electronic Instrument Handbook", McGraw Hill, Third Edition, 2005.

[IBI-19005] Physiological Modeling

Teaching Scheme: **Examination Scheme:**
Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60
Course Project: 2 hrs/week

Course Outcomes
1. Acquire knowledge of Physiological System with ability to evaluate, analyze and synthesize knowledge related to Physiological System and Biomedical Instrumentation perspectives. [PEO1] [PO1]
2. Analyze complex problems related to Biomedical Instrumentation / devices / Systems and synthesize the information for conducting research. [PEO1] [PO3]
3. Extract knowledge related to complex biomedical systems through literature survey, experimentation and appropriate research methodology, techniques and contemporary tools. [PEO1][PO1]
4. Apply knowledge of Physiological modeling to solve biomedical instrumentation problems [PEO3] [PO1]

Course Contents
Physiological modelling: Introduction of physiological modelling, importance of physiological modelling, Classification of models, characteristics of model, model simulation, model validation, Time invariant and time varying systems for physiological modelling

Electrical models: Models of neuron - 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, model for strength-duration curve, model of the whole neuron.

Mechanical models: Modelling neuromuscular system - modelling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex, reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome. Huxley model of isotonic muscle contraction; Eye movement model - Four eye movements, quantitative eye movement models, validity criteria.

Physiological Process Models: Thermoregulatory model - Thermoregulatory mechanisms, model of thermoregulatory system, controller model, validation and application; Modelling of Immune response - Linearized model of the immune response: Germ, Plasma cell, Antibody, system equation and stability criteria.

Other models - Models of drug delivery, Modelling of insulin glucose feedback system

Reference Books:
- A.TeriBahil, Bioengineering, Biomedical, Medical and Clinical Engineering, Prentice-Hall, standard edition, 1981
- H. Nijmeijer and AVD Schaft, "Nonlinear Dynamical Control Systems", Springer Verlag, New York, 1990.
- Endarle, Blanchard &Bronzino, "Introduction to Biomedical Engg.", Academic press, 2001.

Semester II
[ICE (IOC)-19001] Smart Sensors

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Understand the concept of smart sensor. [PEO1],[PO1]
2. Select and analyze the behavior of smart sensor for a given application. [PEO1],[PO3]
3. Simulate, synthesize, and layout a complete sensor or sensor system. [PEO3],[PO4]
4. Design smart sensor and auto-calibration system for measurement of physical parameters. [PEO1],[PO3]

Course Contents

Introduction to smart sensors and emerging trends, measurement techniques, static & dynamic characteristics, Review of Fundamentals of sensors, Review of transducers for various parameters like temperature, pressure, flow, level, humidity, acceleration, Sensors fabrication, Design considerations and selection criterion as per standards, Sensor fabrication techniques, Theory and classifications of chemical sensors, fiber optic sensors, gas sensors, Data Acquisition techniques and Interface electronics, concept of intelligent instrumentation, case studies

Reference Books:
- Sensors and Transducers, D. Patranabis, Second Edition Prentice Hall of India Pvt. Ltd. New Delhi, 2006
- Fiber optics Communication and other applications, Henry Zanger, Cynthia Zanger, Macmillan publishing company, New York, 1991
- Transducers and Instrumentation, D.V.S.Murty, Second edition, PHI publication, Second edition, 2010.
- Handbook of modern sensors: physics, designs, and applications, Jacob Fraden, Third edition.
- Sensors Handbook, SabrieSoloman, McGraw-Hill, 1999
- Smart Sensors, Chapman, P., ISA Publications,1995

[IBI(DE)-19005] Ultrasonic Applications in Bioengineering

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Familiarize with piezoelectric material characteristics. [PEO1] [PO1]
2. To develop piezoelectric sensor systems [PEO1] [PO4]
3. Summarize the current literature, research in bioengineering in ultrasonic field[PEO1] [PO1]
4. Analyze complex problems related to Ultrasonic instrumentation for conducting research. [PEO1] [PO3]

