VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

## SCHOOL OF ELECTRONICS ENGINEERING

# M. Tech Biomedical Engineering

Curriculum

(*2018-2019 admitted students*)

## VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

## MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

**World class Education**: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

**Cutting edge Research**: An innovation ecosystem to extend knowledge and solve critical problems.

**Impactful People**: Happy, accountable, caring and effective workforce and students.

**Rewarding Co-creations**: Active collaboration with national & international industries & universities for productivity and economic development.

**Service to Society**: Service to the region and world through knowledge and compassion.

## VISION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

To be a leader by imparting in-depth knowledge in Electronics Engineering, nurturing engineers, technologists and researchers of highest competence, who would engage in sustainable development to cater the global needs of industry and society.

## MISSION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

- Create and maintain an environment to excel in teaching, learning and applied research in the fields of electronics, communication engineering and allied disciplines which pioneer for sustainable growth.
- Equip our students with necessary knowledge and skills which enable them to be lifelong learners to solve practical problems and to improve the quality of human life.

# PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, whowould help solve industry's technological problems
2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry
3. Graduates will function in their profession with social awareness and responsibility
4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth ofthe country
5. Graduates will be successful in pursuing higher studies in engineering or management
6. Graduates will pursue career paths in teaching or research

# M. Tech Biomedical Engineering

## PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_02: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_03: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_04: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_05: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_06: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_07: Having a clear understanding of professional and ethical responsibility

PO_08: Having a good cognitive load management skills related to project management and finance

# M. Tech Biomedical Engineering

## PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of M. Tech. (Biomedical Engineering) programme, graduates will be able to

PSO1: Apply advanced concepts of Biomedical Engineering to design and develop components and systems for health care applications

PSO2: Use state-of-art hardware and software tools to design experiments in medical electronic systems for the benefit of society.

PSO3: To exhibit independent, and collaborative research with strategic planning, while demonstrating the professional and ethical responsibilities of the engineering profession.

M. Tech Biomedical Engineering

# CREDIT STRUCTURE

## Category-wise Credit distribution

| Category | Credits |
|---|---|
| University core (UC) | **27** |
| Programme core (PC) | **19** |
| Programme elective (PE) | **18** |
| University elective (UE) | **06** |
| Bridge course (BC) | **-** |
| Total credits | **70** |

# M. Tech Biomedical Engineering

# DETAILED CURRICULUM

## University Core - 27

| S. No. | Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|---|
| 1. | MAT6001 | Advanced Statistical Methods | 2 | 0 | 2 | 0 | 3 |
| 2. | ENG5001 and ENG5002 or GER5001 | Technical English I<br>and Technical English II<br>(or) Deutsch fuer Anfaeger | {0<br>0<br>2 | 0<br>0<br>0 | 2<br>2<br>0 | 0<br>0}<br>0 | 2 |
| 3. | STS5001 & STS5002 | Soft skills | 0 | 0 | 0 | 0 | 2 |
| 4. | SET5001 | SET Project-I | 0 | 0 | 0 | 0 | 2 |
| 5. | SET5002 | SET Project-II | 0 | 0 | 0 | 0 | 2 |
| 6. | ECE6099 | Master's Thesis | 0 | 0 | 0 | 0 | 16 |

# M. Tech Biomedical Engineering

**Programme Core - 19**

| S. No. | Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|---|
| **1.** | **BIT5010** | **Anatomy & Physiology (Bridge Course)** | **1** | **0** | **0** | **0** | **NA** |
| **2.** | **ECE5000** | **Basic Electronics & Measurements (Bridge Course)** | **1** | **0** | **0** | **0** | **NA** |
| 3. | ECE5046 | Biomedical Sensors an Data Acquisition Techniques | 2 | 0 | 2 | 4 | 4 |
| 4. | ECE5047 | Bio-signal Processing and Analysis | 3 | 0 | 2 | 0 | 4 |
| 5. | ECE5048 | Embedded Systems and IoT for Biomedical Applications | 3 | 0 | 0 | 4 | 4 |
| 6. | ECE5052 | Medical Image Processing | 2 | 0 | 2 | 4 | 4 |
| 7. | ECE6040 | Biomedical Equipment | 3 | 0 | 0 | 0 | 3 |

# M. Tech Biomedical Engineering

**Programme Elective - 18**

| S. No. | Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|---|
| 1. | BIT5011 | Rehabilitation Engineering | 2 | 0 | 2 | 0 | 3 |
| 2. | BIT6022 | Biomaterials | 3 | 0 | 0 | 0 | 3 |
| 3. | BIT6023 | Biomechanics | 3 | 0 | 0 | 0 | 3 |
| 4. | BIT6024 | Health Care Management | 3 | 0 | 0 | 0 | 3 |
| 5. | CSE6047 | Data Mining in Healthcare | 3 | 0 | 0 | 0 | 3 |
| 6. | CSE6048 | Big Data Analytics in Medical Applications | 3 | 0 | 0 | 0 | 3 |
| 7. | ECE5008 | Micro and Nano Fluidics | 2 | 0 | 0 | 4 | 3 |
| 8. | ECE5049 | MEMS & NEMS for Biomedical Applications | 2 | 0 | 2 | 0 | 3 |
| 9. | ECE5050 | Physiological Control Systems | 2 | 0 | 2 | 0 | 3 |
| 10. | ECE5051 | Artificial Neural Network | 2 | 0 | 0 | 4 | 3 |
| 11. | ECE6052 | Networking and Information System in Medicine | 2 | 0 | 0 | 4 | 3 |
| 12. | ECE6053 | Medical Robotics | 2 | 0 | 0 | 4 | 3 |
| 13. | ECE6054 | Medical Imaging Techniques | 2 | 0 | 2 | 0 | 3 |
| 14. | ECE6055 | Digital Healthcare and Medical Standards | 2 | 0 | 0 | 4 | 3 |

## University Elective Baskets

Management courses

| Sl.No | **Code** | **Title** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|---|
| 1 | MGT1001 | Basic Accounting | 3 | 0 | 0 | 0 | 3 |
| 2 | MGT1002 | Principles of Management | 2 | 0 | 0 | 4 | 3 |
| 3 | MGT1003 | Economics for Engineers | 2 | 0 | 0 | 4 | 3 |
| 4 | MGT1004 | Resource Management | 2 | 0 | 0 | 4 | 3 |
| 5 | MGT1005 | Design, Systems and Society | 2 | 0 | 0 | 4 | 3 |
| 6 | MGT1006 | Environmental and Sustainability Assessment | 2 | 0 | 0 | 4 | 3 |
| 7 | MGT1007 | Gender, Culture and Technology | 2 | 0 | 0 | 4 | 3 |
| 8 | MGT1008 | Impact of Information Systems on Society | 2 | 0 | 0 | 4 | 3 |
| 9 | MGT1009 | Technological Change and Entrepreneurship | 2 | 0 | 0 | 4 | 3 |
| 10 | MGT1010 | Total Quality Management | 2 | 2 | 0 | 0 | 3 |
| 11 | MGT1014 | Supply Chain Management | 3 | 0 | 0 | 0 | 3 |
| 12 | MGT1015 | Business Mathematics | 3 | 0 | 0 | 0 | 3 |
| 13 | MGT1016 | Intellectual Property Rights | 3 | 0 | 0 | 0 | 3 |
| 14 | MGT1017 | Business Regulatory Framework For Start-ups | 3 | 0 | 0 | 0 | 3 |
| 15 | MGT1018 | Consumer Behaviour | 3 | 0 | 0 | 0 | 3 |
| 16 | MGT1019 | Services Marketing | 3 | 0 | 0 | 0 | 3 |
| 17 | MGT1020 | Marketing Analytics | 2 | 0 | 2 | 0 | 3 |
| 18 | MGT1021 | Digital and Social Media Marketing | 3 | 0 | 0 | 0 | 3 |
| 19 | MGT1022 | Lean Start-up Management | 1 | 0 | 0 | 4 | 2 |
| 20 | MGT1023 | Fundamentals of Human Resource Management | 3 | 0 | 0 | 4 | 4 |
| 21 | MGT1024 | Organizational Behaviour | 3 | 0 | 0 | 4 | 4 |
| 22 | MGT1025 | Foundations of Management And Organizational Behaviour | 3 | 0 | 0 | 4 | 4 |
| 23 | MGT1026 | Information Assurance and Auditing | 2 | 0 | 0 | 4 | 3 |

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|---|---|---|---|---|---|---|---|
| 24 | MGT1028 | Accounting and Financial Management | 2 | 2 | 0 | 4 | 4 |
| 25 | MGT1029 | Financial Management | 2 | 1 | 0 | 4 | 4 |
| 26 | MGT1030 | Entrepreneurship Development | 3 | 0 | 0 | 4 | 4 |
| 27 | MGT1031 | International Business | 3 | 0 | 0 | 4 | 4 |
| 28 | MGT1032 | Managing Asian Business | 3 | 0 | 0 | 4 | 4 |
| 29 | MGT1033 | Research Methods in Management | 2 | 1 | 0 | 4 | 4 |
| 30 | MGT1034 | Project Management | 3 | 0 | 0 | 4 | 4 |
| 31 | MGT1035 | Operations Management | 3 | 0 | 0 | 0 | 3 |
| 32 | MGT1036 | Principles of Marketing | 3 | 0 | 0 | 4 | 4 |
| 33 | MGT1037 | Financial Accounting and Analysis | 2 | 1 | 0 | 4 | 4 |
| 34 | MGT1038 | Financial Econometrics | 2 | 0 | 0 | 4 | 3 |
| 35 | MGT1039 | Financial Markets and Institutions | 2 | 0 | 0 | 4 | 3 |
| 36 | MGT1040 | Personal Financial Planning | 2 | 0 | 0 | 4 | 3 |
| 37 | MGT1041 | Financial Derivatives | 2 | 1 | 0 | 4 | 4 |
| 38 | MGT1042 | Investment Analysis and Portfolio Management | 2 | 0 | 0 | 4 | 3 |
| 39 | MGT1043 | Applications in Neuro Marketing | 3 | 0 | 0 | 4 | 4 |
| 40 | MGT1044 | Global Brand Marketing Strategies | 3 | 0 | 0 | 4 | 4 |
| 41 | MGT1045 | Industrial Marketing | 3 | 0 | 0 | 4 | 4 |
| 42 | MGT1046 | Sales and Distribution Management | 3 | 0 | 0 | 4 | 4 |
| 43 | MGT1047 | Social Marketing | 3 | 0 | 0 | 4 | 4 |
| 44 | MGT1048 | Political Economy of Globalization | 3 | 0 | 0 | 4 | 4 |
| 45 | MGT1049 | Sustainable Business Models | 3 | 0 | 0 | 4 | 4 |
| 46 | MGT1050 | Software Engineering Management | 2 | 0 | 0 | 4 | 3 |
| 47 | MGT1051 | Business Analytics for Engineers | 2 | 2 | 0 | 0 | 3 |
| 48 | MGT1052 | Bottom of the Pyramid Operations | 3 | 0 | 0 | 0 | 3 |
| 49 | MGT1053 | Entrepreneurship Development, Business Communication and IPR | 1 | 0 | 2 | 0 | 2 |
| 50 | MGT1054 | Product Planning and Strategy | 2 | 2 | 0 | 0 | 3 |

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|---|---|---|---|---|---|---|---|
| 51 | MGT1055 | Design Management | 2 | 2 | 0 | 0 | 3 |
| 52 | MGT1056 | Accounting and Financial Management | 3 | 0 | 0 | 4 | 4 |
| 53 | MGT6001 | Organizational Behaviour | 2 | 0 | 0 | 4 | 3 |

