COEP Technological University

(COEP Tech)
A Unitary Public University of Government of Maharashtra
w.e.f 21st June 2022
(Formerly College of Engineering Pune)

Department of Instrumentation and Control Engineering

Curriculum Structure & Detailed Syllabus (PG Program)

M.Tech. -Biomedical Instrumentation

(Effective from: A.Y. 2023-24)

PG Program [M. Tech.] Curriculum Structure
W.e.f from AY 2023-24

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5.88
PSBC	Program Specific Bridge Course	1	3	4.41
PCC	Program Core Course	6	18	26.47
PEC	Program SpecificElective Course	3	9	13.24
LC	Laboratory Course	6	6	8.82
VSEC	Vocational and Skill Enhancement Course	2	18	26.47
OE	Open Elective	1	3	4.41
SLC	Self-Learning Course	2	6	8.82
MLC	Mandatory Learning Course	2	--	0
CCA	Co-curricular & Extracurricular Activities	1	1	1.47
	Total	**25**	**68**	**100%**

PG Program [M. Tech.] Curriculum Structure

Biomedical Instrumentation

W.e.f AY from AY 2023-24

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	PSMC	PSMC-01	Statistics	3	1	--	4
2.	PSBC	PSBC-01	Anatomy & Physiology for Engineers	3	0	--	3
3.	PCC	PCC-01	Medical Sensors and Biomaterials	3	0	-	3
4.	PCC	PCC-02	Instrument Design Engineering	3	0	-	3
5.	PCC	PCC -03	Physiological Modeling	3	0	-	3
6.	LC	LC-01	Instrument Design Engineering Lab	-	-	2	1
7.	LC	LC-02	Physiological Modeling Lab	-	-	2	1
8.	LC	LC-03	Medical Sensors and Biomaterials Lab	-	-	2	1
9.	PEC	PEC-01	**Program Specific t Elective –I** I. Embedded System I II. Industrial Internet of Things III. Modern Control Theory IV. Automotive Embedded Product Development*	3	--	--	3
10.	MLC	MLC-01	Research Methodology and Intellectual Property Rights (Audit)	2	--	--	--
11.	MLC	MLC-02	Effective Technical Communication	1	--	--	--
				21	1	6	
Total Credits							**22**

PG Program [M. Tech.] Curriculum Structure

Biomedical Instrumentation

W.e.f from AY 2023-24

Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	OE	OE-01	Smart Sensors	3	-	-	3
2.	PCC	PCC-04	Advanced Medical Instrumentation	3	0	-	3
3.	PCC	PCC-05	Biomedical Signal Processing	3	0	-	3
4.	PCC	PCC-06	Medical Imaging	3	0	-	3
5.	LC	LC-04	Advanced Medical Instrumentation Lab	-	-	2	1
6.	LC	LC-05	Biomedical Signal Processing Lab	-	-	2	1
7.	LC	LC-06	Medical Imaging Lab	-	-	2	1
8.	PEC	PEC-02	**Program Specific t Elective –II** I. Ultrasonic Applications in Bioengineering II. Hospital Management III. Biomechanics IV. Clinical Engineering V. Automotive Electronics Hardware Development*	3	0	0	3
9.	DEC	PEC-03	**Program Specific t Elective –III** I. Embedded Systems-II II. Soft Computing III. Optical Instrumentation IV. Artificial Intelligence and Machine Learning V. Automotive Electronics Software Development*	3	0	0	3
10.	CCA	CCA-01	Liberal Learning Course	1	0	0	1
				19	0	6	
			Total Credits				22

Note: '*' Elective Courses to be offered to only Hella India Automotive Pvt. Ltd. selected students.

Ø Exit option to qualify for PG Diploma in Biomedical Instrumentation:

· Eight weeks domain specific industrial internship in the month of June-July after successfully completing first year of the program.