Course Contents
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, 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:
- Luyben W. L., "Process Modeling Simulation and Control for Chemical Engineers", 2nd Ed., McGraw Hill, 1990
- Edger, Himmelblau, Lasdon, Optimization of Chemical Processes, McGraw-Hill International, Edition.
- S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International P)Ltd., New Delhi, 2000
- John G. Webster, "Encyclopedia of Medical Devices and Instrumentation", Vol. IV, 1988, Wiley Interscience Publication.
- Azhari H, "Basics of Biomedical ultrasound for Engineers", Edition 1, 2010, Wiley IEEE Press Publication.
- Francis A Duck, Andrew Charles Baker, "Ultrasound in Medicine", Edition 1, 1998 Institute of Physics Publication.
- Chrisopher Rownald Hill, J. Bamber, "Medical Ultrasonic", 2004, John Wiley & Sons.

[IBI(DE)-19006] Hospital Management

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course outcomes
1. Explain the principles of Hospital administration. [PEO1] [PO1]
2. Identify the importance of Human resource management [PEO2] [PO5]
3. List various marketing research techniques. [PEO1] [PO1]
4. Identify Information management systems and its uses. [PEO1] [PO4]
5. Understand safety procedures followed in hospitals. [PEO4] [PO4]

Course Contents
Overview of Hospital Administration: Challenges in Hospital Administration – Hospital Planning- Equipment Planning – Functional Planning - Current Issues in Hospital Management – Telemedicine - Bio-Medical Waste Management

Hospital Information Systems & Supportive Services : Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy– Food Services - Laundry Services.

Human Resource Management in Hospital: Different Departments of Hospital, Marketing Research Process: Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research, WTO and its implications.

Quality and Safety Aspects In Hospital: Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – Environment Management Systems. NABA, JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules– Hazard and Safety in a hospital Setup.

Reference Books:
- R.C.Goyal, Hospital Administration and Human Resource Management‖, PHI –4th Edition, 2006
- G.D.Kunders, Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007
- Cesar A.Caceres and Albert Zara, —The Practice of Clinical Engineering, Academic Press, New York, 1977.
- Norman Metzger, —Handbook of Health Care Human Resources Management, 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.
- Peter Berman —Health Sector Reform in Developing Countries - Harvard University Press, 1995.
- William A. Reinke —Health Planning for Effective Management - Oxford University Press.1988
- Blane, David, Brunner, —Health and Social Organization: Towards a Health Policy for the 21st Century, Eric Calrendon Press 2002.
- Arnold D. Kalcizony& Stephen M. Shortell, —Health Care Management, 6th Edition Cengage Learning, 2011

[IBI(DE)-19007] Biomechanics

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Understand design principles of prosthetics [PEO1] [PO1]
2. Understand design principles of orthotics[PEO1] [PO1]
3. Apply principles of mechanics for solving real life problems associated with human locomotion. [PEO1] [PO3]
4. Analyze complex problems related to Ultrasonic instrumentation for conducting research. [PEO1] [PO3]

Course Contents
Introduction to biomechanics, Overview of joints and movements, anatomical levers,Material Characterization of Tissues, Mechanics of Skeletal Muscles,gait, gait parameters

Prosthetics and Orthotics, Principles of three-point pressure,Lower limb prostheses, partial weight bearing-PTB socket, total contact- quadrilateralsocket, Upper limb prosthesis, Spinal orthoses.

Cardiovascular Mechanics: Cardiovascular Physiology, Blood Flow Models, Blood Vessel Mechanics, Heart Valve Dynamics, Prosthetic Valve Dynamics.