Humanities courses

| Sl.No | **Code** | **Title** | **L** | **T** | **P** | **J** | **C** |
|---|---|---|---|---|---|---|---|
| 1 | HUM1001 | Fundamentals of Cyber Laws | 3 | 0 | 0 | 0 | 3 |
| 2 | HUM1002 | Business Laws | 3 | 0 | 0 | 0 | 3 |
| 3 | HUM1003 | Basic Taxation for Engineers | 3 | 0 | 0 | 0 | 3 |
| 4 | HUM1004 | Corporate Law for Engineers | 3 | 0 | 0 | 0 | 3 |
| 5 | HUM1005 | Cost Accounting for Engineers | 3 | 0 | 0 | 0 | 3 |
| 6 | HUM1006 | Business Accounting for Engineers | 3 | 0 | 0 | 0 | 3 |
| 7 | HUM1007 | Contemporary Legal Framework for Business | 3 | 0 | 0 | 0 | 3 |
| 8 | HUM1009 | International Business | 3 | 0 | 0 | 0 | 3 |
| 9 | HUM1010 | Foreign Trade Environment | 3 | 0 | 0 | 0 | 3 |
| 10 | HUM1011 | Export Business | 3 | 0 | 0 | 0 | 3 |
| 11 | HUM1012 | Introduction to Sociology | 3 | 0 | 0 | 0 | 3 |
| 12 | HUM1013 | Population Studies | 3 | 0 | 0 | 0 | 3 |
| 13 | HUM1021 | Ethics and Values | 2 | 0 | 0 | 0 | 2 |
| 14 | HUM1022 | Psychology in Everyday Life | 2 | 0 | 0 | 4 | 2 |
| 15 | HUM1023 | Indian Heritage and Culture | 2 | 0 | 0 | 4 | 2 |
| 16 | HUM1024 | India and Contemporary World | 2 | 0 | 0 | 4 | 2 |
| 17 | HUM1025 | Indian Classical Music | 1 | 0 | 2 | 4 | 1 |
| 18 | HUM1033 | Micro Economics | 3 | 0 | 0 | 0 | 3 |
| 19 | HUM1034 | Macro Economics | 3 | 0 | 0 | 0 | 3 |
| 20 | HUM1035 | Introductory Econometrics | 2 | 0 | 2 | 0 | 2 |
| 21 | HUM1036 | Engineering Economics and Decision Analysis | 2 | 0 | 0 | 4 | 2 |

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|---|---|---|---|---|---|---|---|
| 22 | HUM1037 | Applied Game Theory | 2 | 0 | 0 | 4 | 2 |
| 23 | HUM1038 | International Economics | 3 | 0 | 0 | 0 | 3 |
| 24 | HUM1039 | Community Development in India | 2 | 0 | 0 | 4 | 2 |
| 25 | HUM1040 | Indian Social Problems | 3 | 0 | 0 | 0 | 3 |
| 26 | HUM1041 | Indian Society Structure and Change | 3 | 0 | 0 | 0 | 3 |
| 27 | HUM1042 | Industrial Relations and Labour Welfare in India | 3 | 0 | 0 | 0 | 3 |
| 28 | HUM1043 | Mass Media and Society | 2 | 0 | 0 | 4 | 2 |
| 29 | HUM1044 | Network Society | 3 | 0 | 0 | 0 | 3 |
| 30 | HUM1045 | Introduction to Psychology | 2 | 0 | 2 | 0 | 2 |
| 31 | HUM1706 | Business Accounting for Engineers | 3 | 0 | 0 | 0 | 3 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| **BIT5010** | **ANATOMY AND PHYSIOLOGY (Bridge Course)** | **1** | **0** | **0** | **0** | **NA** |
| **Prerequisite:** | **Nil** | | | | | |
| | | | | | | Syllabus version: 2 |

**Course Objectives:**

1. To define the basic concepts of anatomical and physiological terminologies relating to cell, blood components and joints with their functions.
2. To describe the chemical coordination of human endocrine systems, hormones and its functions, male and female reproductive organs.
3. To brush the basics of anatomical and physiological functions of cardiovascular system, blood pressure with factors affecting it, Human Respiratory system, and mechanism of breathing and gaseous exchange.
4. To discuss about the human Nervous system, physiology and terminologies involved in it, Functions of brain, vision, hearing, taste and smell, Urinary System, functions of kidney and urine formation Functions and absorption property of digestive system and its movement.

**Expected Course Outcomes:**

The students will be able to:

1. Comprehend the basic concepts of human cell and its organelles, general physiological concepts, primary tissues and organ systems of the human body
2. Ability to understand the basic physiological function about endocrine, digestive and circulatory system.
3. Conceive the mechanism about the kidney function and urine formation.
4. Perceive the concepts about the body fluids and its circulatory pathways in human body.
5. Envisage the basic concepts on the human body mechanics, locomotion, bones and joints involved in its movement.
6. Recognize the breathing mechanism, gaseous exchange, human neural system and its conduction of nerve impulse.
7. Ability to understand the necessary information about the human body mechanism with its physiological functions

| Module:1 | Basics of Anatomy and Physiology | 2 hours |
|---|---|---|

Introduction to Human anatomy and physiology- Anatomical and medical terminology- Structure of the human cell – Four primary tissues, organs and organ systems – Physiology of homeostasis. Osteology and joints- Muscles.

| Module:2 | Blood and Body Fluids | 2 hours |
|---|---|---|

Body fluids- Composition and functions of blood- Plasma proteins- Red blood cells, White blood cells and platelets- Blood groups and blood clotting.

| Module:3 | Endocrine and Reproductive Systems | | 2 hours |
|---|---|---|---|

Concept of hormone – Types of hormones and hormone receptors – Adenohypophysis and neurohypophysis, Thyroid gland, Para thyroid gland, Islets of Langerhans, Adrenal modules and adrenal cortex – Male reproductive organs and functions of androgens, Female reproductive organs, functions of oestrogen and progesterone

| | | | | | |
|---|---|---|---|---|---|
| **Module:4** | **Cardiovascular System** | | | | **2 hours** |
| Structure of the heart and blood vessels, Conducting system of the heart and electrocardiogram, Arterial blood pressure – Factors maintaining blood pressure, Factors regulating blood pressure. | | | | | |
| | | | | | |
| **Module:5** | **Respiratory System** | | | | **1 hours** |
| Organs of respiratory system – Structure of lungs, Mechanics of breathing, Lung volume and capacities- Transport of Oxygen in the blood, Transport of carbon-di-oxide in the blood Regulation of respiration- Hypoxia, Dyspnoea. | | | | | |
| | | | | | |
| **Module:6** | **Nervous System and Special Senses** | | | | **2 hours** |
| Structure of neuron- Resting membrane potential and action potential, Neuromuscular junction, Synaptic transmission, Brain and spinal cord, Reflex arc and reflex action, Functions of the parts of the brain – Vision, hearing, taste and smell | | | | | |
| | | | | | |
| **Module:7** | **Urinary System and Digestive System** | | | | **3 hours** |
| Structures of urinary system (malphigian corpuscles, Proximal convoluted tubule, loop of Henle and Distal convoluted tubule), Functions of the kidney, Innervations of urinary bladder, Organs of digestive systems - Salivary secretion, gastric secretion and pancreatic secretion, Bile secretion and functions of liver. Absorption of food substances. Movements of digestive tract. | | | | | |
| | | | | | |
| **Module:8** | **Contemporary Issues** | | | | **1 hour** |
| | | | | | |
| | **Total Lecture:** | **15** | **hours** | | |
| **Text Book** | | | | | |
| 1. | Anne Waugh, Allison Grant, "Ross and Wilson Anatomy and Physiology in Health and Illness"**,** 2014, 12th Edition, Churchill Livingstone, London. | | | | |
| **Reference Books** | | | | | |
| 1. | Richard S. Snell, "Clinical Anatomy by Regions", 2011, 8th edition, Lippincott Williams & Wilkins, Philadelphia. | | | | |
| 2. | Gerard J. Tortora, Bryan H. Derrickson, "Principles of Anatomy and Physiology", 2014,14th Edition, Wiley, New Jersey | | | | |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT | | | | | |
| Recommended by Board of Studies | | 14.09.2017 | | | |
| Academic Council | No: 47 | **Date** | | **05.10.2017** | |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| **ECE5000** | **BASIC ELECTRONICS AND MEASUREMENTS (Bridge Course)** | **1** | **0** | **0** | **0** | **NA** |
| **Prerequisite** | **Nil** | **Syllabus Version** | | | | |

**Course Objectives:**

1. To describe the basic concepts of electrical circuits and to demonstrate the analysis of DC and AC circuits using node and mesh analysis method; To acquaint the students with different types of diodes, transistors and op-Amps.
2. To elucidate the concepts of logic Circuits, memory types and illustrate the architecture and interfacing of 8051 microcontroller.
3. To teach the students to classify and perform several operations of signals; represent the signals and introduce the properties of Continuous and discrete time Fourier transform.
4. To acquaint the students with the different types of sensors and transducers, and their characteristics.

**Expected Course Outcome:**

The students will be able to

1. Analyze electric circuits using the circuit laws and to comprehend the I-V characteristics of diodes.
2. Gains ability to design amplifiers and voltage followers; comprehend the characteristics of op-Amps.
3. Cognize the various logic circuits and memory types; ability to synthesize logic circuits.
4. Comprehend the architecture and instruction sets and programming related to 8051 microcontroller.
5. Assimilate the properties of discrete and continuous time Fourier transforms.
6. Investigate, design and implement small projects, applying the basics acquired from the types of sensors and transducers

| Module:1 | Semiconductor Devices and Circuits | 2 hours |
|---|---|---|

PN Junctions- Formation of Junction- Physical operation of diode, Contact potential and Space Charge phenomena, I - V Characteristics, Zener diode- Introduction to BJT, FET, MOSFET, amplifiers based on BJT and FET - Ohm's Law - KCL, KVL, Node Voltage Analysis, Mesh Current.

| Module:2 | Integrated Circuits | 2 hours |
|---|---|---|

Op-Amp Fundamentals, Practical Limitations of op-amps, Frequency compensation and stability, Gain bandwidth product, Voltage Follower, Introduction to Instrumentation amplifier.

| Module:3 | Digital Systems | 2 hours |
|---|---|---|

Basic Logic Circuit Concepts- Representation of Numerical Data in Binary Form - Combinatorial and Sequential Logic Circuits - Synthesis of Logic Circuits - Computer Organization - Memory Types.

| Module:4 | 8051 Microcontroller | 2 hours |
|---|---|---|

Introduction to 8051 microcontroller and it's architecture - Memory organization - Instruction sets and assembly language programming - Programming timers – interrupts - I/O ports and serial port - I/O interfacing.

| Module:5 | Signals and Systems | 2 hours |
|---|---|---|
| Continuous-time and Discrete-time Signals: Representation of signals, Signal classification, Types of signals - Operations on signals - Scaling, Shifting, Transformation of independent variables, Sampling LTI Systems - Continuous-Time and Discrete-Time Fourier transforms - Properties. | | |
| | | |
| **Module:6** | **Sensors** | **2 hours** |
| Resistive sensors- Potentiometers, Strain gages, Pressure resistive temperature detectors (RTD), Thermistors, Magneto resistors, Light dependent resistor (LDR). Capacitive sensors- Variable capacitor, Differential capacitor. Inductive sensors - Variable reluctance sensors, Eddy current sensors, Linear variable differential transformers (LVDT), Variable transformers, Magneto-elastic and Magnetostrictive sensors. | | |
| | | |
| **Module:7** | **Biopotential Measurement** | **2 hours** |
| Transducers - Electric Transducers – Classification based upon principle of transduction, Characteristics and choice of Transducers, Classification and basic requirements of bio transducers, Factors influencing the choice of the transducer in measuring the Physiological Parameters- Electrodes for ECG, EEG, EMG, EOG. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **1 hour** |
| | | |
| | **Total Lecture hours:** | **15 hours** |