PG Program [M. Tech.] Curriculum Structure

Biomedical Instrumentation

W.e.f from AY 2023-24

Semester-III

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme				Credits
				L	T	P	S	
1.	VSEC	VSEC-01	Dissertation Phase – I	--	--	18	12	9
2.	SLC	SLC-01	Massive Open Online Course -I	3	--	--	3	3
Total Hrs.				3	--	18	15	12
			Total Credits	**12**				

Semester-IV

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme				Credits
				L	T	P		
1.	VSEC	VSEC-02	Dissertation Phase – II	--	--	18	12	9
2.	SLC	SLC-02	Massive Open Online Course -II	3	--	--	3	3
Total Hrs.				3	--	18	15	12
			Total Credits	**12**				

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 Lif 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:

- Ronald E, Walpole, Sharon L. Myers, Keying Ye, Probability and Statistics for Engineers and 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.

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.

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

Instrument Design Engineering

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. 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 instruments 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. Boss hart , -PCB Design and Technology‖ Tata McGraw Hill, 1987.
- Clyde F. Coombs, -Electronic Instrument Handbook‖, McGraw Hill, Third Edition, 2005.

Physiological Modeling

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 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. Teri Bahil, 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.

Instrument Design Engineering Lab Course

Students are required to develop various simulations for the processes or control required for their IDE project. The system model is chosen from the reputed research papers and its simulation is carried out in the suitable simulation environment. The students can validate their results with the base paper and try to do the improvement in the existing process with the addition of some research components. The students are expected to present the comparison of the work done and the existing work mentioned in the paper as a part of outcome.

Physiological Modeling Lab Course

Students are expected to model different physiological system such as cardiovascular system, pharmacokinetics etc and simulate the same using appropriate tools such as Matlab, Labview, Comsol etc. At the end of the semester, present the work and submit the project report.

Medical Sensors and Bio-Materials Lab Course

Students are expected to select appropriate sensors for vital physiological parameters, design and implement appropriate signal conditioning for selected sensors and observe the output using appropriate hardware interfaces on PC/laptop. Also analyze the observed signal using appropriate tools. At the end of the semester, present the work and submit the project report.

Embedded Systems-I

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
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.

Industrial Internet of Things

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
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

Modern Control Theory

Teaching Scheme
Lectures: 3hrs./week

Examination Scheme
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

- **Represent** linear multivariable system via state space descriptions
- **Analysis** of multi variable systems using concept of controllability, observability and stability
- **Analyze and design** multivariable control system using state feedback and state observers.
- **Ability to design** tracking controller using time and frequency domain specifications
- **Understand** the basics of discrete time systems and application in control system

Course Contents

State Space Representation: Introduction to multivariable system, concept of state, state variables and state model, state modeling of linear systems, linearization of state equations, State space representation using physical variables, phase variables and canonical variables, Derivation of state space models for linear continuous time systems from schematic models, differential equations, transfer functions, block diagram and signal flow diagram.

State Space Analysis: Solution of state equations, State transition matrix: Definition, derivation and properties, computation by Laplace transform method, Cayley Hamilton method, Similarity transformation method, Concept of Controllability and Reachability, Observability and Constructibility, Controllable and Uncontrollable subspace, Observable and unobservable subspace, Controllability and Observability tests, Stability analysis.

Control Systems Design in State Space: State feedback controller design, Necessary and Sufficient condition for arbitrary pole placement for state regulator design, State observers: Full order state observers, minimum order observers, and reduced order observers. Case study example: inverted pendulum for analysis and design

Controller Design: Design of PI/PD/PID controller using time domain and frequency domain specifications, Direct synthesis of controller, controller design for systems with and without dead time through controller synthesis formula.

Discrete Time Control Introduction to discrete time control, z transforms, difference equations, analysis of discrete time systems, controller design in discrete domain.

Text Books:

1. B. S. Manke, "Control System Design", 1st ed., Khanna Publishers, New Delhi, 2007.
2. I. J. Nagrath, M. Gopal, "Control System Engineering", 3rd ed., New Age International Publishers, 1999.
3. K. Ogata, "Modern Control Engineering", 2nd ed., PHI, New Delhi, 1994.

Reference Books:

1. Norman S. Nise, "Control System Engineering", 4th ed., John Wiley and Sons, 2003.
2. B. C. Kuo, "Automatic Control Systems", 3rd ed., PHI New Delhi, 1979.
3. Graham C. Goodwin, Stefan F. Graebe and M. E. Salgado, "Control system Design", PHI, New Delhi, 2002.

Automotive Embedded Product Development

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
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.

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

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.