Reference Books:
- Y. C. Fung, Biomechanics,Springer 1993, 2nd ed, New York, NY
- Donald R. Peterson and Joseph D. Bronzino, "Biomechanics: Principles and Practices", 7th ed, 2015, CRC Press.
- Duane Knudson, Fundamentals of Biomechanics, 2nd ed. 2007, Springer

[IBI(DE)-19008] Clinical Engineering

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Identify, formulate and solve a problem of Biomedical Instrumentation Engineering. [PEO1] [PO3]
2. Design different clinical laboratory instruments and ability to analyze and interpret data. [PEO2] [PO4]
3. Select and use latest hardware and software tools for various biomedical systems design. [PEO2] [PO4]
4. Apply knowledge of mathematics, Science and Engineering to Biomedical Instrumentation Discipline. [PEO3] [PO1]

Course Contents
Clinical Engineering evolution, Healthcare environment, Models of Clinical Engineering Practice; Model clinical engineering department; The Role of Clinical Engineers in Hospitals; Technology Management, Design, Manufacture, and Evaluation and Control of Medical Devices, Health-Care Delivery Systems-Organization, Economics, Codes & Standards, Information Flow and Handling, Clinical Engineering Program, Safety education and Program, Utilization and Service of Medical Devices, Information Technology; and Professionalism and Ethics. Guidelines and standards for best practices

Reference Books:
- J.G. Webster, A.M. Cook - Editor, "Clinical Engineering: principles and practices", 1979, Prentice Hall
- Joseph F. Dyro, "Clinical Engineering Handbook" Academic Press Series in Biomedical Engineering, Academic Press
- J. Carr, "Introduction to Biomedical Equipment Technology", 1998, PHI
- Yadin David, "Clinical Engineering – Principles and Applications in engineering", CRC Press,

[IBI(DE)-19010]   Automotive Electronics Hardware Design

Teaching Scheme: **Examination Scheme:**
Lectures: 3 hrs/week   T1, T2 – 30 marks each, End-Sem Exam - 40

Course Outcome
1. Acquire automotive specific hardware design skills. [PEO1],[PO4]
2. Understand concepts such as DFM, DFT, EMC, DFMEA. [PEO1],[PO1]
3. Apply processes, methods and tools to demonstrate design skills. [PEO4],[PO4]
4. Develop, evaluate, and deal with stand-alone automotive electronic hardware module. [PEO1],[PO3]

Course Contents

Low Power Domain: 16/32 bit controllers, Hardware-Software Interfaces, communication interfaces-CAN, LIN, SPI, wireless interfaces-Bluetooth, ISM band applications, I/O interfaces-digital, analog signal conditioning, switches, relays, high side, low side drivers, Introduction to design tools (Microcap, Cadence Concept HDL and Allegro).

High Power Domain: Selection of power switching devices-MOSFETs/ IGBTs/ SiC/GaNFETs, Gate driver design, power loss calculations, thermal management, Design considerations for High Voltage applications.

Electromagnetic Compatibility: Introduction to various regulatory requirements and International electrical and EMC standards, Understanding origin of pulses, disturbances, circuit and PCB layout design techniques to meet EMC.

Design for Manufacturability and Testability: PCB layout considerations, Manufacturing interfaces and process flow, ICT, AOI and EOL testing.

[IBI (DE)-19011] Embedded System-II

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Understanding the RISC architecture of processors, its features and applications. [PEO1][PO1]
2. Hands on usage of IDE of processors and algorithm development. [PEO2][PO4]
3. To understand the concept of OS, embedded OS, and applications perspectives. [PEO3][PO6]
4. Study, design, analyze and prototype high-end embedded systems. [PEO2][PO3]

Course Contents
ARM-Cortex M series architecture: Embedded systems, classification, ARM 32-bit microcontroller Tiva, architecture—technology overview, Architectural Features of ARM Cortex M series: Tiva Block Diagram, CPU modes, register organization, ROM, RAM, timers, data and address bus, Memory and I/O interfacing concepts, memory mapped I/O. CISC Vs RISC design philosophy, pipelining, exceptions and its handling, memory, I/O's and addressing modes.

Peripherals: Interfacing of peripherals using Tiva: LED and sensors, ADC, Timer, PWM, UART, SPI, I2C.

Operating system based development: Operating systems fundamentals, operating system services, memory management, process management, device management, file management, Operating system services- program execution, I/O operation, file manipulation, communication, Operating system properties- multitasking, parallel programming, interactivity, scheduling and scheduling algorithms.

Linux: An overview of Red Hat Linux, installing Ubuntu, Linux commands, shell scrip programming, embedded Linux.