**Text Books**

| | |
|---|---|
| 1. | Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, "Microelectronic Theory and Applications", 2013, 6th edition, Oxford University Press, NewDelhi |
| 2. | E.W Golding, F.C Widdis, "Electrical Measurements and Measuring Instruments", 2011, 1st edition, Reem Publications Pvt. Ltd, NewDelhi. |

**Reference Book(s)**

| | |
|---|---|
| 1. | Allan V. Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", 2015, 2nd edition, Pearson Education India, Bengaluru. |
| 2. | Roy Choudhury and Shail Jain, "Linear Integrated Circuits", 2011, 1st edition, Wiley Eastern Ltd, Bengaluru. |
| 3. | William L Fletcher, "Engineering Approach to Digital Design", 2015, 1st edition, Pearson Education India, Bengaluru. |
| 4. | Muhammad Ali Mazidi, Janice Giillispie Mazidi, "8051 Microcontroller and Embedded Systems", 2014, 2nd edition, Pearson New International Edition, Essex. |
| 5. | Jacob Millman, Christos C Halkias and Satyabrata Jit, "Electronic devices and circuits", 2015, 2nd edition, Tata Mc Graw Hill, NewDelhi. |
| 6. | John. G. Webster and Halit Eren, "Measurements, Instrumentation and Sensors Handbook: spatial, mechanical, thermal and radiation measurements", 2014, 2nd edition, CRC Press, Florida. |

**Mode of Evaluation:** CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT

| Recommended by Board of Studies | | 14.09.2017 | |
|---|---|---|---|
| **Academic Council** | **No: 47** | **Date** | **05.10.2017** |

VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ECE5046 | BIOMEDICAL SENSORS AND DATA ACQUISITION TECHNIQUES | 2 | 0 | 2 | 4 | 4 |
| Prerequisite | Nil | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. To relate the principles of bio potential sensing and electrodes to biomedical applications
2. To identify the type of signal conditioning needed and the data acquisition cards for a specific sensor output
3. To acquaint the students with the communication standards and PC buses for data acquisition
4. To introduce virtual instrumentation and the hardware interfacing.

**Expected Course Outcome:**

The student will be able

1. Perceive the origin of bio signals and their measurement
2. Prescribe a sensor type to measure a specific physiological parameter.
3. Describe the different Bio signals and their characteristics
4. Design signal conditioning circuit for specific biomedical signal.
5. Select a type of interface and data acquisition system for the given biomedical signal.
6. Identify the communication protocol for the given bio signal.
7. Develop graphical user interface for biomedical signal acquisition and analysis.
8. Design a prototype of a medical device

| Module:1 | Bioelectrodes | 4 hours |
|---|---|---|

Origin of bio potential and its propagation. Electrode-electrolyte interface, Electrode–skin interface, Half-cell potential, Impedance, Polarization effects of electrode – Non-polarizable electrodes. Types of electrodes - Surface, Needle and Micro electrodes and their equivalent circuits. Recording problems - Measurement with two electrodes.

| Module:2 | Physiological Transducers | 5 hours |
|---|---|---|

Thermoresistive – Thermoelectric – Semiconductor - Piezoelectric sensors- Electrets in Capacitive transducers- Pyroelectric effect – Piezoresistive effect- strain gauges- Hall Effect- Magnetostrictive effect, SQUID – AC/DC bridges - Temperature compensation.

| Module:3 | Fundamentals of Bioelectric Signal Acquisition | 2 hours |
|---|---|---|

Introduction to bioelectric signals- Configuration and structure- Interface systems- Review of quantization in amplitude and time axis.

| Module:4 | Bioamplifiers | 4 hours |
|---|---|---|

Need for bio-amplifier - Single ended bio-amplifier, Differential bio-amplifier – Right leg driven ECG amplifier- Band-pass filtering, Isolation amplifiers – Transformer and optical isolation - Isolated DC amplifier and AC carrier amplifier. Chopper amplifier- Power line interference, Macroshock and Microshock, Preventive measures to reduce shock hazards

| Module:5 | DAQ cards | 5 hours |
|---|---|---|

Analog to digital conversion and Data acquisition cards- Analog and digital inputs, Counter timer I/O-accuracy and dynamic range, Speed vs throughput-Acquisition of general waveforms and biosignals- Issues in online monitoring- Web-based online monitoring.

| | | |
|---|---|---|
| **Module:6** | **Interface Standards and PC Buses** | **3 hours** |
| RS232, RS422, RS485, GPIB, USB – Firewire - Backplane buses - PCI, PCI-Express, PXI, PXI Express, VME, VXI - Ethernet –TCP/IP protocols. | | |
| | | |
| **Module:7** | **Virtual Instrumentation** | **5 hours** |
| Virtual instrument and traditional instrument, hardware and software-Building Graphical User interfaces for use in data acquisition - Graphical programming- Multi-channel data acquisition in LabVIEW | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Leslie Cromwell, “Biomedical Instrumentation and Measurement”, 2015, 2nd Edition, Pearson Education India, Bengaluru. |
| 2. | John G. Webster, “Medical Instrumentation Application and Design”, 2015, 4th Edition, John Wiley and sons, NewJersey. |
| **Reference Book(s)** | |
| 1. | Robert H King, "Introduction to Data Acquisition with LabVIEW", 2012, 2nd Edition, McGraw Hill, NewYork. |
| 2 | Joseph Bronzino and Donal R. Peterson, Handbook of Biomedical Engineering, 2015, 4th Edition, CRC Press, Florida. |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT. | |

| | | |
|---|---|---|
| **List of Challenging Experiments (Indicative)** | | |
| 1. | Interface ECG electrodes with a PC, using virtual instrumentation platform to acquire ECG signal and determine the heart rate. | 6 hours |
| 2. | Design a pulse oximeter using optical sensors and interface it with a PC, using virtual instrumentation platform to measure peripheral pulse | 6 hours |
| 3. | Interface EMG electrodes with a PC, using virtual instrumentation platform to acquire the signal from different muscles | 6 hours |
| 4. | Interface temperature sensor with data acquisition system to monitor the body temperature and calibrate the same | 6 hours |
| 5. | Interface hot wire anemometer with data acquisition system to measure the air flow rate and calibration of the same | 6 hours |
| | Total Laboratory Hours | 30 hours |
| Mode of Evaluation: Continuous assessment and FAT | | |

**List of Projects (Indicative)**

1. Design a mobile human air bag system for fall protection
2. Develop a wearable physiological parameter monitoring system to monitor the ECG, PPG and temperature of a subject
3. Apply multi sensor technology and develop a mobility system to assist the visually impaired.
4. Develop a wheel chair controlled by voice signal for physically challenged.
5. Develop a screening system of foot ulceration in diabetic patients using FSR sensor

Mode of Evaluation: Review I, II, III

| | |
|---|---|
| Recommended by Board of Studies | 14.09.2017 |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| **ECE5047** | **BIOSIGNAL PROCESSING AND ANALYSIS** | **3** | **0** | **2** | **0** | **4** |
| **Prerequisite** | **Nil** | Syllabus Version | | | | |
| | | 1.1 | | | | |

**Course Objectives:**

1. Compare the basic concepts of signals and analyse time and frequency based transforms
2. To brush the basics of digital filters
3. Students have to investigate the events in the signals
4. Interpret the basic architecture of the DSP processor TMS 320 and its implementation, applications.

**Expected Course Outcome:**

The students will be able

1. Comprehend and analyse the signals in different statistical methods
2. To acquaint the transforms enactments on bio signal
3. Comprehend the implementations of filters in biosignals
4. EEG analysis and modelling
5. To familiarize the digital signal processor with its application aspects
6. Appreciate the operation of processors and its special applications
7. Acquaint the ECG processing and pattern recognition

| **Module:1** | **Introduction to Biomedical Signal Analysis** | **3 hours** |
|---|---|---|

Introduction to signals - Time domain - Statistical and information theoretic analysis.

| **Module:2** | **Time-Frequency Domain Analysis** | **8 hours** |
|---|---|---|

Fourier spectrum of biosignals, short-time Fourier transform and spectrogram - DCT and its applications - Wavelet transform and time frequency analysis - Hilbert transform and its applications - Empirical mode decomposition and empirical wavelet transform - correlation analysis and power spectral estimation.

| **Module:3** | **Digital Filters** | **7 hours** |
|---|---|---|

Types of artefacts and noise - Time domain filters, frequency domain filters, notch and comb filters, optimal filtering, adaptive filters - Signal decomposition based filtering.

| **Module:4** | **Event Detection and Feature Extraction Techniques** | **7 hours** |
|---|---|---|

Signal segmentation - Envelop extraction and analysis, temporal, spectral, statistical, information theoretic and cross spectral features - Waveform complexity.

| **Module:5** | **Digital Signal Processors** | **5 hours** |
|---|---|---|

General purpose DSP processors, architecture, hardware configuration, software development tools - Implementation considerations, fixed point DSP processors, floating point DSP processors.

| **Module:6** | **TMS320 Family of DSP processors** | **7 hours** |
|---|---|---|

Architecture - Functional units - Pipelining-Registers - Linear and Circular addressing - Types

| | | |
|---|---|---|
| of instructions - Sample Programs - Real Time Implementation on DSP processors - Factors to be considered for optimized implementation based on processor architecture: Implementation of simple Real Time Digital Filters, FFT using DSP - Overview of Black Fin Processors. | | |
| | | |
| **Module:7** | **Case Studies** | **6 hours** |
| Linear discrimination - detection of motor activity from EMG, Harmonic analysis - Estimation of heart rate in ECG - Auto-regressive model - Estimation of spectrum of thoughts in EEG - Mmatched and Wiener filter for filtering in ultrasound. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

| **Text Book(s)** | |
|---|---|
| 1. | Rangaraj M. Rangayyan, "Biomedical Signal Analysis", 2015, 2nd Edition, Wiley-IEEE Press, New York. |
| **Reference Book(s)** | |
| 1. | Nasser Kehtarnavaz, "Real Time Signal Processing Based on TMS320C6000", 2011, 2nd Edition, Elsevier, Netherlands. |
| 2. | Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", 2012, 1st Edition, Wiley, New York. |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, online courses, Paper publication, Hackathon/Makeathon and FAT | |

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | Acquire noisy ECG signal. The sampling rate of the signal is 1,000 Hz. Develop a MATLAB program to perform synchronized averaging. Select a QRS complex from the signal for use as the template and use a suitable threshold on the cross-correlation function for beat detection. Plot the resulting averaged QRS complex and comment it. Observe the results when the threshold on the cross-correlation function is low (0.4) or high (0.95). | 6 hours |
| 2. | Record the EEG signals with spike-and-wave complexes. The sampling rate is 100 Hz per channel. Cut out one spike-and-wave complex from any EEG channel and use it as a template. Perform template matching by cross-correlation or by designing a matched filter. Apply the procedure to the same channel from which the template was selected as well as to other channels. Study the results and explain how they may be used to detect spike-and-wave complexes. | 6 hours |
| 3. | Acquire the ECG signal which contains a large number of PVCs, including episodes. Apply the Pan-Tompkins procedure to detect and segment each beat. Label each beat as normal or premature by visual inspection. Record the number of beats missed. Compute the RR interval and the form factor FF for each beat. Use a duration of 80 samples (400 ms) spanning the QRS - T portion of each beat to compute FF. The P wave need not be considered in the present exercise. Compute the mean and standard deviation of the FF and RR values for the normal beats and the PVCs. Evaluate the variation of the two parameters between the two categories of beats. | 6 hours |
| 4. | Compute the PSDs of a few channels of the EEG in the file eegl-xx.dat | 6 hours |

| | | | | |
|---|---|---|---|---|
| | using Welch's procedure. Study the changes in the PSDs derived with variations in the window width, the number of segments averaged, and the type of the window used. Compare the results with the PSDs computed using the entire signal in each channel. Discuss the results in terms of the effects of the procedures and parameters on spectral resolution and leakage. | | | |
| 5. | The file speech.wav contains the speech signal for the word "safety" uttered by a male speaker, sampled at 8 kHz. The signal has a significant amount of background noise. Develop procedures to segment the signal into voiced, unvoiced, and silence portions using ZCR measures. Compute the model based PSD for each segment. Compare the model PSD with the FFT-based PSD for each segment. What are the advantages and disadvantages of the model-based PSD in the case of voiced and unvoiced sounds? | | | 6 hours |
| | | | Total Laboratory Hours | 30 hours |
| Mode of Evaluation: Continuous assessment and FAT | | | | |
| Recommended by Board of Studies | | 14.09.2017 | | |
| Academic Council: | No: 47 | **Date** | **05.10.2017** | |