Semester II
Smart Sensors

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
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

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

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

Medical Imaging

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. 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

Advanced Medical Instrumentation Lab Course

Students are expected to design and implement any diagnostic and therapeutic instruments. Create a rubric for commercial any one diagnostic and therapeutic instrument and compare the performance of designed instruments. At the end of the semester, present the work and submit the project report.

Biomedical Signal Processing Lab Course

Students are expected to analyze the given bio-signal for identification of disease/disorder using appropriate tools. At the end of the semester, present the work and submit the project report.

Medical Imaging Lab Course

Students are expected to design and simulate the methodology for the given image for identification of disease/disorder using appropriate tools and analyze the same. At the end of the semester, present the work and submit the project report.

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.

Hospital Management

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
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

Biomechanics

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
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

Clinical Engineering

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
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,

Automotive Electronics Hardware Design

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
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.

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/O̧s 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.

Soft Computing

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes

- Able to define the expert system architecture and soft computing techniques.
- Recognize the feasibility of applying appropriate soft computing techniques for a given real world problem
- Examine the solution of problem based on of the basics of learning and training algorithms.
- Develop engineering applications using neural network, fuzzy logic, genetic algorithm and hybrid system.

Course Contents

Artificial Intelligence: a Brief Review, Pitfalls of Traditional AI, Need for Computational Intelligence, Importance of Tolerance of Imprecision and Uncertainty, Constituent Techniques, Overview of Artificial Neural Networks, Fuzzy Logic, Evolutionary Computation.

Neural Network: Biological and Artificial Neuron, Neural Networks, Supervised and Unsupervised Learning. Single Layer Perceptron, Multilayer Perceptron, Backpropagation Learning, Neural Networks as Associative Memories, Hopfield Networks, Bidirectional Associative Memory, Topologically Organized Neural Networks, Competitive Learning, Kohonen Maps.

Fuzzy Logic: Fuzzy Sets, Properties, Membership Functions, Fuzzy Operations, Fuzzy Inference System, Fuzzification and defuzzifications module, Scaling factors, Fuzzy controllers.

Genetic Algorithms: Introduction and concept, Coding, Reproduction, Cross Applications, Swarm intelligence, and their applications.

Evolutionary Computation: Overview of other Bio-inspired Algorithms - Swarm Intelligence Algorithms, Particle Swarm optimization, Ant Colony optimization, Grey-Wolf optimization, Hybrid systems: Neuro-fuzzy, Genetic-neuro, Genetic-fuzzy.

Reference books:

1. Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, by S. Rajasekaran and G. A. Vijayalakshmi Pai, 2nd Edition, PHI Learning, 2003.
2. Soft Computing: Neuro-Fuzzy and Genetic Algorithms by Samir Roy and Udit Chakraborty, 1st Edition, Pearson, 2006.
3. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, 3rd edition , Prentice-Hall International, 2000.
4. Introduction to Artificial Systems by J. M. Zurada, 5th Edition, Jaico Publishing House, 2004.
5. An Introduction to Neural Networks by James A. Anderson, 2nd edition , Prentice Hall of India, New Delhi, 1999.

6. An Introduction to Fuzzy Control by D. Drainkov, H. Hellendoorn and M. Reinfrank,, 6th edition , Springer-Verlag Berlin Heidelberg Publisher, 2008.
7. Fuzzy Logic with Engineering Applications by T. J. Ross, 3rd edition, MIT Press, Inc 2011.
8. Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence by Kosko Bart, Prentice Hall of India, New Delhi, 2001.
9. An Introduction to Genetic Algorithms by Melanie Mitchell, 2nd Edition, MIT Press, 1999.

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 HillPublishing, 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.

Artificial Intelligence and Machine Learning

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
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

Automotive Electronics Software Development

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 30 marks each, End-Sem Exam - 40

Course Outcomes

2. Acquire automotive specific software design skills. [PEO1],[PO4]
3. Understand concepts such as AUTOSAR, MATLAB, Communication Protocol. [PEO1],[PO1]
4. Apply processes, methods and tools to demonstrate design skills. [PEO4],[PO4]
5. 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.

Liberal Learning Course

Teaching scheme: **Examination Scheme:**

Lectures: 3 hrs./week each, T1, T2 – 20 marks
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.