Development Tools (Open Source): GNU tools, text editors-vi, nano, pico,etc. IDE-Eclipse, code lite, compilers-gcc, g++, debuggers, cross-compilers, gcc- arm specific tool chains and in line assembly, Writing and compiling C/C++ programs, cross-compilation for ARM development board, Basics of make file, static and dynamic libraries.

Kernel programming: Kernel, basic functionalities of kernel, kernel module programming, Linux kernel sources, kernel configuration, booting kernel, kernel booting parameters, root file system,bootloader,U-boot,portingLinuxonARMboard,devicedriverprogramming, architecture, I/O communication, writing simple character device driver.

Reference Books:
- MichaelBeck, —Linuxkernelprogramming‖, Addison-WesleyProfessional,3rded. 2002.
- Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers, 2014, Jonathan W Valvano Create space publications ISBN: 978-1463590154.
- Sloss Andrew N, Symes Dominic, Wright Chris, —ARM System Developer's Guide: Designing and Optimizing‖, Morgan Kaufman Publication,2004
- Embedded Systems: Introduction to ARM Cortex - M Microcontrollers, 5th edition Jonathan W Valvano, Create space publications ISBN-13: 978-1477508992
- Raj Kamal,—Embedded Systems – Architecture: Programming and Design, Tata McGraw-Hill Education, 3rded.,2003.

[IBI(DE)-19012] Soft Computing

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Contents:
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)

Course Outcomes:
1. Able to define the expert system architecture and soft computing techniques. [PEO1],[PO1].
2. Recognize the feasibility of applying appropriate soft computing techniques for a given real world problem. [PEO1],[PO3]
3. Examine the solution of problem based on of the basics of learning and training algorithms. [PEO4],[PO4]
4. Develop engineering applications using neural network, fuzzy logic, genetic algorithm and hybrid system. [PEO3],[PO6]

Reference Books:
- S N Shivanandam, "Introduction to Neural Networks Using MATLAB 6.0", TMH.
- Timothy Ross, "Fuzzy logic with application to engineering systems", McGraw Hill.
- Klir G and T. Folger, "Fuzzy sets, uncertainty, and information", Prentice Hall.

[IBI(DE)-19013] Optical Instrumentation

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Able to explain the basic concepts of opto-electronic modules. [PEO1],[PO1].
2. Apply LASER and Optical fiber for various physical parameter measurements. [PEO1],[PO4]
3. Analyzing the optical sensor technology on various parameters of measurements. [PEO2],[PO4]
4. Describe selection of the appropriate optical fiber sensors for industrial applications. [PEO3],[PO1]

Course Contents
Optical fiber waveguide: Ray theory of transmission, total internal reflection, and electromagnetic mode theory of optical propagation, cylindrical fiber, classification of fibers, manufacturing of optical fiber.

Transmission characteristics of optical fiber: Attenuation, material absorption losses, scattering losses, nonlinear and linear scattering, fiber bend loss, dispersion, intermodal dispersion, dispersion modified single mode fiber, dispersion flattened fibers, polarization, nonlinear phenomena.

Optical sources and detectors: Optical emission from semiconductor, semiconductor LASER, non-semiconductor LASER, LED as an optical source, optical detector principles, absorption, quantum efficiency, responsively, photo diodes, modulation.

Optical fiber sensors: Introduction to fiber optics sensors, sensors based on intensity modulation, application of optical fiber for displacement, strain, stress and pressure measurement. Active multimode FO sensors, micro-bend optical fiber sensors, current sensors, phase modulated, polarization modulated optical fiber sensors, fiber optic gyroscope.

LASER applications: Introduction, application of LASER in biomedical instrumentation, LASER interferometry, performance parameters, LASER telemeters, measurement of distance, LIDAR, holography: basic principle of holography, measurement of strain, stress, bending moments and vibrations using hologram.

Optical amplification and integrated optics: Optical amplifiers, integrated optics integrated optical devices: beam splitters, directional couplers, modulators, switches, optoelectronics integration and differentiation, analog arithmetic operations, digital optics.