<table>
<tr><td>Course Code</td><td colspan="2">Course Title</td><td>L</td><td>T</td><td>P</td><td>J</td><td>C</td></tr>
<tr><td>ECE5048</td><td colspan="2">EMBEDDED SYSTEM AND IoT FOR BIOMEDICAL APPLICATIONS</td><td>3</td><td>0</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td>Prerequisite:</td><td colspan="7">Nil</td></tr>
<tr><td></td><td colspan="7">Syllabus Version: 47</td></tr>
<tr><td colspan="8">Course Objectives:</td></tr>
<tr><td colspan="8">1. Develop a comprehensive understanding of the technologies behind the embedded systems<br>2. Discover the programming concepts and embedded programming in linux<br>3. Discuss the overview of embedded networking<br>4. Introduce student to the Internet of things (IOT) with interfacing sensors, actuators for portable gadgets.</td></tr>
<tr><td></td><td colspan="7"></td></tr>
<tr><td colspan="8">Expected Outcomes:</td></tr>
<tr><td colspan="8">1. To understand the architectural blocks in 32 bit microcontrollers<br>2. Ability to develop appreciation of the technology capabilities and limitations of the hardware, software components for building embedded systems.<br>3. Aware of fundamentals of programming concepts<br>4. Acquire basic knowledge about the system control to perform a specific task.<br>5. Understand the IoT application development.<br>6. Implement the IoT concept in biomedical applications.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="2"></td><td colspan="6"></td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Module:1</td><td>Introduction to Embedded Systems</td><td colspan="6">5 hours</td></tr>
<tr><td colspan="8">Characteristics of embedded computing applications, concepts of real time systems, general purpose and customized processor, different architectures, caches, virtual memory. Embedded design life cycle – Tools used in Design Process – Challenges in Embedded system design for bio medical applications.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Module:2</td><td>Health care System design using general purpose processor</td><td colspan="6">7 hours</td></tr>
<tr><td colspan="8">ARM instruction set, ,ARM Cortex MX architecture, bus, exception, floating point implementation, memory map, bit banding, peripherals, Programming the peripherals, ADC,DAC, GPIO, Timer, PWM, UART, SPI, I2C, Embedded health care monitoring systems ( Temperature, BP, Blood Glucose, non-invasive pulse oximeter, ECG & panic alarm).</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Module:3</td><td>Embedded Linux programming</td><td colspan="6">5 hours</td></tr>
<tr><td colspan="8">Fundamentals of Linux, shell scripting, process and thread creation, semaphores, single board computers (Raspberry pi)</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Module:4</td><td>Embedded Networking</td><td colspan="6">5 hours</td></tr>
<tr><td colspan="8">UART, I2C, WIFI, Bluetooth, Zigbee, Ethernet, Infrastructures for networking , LAN, Routers, Switches, hub, WLAN, Access Points, Hubs, Linux Network configuration Concepts: Networking configurations in Linux Accessing Hardware & Device Files interactions, IP and MAC addressing</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td>Module:5</td><td>IoT Architecture and platforms</td><td colspan="6">7 hours</td></tr>
<tr><td colspan="8">HistoryofIoT,M2M communication, Web of Things, IoT protocols, IOT reference layer,IoTCommunicationPattern,IoTprotocolArchitecture,6LoWPAN, Security aspects in IoT,</td></tr>
</table>

| | | |
|---|---|---|
| Hardware platforms- ARM Cortex Processors, TI CC3200 Launch pad, Intel Galileo boards, fast prototyping using Proteus, Single board computers(SBC), Aurdino. | | |
| | | |
| **Module:6** | **Sensors with Cloud and Internet connectivity** | **7 hours** |
| Streaming sensor data to Internet, Control of IO ports on Sensor hardware from Internet, Headless systems programming and configuring, Working with MAC Addresses , Cloud Dashboards and Monitoring | | |
| | | |
| **Module:7** | **IoTin Biomedical Applications** | **7 hours** |
| IoT client and IoT gateway in healthcare, IoT driven smart health care application for everyday use, life critical applications, Health care IOT for rural area, Use of Big Data and Visualization in IoT, Industry4.0 concepts., sensor markup language | | |
| | | |
| **Module:8** | **Contemporary Issues:** | **2 hours** |
| | | |
| | **Total Lecture:** | **45 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Samuel Greengard, “The Internet of Things”, 2015, 1st Edition, MIT Press. |

**Reference Book(s)**

| | |
|---|---|
| 1. | Peter Waher, Learning Internet of Things, 2015, 1st Edition, Packt Publishing, Birmingham, United Kingdom |
| 2. | Arshdeep Bahga, Vijay Madisetti, “Internet of Things” (A Hands-on-Approach), 2014, 1st Edition, VPT publishing Inc. |
| 3. | Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, 2013, 1st Edition, Wiley. |

**List of Projects:**

1. Design an IoT System for Vital Sign Monitors
   i. Weight measuring device
   ii. Blood pressure measuring device
   iii. ECG
   iv. Blood glucose measuring device
   v. Heart rates measuring devices
   vi. Pulse Oximeters

2. Design an IoT System for Activity Monitors
   i. Walking time measuring device
   ii. Step counting device
   iii. Speed measuring device
   iv. Calorie spent measuring device
   v. Time spent in rest or sleeping measuring device

Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT.

| | | | |
|---|---|---|---|
| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ECE5052 | MEDICAL IMAGE PROCESSING | 2 | 0 | 2 | 4 | 4 |
| Prerequisite | Nil | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. To define the principles of image sampling, quantization, enhancement and filtering techniques
2. To discover the different image compression methods and morphological based processes and machine learning techniques for image segmentation
3. To develop the methods of image registration and visualization for medical applications
4. To acquire the student with the techniques of shape analysis and image classification using neural networks for brain computer interface and computer aided diagnosis.

**Expected Course Outcome:**

The student will be able

1. Comprehend image sampling and DFT
2. Process the given medical images to enhance them
3. Apply compression techniques and morphological operations for segmentation
4. Predict a machine learning algorithm on the given image for segmentation
5. Register images of different modalities, render their volumes for visualization
6. Use neural networks for image classification
7. Design and develop algorithms to process and visualize images from different modalities
8. Develop algorithms to process and visualize images from different modalities for diagnostic application

| Module:1 | Image Fundamentals | 2 hours |
|---|---|---|
| Image perception- Image model- Image sampling and quantization - 2D DFT and DCT. | | |

| Module:2 | Image Enhancement and Filtering | 5 hours |
|---|---|---|
| Image enhancement- Histogram modelling, Spatial operations - Image restoration, Noise models, Image degradation model, Wiener filtering, Maximum entropy restoration | | |

| Module:3 | Image Compression and Morphological Processing | 4 hours |
|---|---|---|
| Image compression - Lossy and lossless Compression, Predictive techniques - Dilation, Erosion, Open, Close, Skeleton operations, Top-hat algorithm - Morphology based segmentation | | |

| Module:4 | Image Segmentation | 5 hours |
|---|---|---|
| Machine Learning based segmentation algorithms - Singular Value Decomposition (SVD) - Principal Component Analysis and its applications - Support Vector Machine and its applications - Independent Component Analysis and its application | | |

| Module:5 | Image Registration and Visualization | 4 hours |
|---|---|---|
| Image Registration - Medical image Fusion, SPECT/CT, MR/CT, PET/CT - Image visualization - Volume Rendering, Surface rendering and Maximum Intensity Projection | | |

| Module:6 | Shape Analysis and Image Classification | 4 hours |
|---|---|---|
| Topological attributes - Shape orientation descriptors, Fourier descriptors, - K means clustering, | | |

| | | |
|---|---|---|
| machine learning, Neural Network approaches- Statistical Parametric Mapping in Imaging - Regression analysis | | |
| | | |
| **Module:7** | **CAD and Brain Computer Interface** | **4 hours** |
| Applications of Computer Aided Design (CAD) - General Linear Model (GLM) and its application in functional brain mapping - Group analysis using t-test - Computer Aided Manufacturing (CAM) in Medical Imaging applications, Patient specific modelling - Brain Computer Interface (BCI) and its applications in Neuroscience | | |
| | | |
| **Module:8** | **Contemporary Issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30hours** |

| | | |
|---|---|---|
| **Text Book** | | |
| 1. | Reiner Salzer, "Biomedical Imaging: Principles and Applications", 2012, 1st Edition, Wiley, New Jersey | |
| **Reference Books** | | |
| 1. | Jonathan Wolpaw, Elizabeth Winter, (Eds.) "Brain-Computer Interfaces: Principles and Practice", 2012, 1st Edition, Oxford University Press, Oxford. | |
| 2 | Pears, Nick, Liu, Yonghuai, Bunting, Peter (Eds.) "3D Imaging, Analysis and Applications", 2012, 2nd Edition, Springer, Berlin. | |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT | | |
| **List of Challenging Experiments (Indicative)** | | |
| 1. | Using spatial filters enhance the given noisy image. Compare the performance of various filters | 6 hours |
| 2. | Design suitable filters in frequency domain for noise removal from the given image | 6 hours |
| 3. | Using region growing algorithm segment the gray matter, white matter and CSF from the given MR brain image | 6 hours |
| 4. | Extract the features of interest from the given CT abdomen images and classify | 6 hours |
| 5. | Read the given PET and CT image and register them. | 6 hours |
| | Total Laboratory Hours | 30 hours |
| Mode of Evaluation: Continuous assessment and FAT | | |
| **List of Projects (Indicative)** | | |

1. Develop an optical character recognition system to classify optical patterns corresponding to alphanumeric or other characters for Electronic Medical Record applications
2. From the given MR images segment the tumour tissues and classify them as benign and malignant.
3. Develop an algorithm to detect Leukaemia types from digital microscopic images
4. Segment the organs of the abdomen from the given ultrasound image and using morphological segmentation method.
5. Develop a code for Digital 3D Facial Reconstruction Based on Computed Tomography skulls

Mode of Evaluation: Review I, II, III

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|---|---|---|---|
| Recommended by Board of Studies | | 14.09.2017 | |
| Academic Council: | No: 47 | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ECE6040 | BIOMEDICAL EQUIPMENT | 3 | 0 | 0 | 0 | 3 |
| Prerequisite | Nil | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. Discuss and express the basic principle, working and design of various bio potential recording equipment
2. To acquaint the students with the different types of flowmeters and radiation detectors and the analytical equipment used in medical field.
3. To describe the modes of operation and functioning of cardiac and respiratory devices.
4. To provide a comprehensive knowledge of the features of extracorporeal dialysis units, physiotherapy and surgical equipment.