Reference Books:
- Jose Miguel Lopez, "Optical fiber sensing technology", John Wiley & Sons, 2002.
- AjoyGhatak, "Optics", Tata Mc- Graw Hill Publishing, 5th ed., 2012.
- Joseph T Verdeyen, "LASER Electronics", Prentice Hall of India, 3rd ed., 2003.
- John M. Senior, "Optical fiber Communications Principles and Practice", PHI publication, 2nd ed., 2008.

[IBI(DE)-19014] Artificial Intelligence and Machine Learning

Teaching Scheme: **Examination Scheme:**
Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course outcome
1. Understand Artificial Intelligence and its approaches. [PEO1][PO1].
2. Solving some problems using supervised, unsupervised and semi supervised machine learning algorithm. [PEO1],[PO4]
3. Study of probabilistic analysis, parametric and non-parametric algorithms. [PEO1],[PO1].
4. Estimation of Maximum Likelihood, losses and risks for classifications problems. [PEO1],[PO3]

Course Contents
Artificial Intelligence - Introduction, Intelligent Agents, Problem-solving, Solving Problems by Searching, Informed Search and Exploration, Constraint Satisfaction Problems, Adversarial Search, Knowledge and reasoning, Logical Agents, First-Order Logic, Inference in First-Order Logic, Knowledge Representation. Planning, Planning and Acting in the Real World, Uncertain knowledge and reasoning, Uncertainty, Probabilistic Reasoning, Probabilistic Reasoning over Time, Making Simple Decisions, Making Complex Decisions. Introduction to Machine Learning: What is machine learning, Applications of ML, Design Perspective and Issues in ML, Supervised, Unsupervised, Semi-supervised learning with applications and issues, Input : Concepts, instances and attributes, Output: Knowledge Representation: Decision tables, Decision trees, Decision rules, Rules involving relations, Instance-based representation, Data Pre-processing-data cleaning, data integration and transformation, data reduction, data discretization and concept hierarchy generation. Introduction to Classification, issues regarding classification, Classification: Model(or hypothesis) representation, decision boundary, cost function, gradient descent, regularization. Diagnostic: debugging a learning algorithm, evaluating a hypothesis (Model selection), training/validating/testing procedures, diagnosing bias versus variance and vice versa, regularization and bias/variance, learning curves. Accuracy and Error measures: classifier accuracy measures, predictor error measure, evaluating the accuracy of a classifier or predictor, Confusion metric, precision, recall, tradeoff between both, accuracy. Decision Tree : representation, hypothesis, issues in Decision Tree Learning, Pruning, Rule extraction from Tree, Learning rules from Data, Probabilistic classifier: Bayes rule, Maximum Likelihood Estimation, case Study, Clustering :Unsupervised learning technique, Similarity and Distance Measures, k-means and k-medoids algorithm, optimization objective, random initialization, choosing value of k, EM algorithm. Framework for machine learning applications, human-computer interaction, Case studies in the domain of Measurement, Analysis and Control, etc.

Reference Books:
- Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach," 3rd edition, Prentice Hall
- Tom Mitchell, "Machine Learning", McGraw-Hill, 1997
- EthemAlpaydin, "Introduction to Machine Learning", PHI, 2005
- Bishop, C., "Pattern Recognition and Machine Learning:," Berlin: Springer-Verlag, 2006

- K.P. Soman, R. Longonathan and V. Vijay, "Machine Learning with SVM and Other Kernel Methods", PHI-2009
- Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer 2006.
- Tom M. Mitchell , "Machine Learning", McGraw-Hill, 1997
- The Elements of Statistical Learning - by T. Hastie, R. Tibshirani, and J. Friedman, 2009

[IBI(DE)-19015] Automotive Electronics Software Development

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week   T1, T2 – 30 marks each, End-Sem Exam - 40

Course Outcomes

1. Acquire automotive specific software design skills. [PEO1],[PO4]
2. Understand concepts such as AUTOSAR, MATLAB, Communication Protocol. [PEO1],[PO1]
3. Apply processes, methods and tools to demonstrate design skills. [PEO4],[PO4]
4. Develop, evaluate, and deal with stand-alone automotive electronic software module. [PEO1],[PO3]

Course Contents

Software Architecture: Classical architecture, Layered Architecture (AUTOSAR), All layer information (e.g. RTE, BSW, Application) Tool: Davinci developer, configurator, Raphsody.