**Expected Course Outcome:**

The students will be able to

1. Envision the design of various bio potential recording equipment and its applications
2. Comprehend the working principle and applications of the analytical equipment used in medical field.
3. Perceive the advantages and disadvantages of the different types of flowmeters and radiation detectors; limits of usage.
4. Develop first end devices for cardiology applications and to monitor respiratory parameters.
5. Summarize the variety of dialysis units, its supporting facilities and various kinds of dialyzers.
6. Intuit the application of physiotherapy and surgical equipment; range of operation.

| Module:1 | Bio Potential Recording | 6 hours |
|---|---|---|

Introduction to ECG, EEG, EMG, PCG, EOG, lead system and recording methods, typical waveform, frequency spectrum, abnormal waveforms. Evoked response, Electroencephalography, Electrocardiography, Electromyography.

| Module:2 | Analytical & Diagnostic Instruments | 6 hours |
|---|---|---|

Common analytical equipment used in hospitals and those in Biochemistry laboratories - Blood Flow meters - Pulmonary function analyzers - Blood gas analyzers - Different types of Oximetry systems - Blood pressure measurement - Blood cell counters

| Module:3 | Blood Flow Meters and Radiation Detectors | 6 hours |
|---|---|---|

Ultrasonic blood flow meters, NMR blood flow meter, Laser Doppler blood flow meters, Pulse oximeter- Radiation detectors, Pulse height analyzer, Gamma camera, Medical ultrasound, Basic pulse echo apparatus.

| Module:4 | Cardiac Devices | 6 hours |
|---|---|---|

External and Implantable Pacemaker, Performance aspects of Implantable Pacemaker - DC defibrillator, Modes of operation and electrodes, Performance aspects of dc-defibrillator, Implantable defibrillator, defibrillator analyzers - Heart lung machine- Different types of

| | | |
|---|---|---|
| Oxygenators, Pumps. | | |
| | | |
| **Module:5** | **Hemodialysis Machine** | **6 hours** |
| Basic principle of Hemodialysis and its type - Membrane, Dialysate, Different types of hemodialyzers, Monitoring Systems, Portable and Wearable Artificial Kidney, Implanting Type - Different types of dialyzer membrane. | | |
| | | |
| **Module:6** | **Physiotherapy and Surgical Instruments** | **6 hours** |
| Basic principle, working and technical specifications of Shortwave Diathermy - Ultrasonic therapy unit, Infrared and UV lamps - Nerve and Muscle Stimulator - Surgical Diathermy machine, Electrodes used with surgical diathermy, Safety aspects in electronic surgical units, Surgical diathermy analyzers. | | |
| | | |
| **Module:7** | **Ventilators and Anaesthesia System** | **7 hours** |
| Basic principles of ventilators, Different generators, Inspiratory phase and expiratory phase, Different ventilator adjuncts, Neonatal ventilators, Ventilator testing - Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Anaesthesia - Need of anaesthesia, Gas used and their sources, Gas blending and vaporizers, Anaesthesia delivery system, Breathing circuits. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

| | |
|---|---|
| **Text Book** | |
| 1. | Carr –Brown, "Introduction to Biomedical Equipment Technology", 2011, 1st Edition, Pearson, New York |
| **Reference Books** | |
| 1. | John G. Webster, "Medical Instrumentation Application and Design", 2015, 4th Edition, John Wiley and sons, New Jersey |
| 2. | R S. Khandpur, "Handbook of Biomedical Instrumentation", 2014, 3rd Edition, Tata Mc Graw Hill, New Delhi. |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT | |

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|---|---|---|---|
| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council** | **No: 47** | **Date** | **05.10.2017** |

VIT®
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| BIT5011 | REHABILITATION ENGINEERING | 2 | 0 | 2 | 0 | 3 |
| Prerequisite: | Nil | Syllabus Version | | | | |
| | | 1.1 | | | | |

**Course Objectives**

1. To identify the engineering concepts that can be applied in rehabilitation medicine and realise the role of engineers in various rehabilitation disciplines
2. To predict the design of mobility aids like wheelchair, robotic legs and fabrication process of orthoses and prosthoses
3. To discover various tools available for sensory and motor rehabilitation
4. To identify the challenges faced in paediatric and geriatric rehabilitation and formulate the ways to overcome those challenges.

**Expected Outcomes**

The students will be able to

1. Ability to apply engineering concepts in rehabilitation medicine
2. Ability to be a part of rehabilitation team and suggest appropriate technological solution to rehabilitation problems
3. Design and analysis mobility aids like wheelchair, robotic legs etc
4. Ability to design and fabricate upper and lower limb orthoses and prostheses
5. Design and analyse various tools to be used in sensory and motor rehabilitation
6. Ability to provide technical solution to overcome the challenges faced during geriatric and paediatric rehabilitation
7. Understand the contemporary issues and methods that are faced and implement respectively during the rehabilitation process

| Module:1 | Principle Of Rehabilitation Engineering | 4 hours |
|---|---|---|
| Introduction to Rehabilitation Engineering- Clinical practice of rehabilitation Engineering. Universal design - Design based on human ability - Standards for assistive technology. | | |

| Module:2 | Assistive Device Technology | 4 hours |
|---|---|---|
| Mobility aids, Different kinds of wheelchair - Robotic legs - Myoelectric arm. | | |

| Module:3 | Prosthetic And Orthotic Devices | 4 hours |
|---|---|---|
| Hand and arm replacement - Different types of models for externally powered limb prosthetics - Lower limb, Upper limb orthotics, and material for prosthetic and orthotic devices. | | |

| Module:4 | Sensory Rehabilitation | 4 hours |
|---|---|---|
| Types of deafness - Hearing aids, application of DSP in hearing aids - Cochlear implants - Voice synthesizer, speech trainer - Ultra sonic, Infrared and LASER canes - Intra ocular lens - Braille Reader - Tactile devices for visually challenged - Text voice converter - Screen readers. | | |

| Module:5 | Motor Rehabilitation | 4 hours |
|---|---|---|
| Functional Electrical Stimulation - Robotics in rehabilitation - Sports, stroke and geriatric Rehabilitation - Assistive technology for dyslexia - Computer & internet access for challenged | | |

| | | |
|---|---|---|
| people - Neural engineering in rehabilitation engineering - Role of biomedical engineer in rehabilitation. | | |
| | | |
| **Module:6** | **Geriatric Rehabilitation** | **4 hours** |
| Neurological - Visual and auditory challenges faced by geriatrics and methods to overcome those challenges. | | |
| | | |
| **Module:7** | **Pediatric Rehabilitation** | **4 hours** |
| Neurological - Visual and auditory challenges faced by cerebral palsy - Muscular dystrophy and autism children - Methods to overcome those challenges. | | |
| | | |
| **Module:8** | **Contemporary issues** | **2 hours** |
| | | |
| | **Total Lecture:** | **30 hours** |
| **Text Book(s)** | | |
| 1. | Marion A Hersh, Michael A, Johnson, "Assistive Technology for Visually impaired and blind people", 2014, 1st Edition, Springer Verlag, London. | |
| **Reference Book(s)** | | |
| 2. | Rory A, Cooper, Hisaichi Ohnabe, Douglas A, Hodson, "An Introduction to Rehabilitation Engineering", 2014, 1st edition, CRC Press, Florida. | |
| 3. | Suzanne Robitaille, "The illustrated guide to Assistive technology and devices–Tools and gadgets for living independently", 2010, 2nd Edition, Demos Health, USA. | |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT | | |
| **List of Challenging Experiments (Indicative)** | | |
| 1 | Design an FES setup and explain the feature and wave form generated. Discuss about the usage of different wave forms. | 5 hours |
| 2 | Design an obstacle system for visually challenged Identify the cost effective technology. | 5 hours |
| 3 | In case of sensing loss, perception of pain, temperature, touch is lost and the patient become vulnerable to burns and other wounds that cannot be cured easily. Design a device to help in monitoring the temperature that is sensed by hand. | 5 hours |
| 4 | Design a solution when the problems are multiple as in combination of both motor and sensory loss. This would help them understand the issues that practical implication. | 5 hours |
| 5 | Design a wheel chair of your interest considering a contemporary problem. | 5 hours |
| 6 | Device an IOT based remote control strategy for Parkinson or Alzheimer disease. | 5 hours |
| | Total Laboratory Hours | 30 hours |
| Mode of Evaluation: Continuous assessment and FAT | | |

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|---|---|---|---|
| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| **BIT6022** | **BIOMATERIALS** | **3** | **0** | **0** | **0** | **3** |
| **Prerequisite** | **Nil** | **Syllabus Version** | | | | |
| | | **1.0** | | | | |

**Course Objectives:**

1. To define the basic concepts of biomaterials, classification (metals, polymers, and ceramics, bioresorbable and biodegradable materials), different properties on materials used in medicine.
2. To describe the basics of in-vitro and in-vivo testing of biomaterials, materials degradation in body fluids and its effects.
3. To discuss the various process of wound healing and foreign body response, toxicity levels, blood material interactions and its associated infections.
4. To relate the biomaterial standards, Indian and international standards with its specifications.

**Expected Course Outcome:**

The student will be able to

1. Comprehend the basic biomaterials concepts with different classes, properties and standards to be used in healthcare industry.
2. Ability to understand the various classification of biomaterials used in medicine, its bulk and surface properties and its wide applications.
3. Appreciate the specific properties of biopolymers (synthetic and natural) and ceramics used in healthcare applications.
4. Envision the different evaluation methods to analyse the biomaterials under in-vitro and in-vivo environment with its degradation properties.
5. Perceive the knowledge on host response to biomaterial, toxic effect and its interactions.
6. Ability to understand the significant applications of biomaterials used in contact with the human body.

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| **Module:1** | **Introduction** | **6 hours** |

History of biomaterials, General Properties of Bio–materials, Classes of materials used in medicine.

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| **Module:2** | **Properties of materials** | **6 hours** |

Properties of materials - Bulk and surface properties and their characterization. Mechanical Properties of Biomaterials. Classes of materials used in medicine - Metals, Polymers, Hydrogels Bioresorbable and Biodegradable Materials

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| **Module:3** | **Metallic and Ceramic biomaterials** | **7 hours** |

Stainless steel, Titanium, Alloys, Cardiovascular Orthopaedic and Dental applications. Corrosion of Bio-metals - Types of Valve Prostheses - Cardiac Stent- Bio-Ceramics - Bio–inert ceramics, Bio–active ceramics, Biodegradable ceramics, Alumina, Zirconia, Hydroxyapatite.

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| **Module:4** | **Polymeric Biomaterials** | **7 hours** |

Types of polymers - Sterilization, Structure, Bio-compatibility relationship, Stability, Examples of polymers used in medicine - Hydrogels and drug delivery systems - Sutures, Adhesives, and Hydro colloids - Super absorbents - artificial skin and blood.

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| **Module:5** | **Testing of biomaterials** | **6 hours** |

In- vitro and In- vivo assessment of tissue compatibility - Testing of blood-materials interactions -

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| Degradation of materials in the biological environment - Effects of the Biological environment on metals, polymers and ceramics. | | |
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| **Module:6** | **Host reactions to biomaterials** | **6 hours** |
| Inflammation - Wound healing and the Foreign body response - System toxicity and Hypersensitivity - Blood coagulation and Blood-material Interactions - Tumorigenesis, Implant associated infection. | | |
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| **Module:7** | **Standards for Biomaterials** | **5 hours** |
| World standards - Indian Standards - Specifications - General specifications, Classification of Specifications. | | |
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| **Module:8** | **Contemporary Issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **45 hours** |

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|---|---|
| **Text Book** | |
| 1. | Michael F. Ashby, Hugh Shercliff, David Cebon, “Materials: engineering, science, processing and design”, 2013, 3rd Edition, Elsevier Ltd, Cambridge. |
| **Reference Books** | |
| 1. | Ratner, Hoffman, Schoen, Lemons, “Biomaterials Science”,2012, 1st Edition, Academic Press, Massachusetts. |
| 2. | Steven M. Kurtz , “PEEK Biomaterials Handbook”,2011, 1st Edition, Elsevier, Atlanta. |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT. | |

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|---|---|---|---|
| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| **BIT6023** | **BIOMECHANICS** | **3** | **0** | **0** | **0** | **3** |
| **Prerequisite:** | **Nil** | **Syllabus Version** | | | | |
| | | **1.0** | | | | |

**Course Objectives:**

1. To recall the mechanical concepts and the laws of fluid dynamics that are applicable in human body and governs the properties of biological fluids.
2. To discover and also predict the mechanics of human bones, joints, soft tissues and orthopaedic and cardiovascular implants.
3. To estimate human posture, gait during physiological and pathological conditions.
4. To model and analyse human body parts using software tools

**Expected Outcomes:**

The students will be able to

1. Ability to apply mechanical concepts to understand the movements of human body
2. Differenciate and analyse the laws of fluid dynamics in biological fluids
3. Perceive and analyse kinetics and kinematics of human bones and joints
4. Ability to understand the mechanics of ligaments, tendons and muscles
5. Understand and investigate the orthopaedic and cardiovascular implants
6. Classify and examine the posture, gait using software tools
7. Ability to choose a suitable software for particular application

| Module:1 | Introduction to Biomechanics | 6 hours |
|---|---|---|

Introduction to bio-mechanics, relation between mechanics and Medicine - Newton's laws, stress, strain, shear rate, viscosity - Fluid Mechanics: viscoelasticity, non-Newtonian viscosity, soft tissue mechanics - Mechanical properties of soft biological tissues - Euler equations and Navier Stokes equations.

| Module:2 | Mechanics and Circulation | 6 hours |
|---|---|---|

Rheology of blood and micro vessels - Dynamics of circulatory system - Turbulence flow around prosthetic heart valves.

| Module:3 | Mechanics of Biological System | 7 hours |
|---|---|---|

Orthopaedic biomechanics - Mechanical properties of bones, stress induced bone growth, kinematics and kinetics of joints - Lubrication of joints, and analysis of force in orthopaedic implants - Skeletal muscles servo mechanism - Cardio vascular control mechanism - Respiratory control mechanism.

| Module:4 | Bio -Solid Mechanics of Hard Tissues | 6 hours |
|---|---|---|

Hard Tissues - Bone structure & composition mechanical properties of bon - Cortical and cancellous bones - Viscoelastic properties, Maxwell and Voight models - anisotropy.

| Module:5 | Bio-Solid Mechanics of Soft Tissues | 6 hours |
|---|---|---|

Soft Tissues: Structure, functions, material properties and modelling of soft tissues - Cartilage,

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| Tendon - Ligament - Muscle. | | |
| | | |
| **Module:6** | **Biomechanics of Implants** | **6 hours** |
| Design of orthopaedic implant, specifications for a prosthetic joint, biocompatibility - Requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants. | | |
| **Module:7** | **Soft Computing in Biomechanics** | **6 hours** |
| Introduction to Finite Element Analysis - Analysis of bio mechanical systems using Finite element Modelling - Gait analysis using imaging tools - Design of work station. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | | |
| | **Total Lecture:** | **45 hours** |
| **Text Book(s)** | | |
| 1. | Susan J.Hall, “Basics Bio Mechanics” 2014, 5th Edition, McGraw-Hill Publishing Co, USA. | |
| **Reference Book(s)** | | |
| 1. | Pamela K. Levangie, Cynthia C. Norkin, “Joint Structure and Function: A Comprehensive Analysis”, 2011, 5th Edition, F.A. Davis Company, USA. | |
| 2. | Subrata Pal, “Text book of Biomechanics”, 2014, 1st Edition, Viva education private limited, India. | |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT. | | |

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|---|---|---|---|
| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| BIT6024 | HEALTH CARE MANAGEMENT | 3 | 0 | 0 | 0 | 3 |
| Prerequisite | Nil | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. Introduction to general management principles and basic healthcare application
2. Explore on International and national healthcare problems and issues
3. Discuss Planning, budgeting and uses of computers and information technology
4. To Explore International standards and protocol for hospital management

**Expected Course Outcome:**

The student will be able

1. Basic Management, elements of healthcare management, organizational hierarchy, Introduction to principles of management in Healthcare environment, health ergonomics and related technologies
2. Importance of Healthcare service providers, knowledge about the healthcare market in India, important requirement of health care setup system
3. Comprehend indian and global healthcare market and organisation structure
4. Knowledge of Various hierarchy of hospital system, Role of biomedical engineers
5. Communication within the hospital, Orientation and budgeting
6. Implementation of Computer and Information Management in Hospitals, software for billing, maintenance of patient records

| Module | Title | Hours |
|---|---|---|
| **Module:1** | **Introduction** | **7 hours** |

Principles of Management – Origin of principles of Management, What is management? Henry Fayol's 14 principles of Management, elements of management, organizational hierarchy, Introduction to principles of management in Healthcare environment, health ergonomics.

| Module | Title | Hours |
|---|---|---|
| **Module:2** | **Healthcare Service Providers** | **6hours** |

Role of the healthcare service providers Conventional hospital setup, types of leadership in healthcare environment, Private clinics, Corporate hospitals.

| Module | Title | Hours |
|---|---|---|
| **Module:3** | **Global and Indian Healthcare Scenario** | **6 hours** |

Global Healthcare Scenario - Global spending on healthcare, WHO Statistics, Global Healthcare Care Market, Medicare, Medicaid, Indian Healthcare Scenario – Indian healthcare system, composition, organizational structure, Indian Healthcare Market, Key Stake Holders, Global players in Indian healthcare market Case studies – USA, India and Singapore.

| Module | Title | Hours |
|---|---|---|
| **Module:4** | **Classification of Hospital Systems** | **6 hours** |

General Hospital –Specialist Hospital –Teaching – Research, Primary Health Centre –Their role, Functions. Role of Biomedical Engineers, Aspects of Hospital Services-Outpatient- Inpatient supportive emergency, drug and medical supply, Nursing Services, Dietary services, Transport services

| Module | Title | Hours |
|---|---|---|
| **Module:5** | **Hospital Planning** | **7 hours** |

Orientation, Budgeting, Communication within the hospital and outside the hospitals - Electric power supply for various theatres and rooms, Diesel generator, Stand by power supply- Air

<table>
<tr><td colspan="4">conditioning of important theatres and equipment housings - Water supply requirements & management, Lifts and firefighting equipment’s - Sanitation within the hospitals, Laundry services</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Module:6</td><td colspan="2">Computer and Information Management in Hospitals</td><td>6 hours</td></tr>
<tr><td colspan="4">Computer aided hospital management - Application, Administration/Discharge records of patients, Patient billing, Maintenance of patient records and their history - Maintenance of inventory of medicines and drugs – Purchase.</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Module:7</td><td colspan="2">Hospital Standards and Maintenance</td><td>5 hours</td></tr>
<tr><td colspan="4">Module content</td></tr>
<tr><td colspan="4">Introduction to ISO - WHO standards, FDA standards, Indian standards for biomedical equipment services, Their purchase, Servicing and maintenance- Keeping intact and throwing the condemned equipment, Training personal for medical equipment, Preventive and periodical maintenance procedures.</td></tr>
<tr><td>Module:8</td><td colspan="2">Contemporary issues:</td><td>2 hours</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td></td><td colspan="2">Total Lecture hours:</td><td>45 hours</td></tr>
<tr><td colspan="4">Text Book</td></tr>
<tr><td>1.</td><td colspan="3">Joan Gratto Liebler, Charles R. McConnell, “Management Principles for Health Professionals”, 2011, 6th Edition, Jones and Bartlett Learning, Massachusetts.</td></tr>
<tr><td colspan="4">Reference Books</td></tr>
<tr><td>1.</td><td colspan="3">Sharon Bell Buchbinder, Nancy H. Shanks, “Introduction to Health Care Management”, 2011, 1st Edition, Jones and Bartlett Learning, Massachusetts.</td></tr>
<tr><td>2.</td><td colspan="3">Walshe, Kieran, Smith, Judith, “Healthcare Management”, 2011, 1st Edition, McGraw Hill, New York</td></tr>
<tr><td colspan="4">Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT</td></tr>
<tr><td colspan="2">Recommended by Board of Studies</td><td colspan="2">14.09.2017</td></tr>
<tr><td>Academic Council:</td><td>No: 47</td><td>Date</td><td>05.10.2017</td></tr>
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VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ECE5008 | MICRO AND NANO FLUIDICS | 2 | 0 | 0 | 4 | 3 |
| Prerequisite: | Nil | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. Introduce and discuss the fundamental physics of micro and nano scale fluids and their hydrodynamics.
2. Comprehend techniques of miniaturization, methods and tools to create microfluidic architectures and discuss various existing microfluidic devices.
3. Discuss and identify the usage of microfluidics in various lab-on-chip and bioreactor applications
4. Investigate and compare microfabrication techniques to design vasculature and 3D microchannels.

**Expected Course Outcomes:**

The student will be able to

1. Inception of historical background of evolution of MEMS and Microsystems to the students.
2. Comprehend the understanding of miniaturization, methods and tools to create microfluidic architectures.
3. Highlighted various existing microfluidic devices and their fabrication technique.
4. Exposure to various microfluidic lab-on-chip applications
5. Various bioreactor based microchips were described to the students.
6. Investigation and comparison with existing techniques of various microfabrication techniques to design vasculature and 3D microchannels.
7. Design and simulation of microfluidic devices and fabrication of the same.

| Module:1 | Fundamentals for Microscale and Nanoscale Flow | 5 hours |
|---|---|---|

Fluids and nonfluids, properties of fluids, classification of fluids, Newtonian and Non Newtonian fluids, pressure driven flow, reynolds number , Electrokinetic phenomena, Electric double layer, debye length, coupling species transport and fluid mechanics, Micro channel Resistance, Shear stress, capillary flow, flow through porous media, Diffusion, surface tension, contact angle and Wetting.

| Module:2 | Hydrodynamics | 4 hours |
|---|---|---|

Introduction to surface, surface charge, surface energy, Thermodynamics of surfaces, Fluids in Electrical fields, The Navier Strokes equation, Boundary and Initial conditions problems,

| Module:3 | Fabrication methods and techniques | 4 hours |
|---|---|---|

Patterning, Photolithography, Micromachining, Micromolding, Soft lithography, PDMS properties, Fabrication of microfludics channels.

| Module:4 | Microfluidic Devices | 3 hours |
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Droplet Microfluids, Active Flow control, Microvalves, Electrically actuated microvalves, Micromixers, Combinational Mixers, Elastomeric Micromixers

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| **Module:5** | **Microfluidics Lab on Chip** | **3 hours** |
| Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment. | | |
| | | |
| **Module:6** | **Bioreactors on Microchips** | **4 hours** |
| Enzyme assay and inhibition, Chemical synthesis in microreactors, Sequential reaction and Parallel reaction in micro reactors, chemical separation, liquid chromatography | | |
| | | |
| **Module:7** | **3D Vascular Network for Engineered tissues** | **5 hours** |
| Fabrication, Microfabrication of vasculature, Materials for 3D Microfluidic vasculature, Laser Micro-machined 3D channels, Introduction to Comsol Multiphysics, Mathematical Modeling of Microchannels in Microfludics Model builder. | | |
| | | |
| **Module:8** | **Contemporary Issue** | **2 hours** |
| | | |
| | **Total Lecture:** | **30 hours** |

| | |
|---|---|
| **Text Book(s)** | |
| 1. | Clement Kleinstreuer, "Microfluidics and Nanofluidics: Theory and Selected Applications",2013, 1st ed., John Wiley & Sons, New Jersey. |
| 2. | Shaurya Prakash, JunghoonYeom, "Nanofluidics and Microfluidics: Systems and Applications",2014, 1st ed., William Andrew; Norwich, New York. |
| **Reference Book(s)** | |
| 1 | Albert Folch, "Introduction to BioMEMS", 2012, 1st ed., CRC Press, United Kingdom. |
| 2. | Patrick Tabeling, "Introduction to Microfluidics", 2011, Reprint ed., Oxford University Press, Great Britain. |
| 3. | Xiujun James Li, Yu Zhou , "Microfluidic Devices for Biomedical Applications", 2013, 1st ed., Wood head Publishing, Cambridge. |
| 4. | Terrence Conlisk. A, "Essentials of Micro- and Nanofluidics: With Applications to the Biological and Chemical Sciences", 2012, 1st ed., Cambridge University Press, New York. |
| Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects, Hackathon/Makeathon and FAT | |

**List of Projects: (Indicative)**

1. In finite element method , CFD Module is a numerical simulation platform for computational fluid dynamics (CFD) that accurately describes your fluid flow processes and engineering designs. Using the CFD Module, design a model that includes fluid flow, considering the cases for compressible, non-isothermal, non-Newtonian, multiphase, and porous media flows in the laminar and turbulent flow regimes.