Communication Protocols: Communication Protocol, CAN, LIN, Automotive Ethernet, RF, Bluetooth, Wi-Fi, Diagnostic Protocol: UDS, Tools: CANoe, Vehicle spy, CAPEL, TAE scripting.

Model Based Development: Model Based Development: Algorithm/application development using Simulink, stateflow, code generator.

Embedded C: Concepts of C (structure, union, pointer, bitwise operator), Logic building according to requirement, MISRA C guidelines.

Software Testing: Unit testing, Model in loop(MIL) testing, module testing, integration testing, software in loop(SIL) testing, Hardware in Loop (HIL) testing, Tools: Tessy, PolySpace, TPT, Winidea, QAC, HIL Test Setup.

[LLC-19001] Liberal Learning Course

Teaching scheme:
Lectures: 3 hrs./week

Examination Scheme:
T1, T2 – 20 marks each,
End-Sem Exam – 60

Course Outcomes:
1. Ability to exhibit self-learning capabilities and its use in effective communication. [PEO2], [PO5].
2. An ability to inculcate impact of various areas to relate with society at large. [PEO4], [PO6].
3. Demonstrate the familiarity with one or more multi-disciplinary areas of their choice. [PEO2], [PO5].
4. Communicate effectively, through written and oral communication and through other forms as appropriate. [PEO2], [PO5].

Course Contents:
Identification of topic and resources, scope, and synthesize viewpoints for the areas such as performing arts, basic Sciences, business, philosophy, sports and athletics, defense studies and education.

[IBI-19006] Advanced Medical Instrumentation

Teaching Scheme:
Lectures: 3 hrs/week
Course Project:2 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Acquire knowledge of Instrumentation and Control Engineering with ability to evaluate, analyse and synthesize knowledge related Biomedical Instrumentation / devices / systems. [PEO1] [PO3]
2. Analyse complex problems related to Instrumentation and Control Engineering and synthesize the information for conducting biomedical related research. [PEO1] [PO3]
3. Design different Medical instruments and ability to analyze and interpret data. [PEO2] [PO4]
4. Learn and use contemporary tools for solving problems related to Biomedical Instrumentation / systems/ devices, etc[PEO4] [PO4]

Course Contents
Computer based medical instrumentation - Computerized versions of ECG, EEG, EMG, Tread Mill Test ECG– Fetal monitor, cardiac arrthymias 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, Hemodialysis - 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, Medical software, m-health, Introduction to c-Health – Medical Informatics, Certification Process

Reference books:
- John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2009.
- Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice Hall of India, New Delhi, 2007.
- Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.
- Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGraw-Hill Publisher, UK,2003
- Claudio Becchetti, Alessandro Neri, "Medical Instrument Design and Development from Requirement to Market Placements", Wiley Publication, 2013

- Joseph D. Bronzino," The biomedical engineering handbook", Volume 1 & 2, CRC Press, USA, 2000.
- John G. Webster, "Encyclopedia of Medical Devices and Instrumentation Vol. I , II, III, IV", Wiley Publication
- Manfred Clyner, John H. Milsum, "Bio medical Engineering System", McGraw Hill
- Rangaray M. Rangayyan, "Biomedical Signal Analysis – A Case Study Approach", John Wiley and Sons Inc
- Joon Bu Park, Joseph D. Bronzino, "Biomaterials: principles and applications", CRC press, USA, 2003

[IBI-19007] Biomedical Signal Processing

Teaching Scheme:
Lectures: 3 hrs/week
Course Project:2 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes
1. Understanding of various bio-signal acquisition systems. [PEO1] [PO4]
2. Able to identify image processing technique for specific biomedical application. [PEO1] [PO4]
3. Able to implement and analyze biomedical signal processing technique. [PEO2] [PO4]
4. Analyse complex problems related to Instrumentation and Control Engineering and synthesize the information for conducting biomedical related research. [PEO1] [PO3]

Course Contents
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 artifact, 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 (Computation of signal parameters that are diagnostically significant), Classification of signals and noise, Spectral analysis of deterministic, stationary random signals and nonstationary 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 analysis.