2. The aim of microfluidic mixing is to achieve a thorough and rapid mixing of multiple samples in microscale devices. Design a device in which, sample mixing is essentially achieved by enhancing the diffusion effect between the different species flows. Analyze the microfluidic mixing schemes such as active, where an external energy force is applied to perturb the sample species, and passive, where the contact area and contact time of the species samples are increased through specially-designed microchannel configurations.

3. Microfluidic bioreactor systems have length scales that are well matched to the physical dimensions of most cells and microorganisms. Due to their small footprint, micro-bioreactor

platforms offer a number of advantages over conventional macroscale systems. Design a bioreactor to predict process variables, such as temperature, pH and partial pressure of oxygen (pO2) within the Microfluidic bioreactor.

4. Blood separation is a strategic preliminary step in preparation for on-chip biological analysis. Design and analyze a microfluidic device based on the principle of particle retention using micro-filter structures with different pore sizes (10~30µm) and a micro-well structure to automatically separate Red Blood cells (RBCs), White Blood cells (WBCs), and plasma into different compartments so that blood morphology study can be performed easily.

5. Polydimethylsiloxane is called PDMS, a polymer widely used for the fabrication and prototyping of microfluidic chips. Design a soft lithography mold for rapid prototyping of polydimethylsiloxane (PDMS)-based microfluidic device. Design a microfluidic device with different microfluidic channel heights (50, 100, 200, 500, 1000 and 2000 µ m) considering the other parameters for microfluidic channels were consistent [10 mm (L)×1.5 mm (W) and an inlet and outlet (0.75 mm in diameter)]. Study the flow characteristics of the fabricated microfluidic device.

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| Mode of Evaluation: Review I, II, III | | | |
| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

VIT
Vellore Institute of Technology
(Deemed to be University under section 3 of UGC Act, 1956)

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ECE5049 | MEMS & NEMS FOR BIOMEDICAL APPLICATIONS | 2 | 0 | 2 | 0 | 3 |
| Prerequisite | Nil | Syllabus Version | | | | |
| | | 1.1 | | | | |

**Course Objectives:**

1. Introduce and discuss the historical background of evolution of MEMS and Microsystems.
2. Comprehend various modern micromachining techniques and discuss scaling effects in miniaturizing devices.
3. Discuss and compare various tools and techniques to create microfluidic devices for various BioMEMS and Microfluidic applications.
4. Acquaint with various Nanofabrication techniques and discuss its effects in Bio- medical nanotechnology and Healthcare.

**Expected Course Outcome:**

The student will be able to

1. Inception of historical background of evolution of MEMS and Microsystems to the students.
2. Comprehend the understanding of various modern micromachining techniques and device fabrication.
3. Hands-on exposure to scaling effects in different Physical domains on miniaturising devices was done.
4. Exposure to various tools and techniques to create microfluidic devices for BioMEMS and Microfluidic applications .
5. Acquaintance with various applications of MEMS/NEMS in Bio- medical nanotechnology and Healthcare.
6. Incepted various Nanofabrication techniques to the students.
7. Design and simulation for developing various MEMS/NEMS devices

| Module:1 | Introduction to MEMS | 3 hours |
|---|---|---|
| What is MEMS? Historical Background- Smart materials and structures-Microsystems and their advantages-Materials used- Technology involved in MEMS | | |
| **Module:2** | **Micro Machining Technology** | **5 hours** |
| Lithography, etching, Ion implantation, Wafer bonding, Integrated processing- Bulk micro machining, Surface micro machining, Coating technology and CVD, LIGA process | | |
| **Module:3** | **Scaling** | **3 hours** |
| Scaling in Geometry-Scaling in Rigid, Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces-Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer. | | |
| **Module:4** | **Microfluidic System** | **4 hours** |
| General principles, Micro sensors, Pressure sensors, Actuators, Electrostatic forces, Piezoelectric crystals, Intelligent materials and structures - Important consideration on micro-scale fluid, Properties of fluid, Fluid actuation methods, Micro-pumps, Typical Micro-fluidic channel, Micro-fluid dispenser | | |

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| **Module:5** | **MEMS Application in Medicine (BioMEMS)** | **5 hours** |
| Special features / requirements for medical applications. Current scenario of MEMS for health care. Drug delivery systems and MEMS. Application models – Blood pressure sensors – Biochip – Micro needles-Microelectrodes- Neural prosthesis and catheter end sensors | | |
| | | |
| **Module:6** | **Biomedical Nanotechnology** | **4 hours** |
| Nanotechnology and biomedicine- Medical applications of Nanotechnology- Drug synthesis and delivery-Nano-biomedicine and diagnostic | | |
| | | |
| **Module:7** | **Nanofabrication Techniques** | **4 hours** |
| Nanofabrication methods – Nano materials in human body- Toxicity in nano-materials. Medical applications and expert lectures. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| | |
|---|---|
| **Text Book** | |
| 1. | Albert Folch, “Introduction to Biomems”,2016, 1st Edition, CRC Press, Florida. |
| **Reference Books** | |
| 1. | Francis E. H. Tay, “Microfluidics and Biomems application”, 2013, 1st Edition, Springer, Berlin. |
| 2. | Tai-Ran Hsu, “MEMS & Microsystem, Design and manufacture”,2017, 1st Edition, McGraw Hill, New York |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT | |

| | | |
|---|---|---|
| **List of Challenging Experiments: (Indicative)** | | |
| 1. | Design a non- invasive blood glucose level monitor using NIR LED on ear lobe | 6 hours |
| 2. | Development of mems based body temperature monitoring system using microsensorv(OMRON 06T) | 6 hours |
| 3. | Fall detection for geriatric patients using accelerometer and position sensor | 6 hours |
| 4. | Development of touch keypad using microsensor AT 43QT | 6 hours |
| 5. | Design of microfluidic channel system using hydrogel for separation of blood proteins of molecular weight 9-16 KD | 6 hours |
| | Total Laboratory Hours | 30 hours |
| Mode of Evaluation: Continuous assessment and FAT | | |

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| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| **ECE5050** | **PHYSIOLOGICAL CONTROL SYSTEMS** | **2** | **0** | **2** | **0** | **3** |
| **Prerequisite** | **Nil** | **Syllabus Version** | | | | |
| | | 1.1 | | | | |

**Course Objectives:**

1. To introduce the basic system concepts and differences between an engineering and physiological control systems.
2. To acquaint students with different mathematical techniques applied in analysing a system and the various types of nonlinear modelling approaches.
3. To teach neuronal membrane dynamics and to understand the procedures for testing, validation and interpretation of physiological models.
4. To study the cardiovascular model and apply the modelling methods to multi input and multi output systems.

**Expected Course Outcome:**

The students will be able to

1. Comprehend the basic system concepts and differences between an engineering and physiological control systems.
2. Understand the application of various mathematical techniques in designing a bio-control system.
3. Analyze a given system in time domain and frequency domain.
4. Comprehend the techniques of plotting the responses in both the domain analysis.
5. Apply time domain and frequency domain analysis to study the biological systems.
6. Identify and optimize the physiological control systems.
7. Develop simple models of the physiological control systems and analyze its stability.

| **Module:1** | **Introduction to Physiological Control Systems** | **4 hours** |
|---|---|---|

Introduction-Systems Analysis: Fundamental concepts – Physiological control systems analysis: simple examples – Difference between engineering and physiological control systems.

| **Module:2** | **Mathematical Modeling** | **4 hours** |
|---|---|---|

Generalized system properties – Models with combinations of systems elements – Linear models of physiological systems – Laplace transform and transfer functions.

| **Module:3** | **Time Domain Analysis of Linear Control Systems** | **4 hours** |
|---|---|---|

Linearized Respiratory Mechanics: open loop vs closed loop - Open loop and closed loop Transient Response: First Order Model, Second Order Model - Descriptors of Impulse and Step Responses - Open loop versus closed loop Dynamics - A Model of Neuromuscular Reflex motion.

| **Module:4** | **Frequency Domain Analysis of Linear Control Systems** | **4 hours** |
|---|---|---|

Steady state responses to sinusoidal inputs - Graphical representation of frequency response - Frequency response of a model of circulatory control - Frequency response of Glucose Insulin regulation.

| **Module:5** | **Stability Analysis** | **4 hours** |
|---|---|---|

Stability and Transient Response - Root Locus Plots - Routh - Hurwitz Stability Criterion - Nyquist Criterion for Stability - Relative Stability - Stability Analysis of the Pupillary light Reflex - Model of Cheyne-Stokes Breathing.

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|---|---|---|
| **Module:6** | **Identification of Physiological Control Systems** | **4 hours** |
| Basic problems in physiological system analysis-Non parametric and parametric identification methods-Problems in parameter estimation: Identifiability and input design-Identification of closed loop systems. | | |
| **Module:7** | **Optimization in Physiological Control** | **4 hours** |
| Optimization in systems with negative feedback – single parameter optimization: control of respiratory frequency – Constrained optimization: Airflow pattern regulation –constrained optimization: control of Aortic flow-Adaptive control of physiological variables. | | |
| **Module:8** | **Contemporary Issues** | **2 hours** |
| | **Total Lecture hours:** | **30hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | Michael C.K. Khoo, Physiological Control Systems: Analysis, Simulation and Estimation, 2012, 1st Edition, Prentice Hall of India. |
| 2. | Joseph DiStefano, Dynamic Systems Biology Modeling and Simulation, 2015, 1st Edition, Academic Press, Massachusetts. |

**Reference Book(s)**

| | |
|---|---|
| 1. | H. Thomas Milhorn, Application of Control Theory to Physiological Systems, 2010, 1st Edition, Saunders (W.B.) Co Ltd., Philadelphia,. |
| 2. | Robert Rushmer, Medical Engineering – Projections for Health Care Delivery, 2012, 1st Edition, Academic Press, Massachusetts. |
| 3. | David Cooney, Bio-Medical Engineering Principles, 2015, 1st Edition, Marcel Deckker Pub Co., New York. |

Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | Develop a mathematical model and analyse the response of muscle stretch reflex mechanism for an impulse input. | 6 hours |
| 2. | Develop the simplified model of cardiovascular system and measure the rise time, peak overshoot, settling time and steady state error for the nominal values of L, C and R and compare with the response of diseased person. | 6 hours |
| 3. | Identify the physiological system from the time response analysis for the known input and output conditions. | 6 hours |
| 4. | Frequency response analysis and designing of lag/lead compensator for improving the phase margin, gain margin and bandwidth of the light pupil reflex model. Estimate the rage of K for stability. | 6 hours |
| 5. | Design of controllers (P,PI, PID) for improving time domain specifications of lung mechanics | 6 hours |
| | Total Laboratory Hours | 30 hours |

Mode of Evaluation: Continuous Assessment and FAT

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|---|---|---|---|
| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