Reference Books:
- W. J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall, 1993.
- Eugene N Bruce, "Biomedical signal processing and signal modeling", John Wiley & Son's publication, 2001.
- Myer Kutz – Editor, "Biomedical Engineering and Design Handbook", McGraw Hill Professional, 2009.
- D C Reddy, "Biomedical signal processing", McGraw Hill, 2005

[IBI-19008] Medical Imaging

Teaching Scheme: **Examination Scheme:**

Lectures: 3 hrs/week   T1, T2 – 20 marks each, End-Sem Exam - 60

Course Project: 2 hrs/week

Course Outcomes
1. Acquired the knowledge of different image processing techniques. [PEO1] [PO1]
2. Understanding of Different Imaging Modalities. [PEO1] [PO4]
3. Apply knowledge of imaging modalities and image processing techniques to solve different biomedical problems. [PEO1] [PO3]
4. Learn and use contemporary tools for solving problems related to Biomedical imaging. [PEO4] [PO4]

Course Contents

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.

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, Introduction to machine learning, deep learning, Application of machine learning, deep learning   tools for Biomedical Analysis and Clinical predictions

Reference books:
- Rangaraj M. Rangayyan, "Biomedical Image Analysis" CRC Press, 2005
- Rafael G. Gonzaleg, Kichard E. Wood, "Digital Image Processing" Pearson Education, LPE
- Bishop, C., "Pattern Recognition and Machine Learning:," Berlin: Springer-Verlag, 2006
- Thomas S. Curry, Jumer E. Dowdey, Robert C. Murry, "Christensen's physics of Diagnostic Radiology", Lippincott Williams & Wilkins, ISBN -10 0812113101
- John G. Webster, "Encyclopedia of Medical Devices and Instrumentation Vol. I , II, III, IV", Wiley Publication
- KavyanNajarian and Robert Splerstor," Biomedical signals and Image processing", CRC – Taylor and Francis, New York, 2006

[IBI-20001] Dissertation Phase I

Teaching Scheme: **Examination Scheme:**
--   Marks: 100 each for phase I and II

Course Outcomes
1. Ability to synthesize knowledge and skills previously gained and applied to an in depth study and execution of new technical problem. [PEO1][PO1]
2. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design and justify their design. [PEO3][PO6]
3. Ability to present the findings of their technical solution in a written report. [PEO2],[PO2].
4. Demonstrate an ability to present and defend their research work to a panel of experts. [PEO1],[PO3].

Course Contents
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:

1. Relevance to social needs ofsociety
2. Relevance to value addition to existing facilities in theinstitute
3. Relevance to industry need /requirement
4. Problems of nationalimportance
5. Research and development in variousdomain

The student should complete the following:

1. Literaturesurvey
2. ProblemDefinition
3. Motivation for study andObjectives
4. Preliminary design / feasibility / modularapproaches
5. Implementation andVerification
6. Report andpresentation

[IBI-20002] Dissertation Phase II

Teaching Scheme: **Examination Scheme:**
         --   Marks: 100 each for phase I and II

Course Outcomes
1. Ability to synthesize knowledge and skills previously gained and applied to an in depth study and execution of new technical problem. [PEO1][PO1]
2. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design and justify their design. [PEO3][PO6]
3. Ability to present the findings of their technical solution in a written report. [PEO2],[PO2].
4. Demonstrate an ability to present and defend their research work to a panel of experts. [PEO1],[PO3].

Course Contents

The dissertation stage II is based on a report prepared by the students on dissertation allotted to them.

It may be based on:

1. Entirely on study and analysis of typical Instrumentation and Control system, Biomedical Instrumentation / devices / instruments / relatedtopic
2. Experimental verification / Proof ofconcept
3. Design, fabrication, testing, and calibration of an instrumentationsystem.
4. The viva-voce examination will be based on the above report andwork.