<table>
<tr><td>Course Code</td><td>Course Title</td><td>L</td><td>T</td><td>P</td><td>J</td><td>C</td></tr>
<tr><td>ECE5051</td><td>ARTIFICIAL NEURAL NETWORKS</td><td>3</td><td>0</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Prerequisite</td><td>Nil</td><td colspan="5">Syllabus Version</td></tr>
<tr><td colspan="2"></td><td colspan="5">1.0</td></tr>
<tr><td colspan="7">Course Objectives:</td></tr>
<tr><td colspan="7">1. To study basics of biological Neural Network<br>2. To understand the basics of artificial Neural Network<br>3. To study different pattern recognition task using ANN</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="7">Expected Course Outcome:</td></tr>
<tr><td colspan="7">1. Acquire the information about components of biological neurons namely, the dendrites, the axons and the cell body.<br>2. Will be expedient in the concepts and classify the features of fundamental neural network models such as perceptron, McCulloch Pitts, and ADALINE.<br>3. Understand and analysis the mechanism of backpropagation in neural networks along with importance of tuning parameters.<br>4. Elaborate on concepts of Activation and Synaptic dynamics.<br>5. Understand the basics of competitive learning neural network, pattern recognition and pattern mapping.<br>6. Understand the basic gradient search methods, stochastic networks and machine learning based optimization mechanisms.<br>7. Visualize the components of competitive learning neural networks and to differentiate the features of ART models.<br>8. Develop real-time working prototypes of different small-scale and medium-scale artificial neural network based systems to address Engineering challenges.</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td></td><td colspan="6"></td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Module:1</td><td>Introduction to ANN</td><td colspan="5">6 hours</td></tr>
<tr><td colspan="7">Features , structure and working of Biological Neural Network Trends in Computing Comparison of BNN and ANN</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Module:2</td><td>Basics of Artificial Neural Networks</td><td colspan="5">7 hours</td></tr>
<tr><td colspan="7">History of neural network research, characteristics of neural networks terminology, models of neuron McCulloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Module:3</td><td>Back propagation Networks</td><td colspan="5">7 hours</td></tr>
<tr><td colspan="7">Architecture of feed forward network, single layer ANN, multilayer perceptron, back propagation learning, input - hidden and output layer computation, backpropagation algorithm, applications, selection of tuning parameters in BPN, Numbers of hidden nodes, learning.</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Module:4</td><td>Activation & Synaptic Dynamics</td><td colspan="5">5 hours</td></tr>
<tr><td colspan="7">Introduction, Activation Dynamics models, synaptic Dynamics models, stability and convergence, recall in neural networks.</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td>Module:5</td><td>Functional units of ANN for Pattern Recognition Tasks:</td><td colspan="5">6 hours</td></tr>
<tr><td colspan="7">Basic feed forward, Basic feedback and basic competitive learning neural network. Pattern association, pattern classification and pattern mapping tasks.</td></tr>
</table>

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| **Module:6** | **Feedforward & Feedback Neural Networks** | **5 hours** |
| Linear responsibility X-OR problem and solution. Analysis of pattern mapping networks summary of basic gradient search methods. Pattern storage networks, stochastic networks and simulated annealing, Boltzmann machine and Boltzmann learning | | |
| | | |
| **Module:7** | **Competitive Learning Neural Networks :** | **7 hours** |
| Components of CL network pattern clustering and feature mapping network, ART networks, Features of ART models, character recognition using ART network, Pattern classification, Recognition of Olympic games symbols, Recognition of printed Characters. Neocognitron, Recognition of handwritten characters. NET Talk: to convert English text to speech. Recognition of consonant vowel (CV) segments, texture classification and segmentation. | | |
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| **Module:8** | **Contemporary issues:** | **2 hours** |
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| | **Total Lecture hours:** | **45 hours** |

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|---|---|---|---|
| **Text Book(s)** | | | |
| 1. | Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification, 2012, 1st Edition, John Wiley and sons, New Jersey. | | |
| **Reference Book(s)** | | | |
| 1. | Hagan, Demuth and Beale, “Neural network design”, 2014, 1st Edition, Vikas Publishing House Pvt Ltd., New Delhi, India. | | |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT | | | |
| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No:47** | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ECE6052 | NETWORKING AND INFORMATION SYSTEM IN MEDICINE | 2 | 0 | 0 | 4 | 3 |
| Prerequisite | Nil | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. Introduce fundamentals of data communication and principles of multimedia
2. Discuss the overview of available networks for telemedicine
3. Express the knowledge of tele medical standards, mobile telemedicine and its applications
4. Develop the basic parts of Tele radiology Systems like Image Acquisition System, Display System, Communication Network, Interpretation

**Expected Course Outcome:**

1. Comprehensive coverage to concepts of Telemedicine
2. To apply multimedia technologies telemedicine
3. Develop a protocols behind encryption techniques for secure data transmission
4. Students will acquire a basic knowledge about the hospital at home and remote diagnostics
5. Understand the often complex legal, regulatory and reimbursement in telemedicine
6. Able to identify and address the sociotechnical factors in telehealth

| Module:1 | Introduction to Networking | 4 hours |
|---|---|---|
| Introduction, System Components, Networked Communities, Host Management, User Management- Application Level Services, Network Level Services, Principles of Security, Security Implications, and Analytical System Administration. | | |

| Module:2 | Communication Network and Services | 4 hours |
|---|---|---|
| Types of information: Audio, Video, Still Images, Text and data, and Fax - Types of Communication and Network: PSTN, POTS, ATN, and ISDN - Basic concepts of Communication and Network: Internet, and Wireless communications. | | |

| Module:3 | Standards for Data Exchange | 4 hours |
|---|---|---|
| Real-time Telemedicine. Data Exchange: Network Configuration, circuit and packet switching, H.320 series (Video phone based ISBN) T.120, H.324 (Video phone based PSTN). Video Conferencing. | | |

| Module:4 | Hospital Management | 4 hours |
|---|---|---|
| Need for HMIS, Capabilities & Development of HMIS, functional area, modules forming HMIS, (like Pathology Lab, Blood bank, Pharmacy, Diet planning). | | |

| Module:5 | Hospital Information System | 4 hours |
|---|---|---|
| Maintenance and development of HMIS-Ideal Features and functionality of CPR, Development tools for CPR. | | |

| Module:6 | Picture Archival Communication Systems (PACS) | 5 hours |
|---|---|---|
| Types of image formats, DICOM standard, PACS system: Block diagram, Storing & retrieving images, Algorithm for retrieving images, Compressions and its significance, Lossless data Storage and in-house communication, Computer aided diagnosis (CAD), Centralized Database. | | |

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| **Module:7** | **Recent Trends in Medical Healthcare Management** | **3 hours** |
| Impact of Systems on Health Care, Care Providers and Organizations, mobile health care technologies. | | |
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| **Module:8** | **Contemporary issues** | **2 hours** |
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| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

| | |
|---|---|
| 1. | A.S. Tanenbaum, "Computer Networks", 2012, 5th Edition, Pearson Education, London. |
| 2. | Kenneth R. Ong, "Medical Informatics: An Executive primer", 2015, 1st Edition, HIMSS Publishing, Chicago. |

**Reference Book(s)**

| | |
|---|---|
| 1. | Bernard Fong, A.C.M. Fong and C.K. Li, "Telemedicine Technologies: Information Technologies in Medicine and Tele-health", 2011, 1st Edition, Wiley- Blackwell, New Jersey. |
| 2. | Lazakidu, "Web-based Application in Healthcare and Biomedicine", 2012, 1st Edition, Springer, New York. |

**Mode of Evaluation**: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT

**Typical Projects:**

1. Design an Electronic Health Record System for a hospital and define criteria to assess the usability of the system and its patient portals.
2. Evaluate the impact of an Electronic Health Record System on Outpatient and Inpatient Clinical Practices.
3. Design a robust information system to secure the data in a hospital which is compliant with the norms and standards for safety and quality control.
4. Propose an integrated model to network the various systems in the different departments in a hospital.
5. Design an Electronic Prescribing System for a 600 bed super specialty hospital and review its costs and benefits.

**Mode of Evaluation**: Review I, II, III

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| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| ECE6053 | MEDICAL ROBOTICS | 2 | 0 | 0 | 4 | 3 |
| Prerequisite | Nil | Syllabus Version | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. To understand the drives and sensors required for robotics.
2. To study the kinematics, dynamics, motion planning and control of robotics.
3. To understand the importance of medical automation and medical robotics.
4. To compare the various future technologies being proposed.

**Expected Course Outcome:**

The student will be able to:

1. Have an understanding of the basics of robotics
2. Understand the kinematics and dynamic involved in design of robotic systems
3. Determine the path and plan a trajectory for a mobile system
4. Understand the importance of robotics in the field of surgery.
5. Identify the robotic system used for nueorsurgery
6. Compare robotic systems used for cardiovascular interventions
7. Focus on future trends on medical robotics.

| Module:1 | Drives and sensors for robots | 4 hours |
|---|---|---|

Basics - Component classification, Performance characteristics – Drives - Electric, Hydraulic and Pneumatic drives- Tactile sensors, Proximity and range sensors, Acoustic sensors, Vision sensor systems- Image processing and analysis - Image data reduction, Segmentation, Feature extraction and Object recognition.

| Module:2 | Robot Kinematics and Dynamics | 5 hours |
|---|---|---|

Kinematics of manipulators - Rotational, Translation and transformation, Homogeneous transformations, Denavat – Hartenberg representation - Inverse kinematics - Linearization of Robot Dynamics – State variable continuous and discrete models.

| Module:3 | Path Planning and Programming of Robots | 3 hours |
|---|---|---|

Types of trajectories - Trajectory planning and avoidance of obstacles, Path planning, Skew motion, Joint integrated motion and Straight line motion – Robot Programming - Languages and software packages.

| Module:4 | Robot assisted minimally invasive surgery | 4 hours |
|---|---|---|

Introduction- Minimally invasive surgery and robotic integration- Development of surgical robotics systems- Perceptual docking for synergistic control- Future scope

| Module:5 | Robotics for neurosurgery | 4 hours |
|---|---|---|

Introduction to neurosurgical progression-Evolution of neurosurgical robots-Maintaining operator Control – Human machine interface-Future trends: informatics surgery

| Module:6 | Robotic systems for cardiovascular interventions | 4 hours |
|---|---|---|

Introduction-Heart conditions and evolving role of cardiac surgeons and cardiologist- Surgical robot requirements and availability for cardiovascular interventions-Future trends

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|---|---|---|
| **Module:7** | **Robotics in Orthopaedic and Knee replacement surgery** | **4 hours** |
| Introduction- Existing orthopedic robotic systems, evaluation of impact of orthopedic surgical robots- Knee replacement surgery - Apex Robotic Technology (ART), Challenges and future scope | | |
| | | |
| **Module:8** | **Contemporary Issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

**Text Book(s)**

1. Paula Gomes, "Medical Robotics: Minimally Invasive Surgery", 2012, 1st Edition, Woodhead Publisher, Cambridge.

**Reference Book(s)**

1. Jocelyne Troccaz, "Medical Robotics", 2013, 1st edition, Wiley, London.
2. Mikell P Groover, "Industrial Robotics", 2017, 2nd Edition, Tata McGraw Hill, New Delhi

Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT

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| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| **ECE6054** | **MEDICAL IMAGING TECHNIQUES** | **2** | **0** | **2** | **0** | **3** |
| **Prerequisite** | **Nil** | **Syllabus Version** | | | | |
| | | 1.1 | | | | |

**Course Objectives:**

1. To provide comprehensive understanding of medical image acquisition in different modalities and the historical evolution of these imaging methods.
2. To acquaint the students with different reconstruction techniques and noise removal for medical images and to apprise the manipulation of acoustic radiation fields for medical applications
3. To relate all the modules employed in magnetic resonance imaging and to demonstrate knowledge, clinical and technical skills and decision-making capabilities with respect to diagnostic imaging
4. To investigate the relevant theory to apply imaging principles for 3D visualization.

**Expected Course Outcome:**

The student will be able

1. To comprehend the acquisition techniques involved in different modalities of medical imaging
2. To conceive the historical evolution of the imaging methods pertaining to computed tomography
3. To excel with different reconstruction techniques and programming techniques for noise removal.
4. To manipulate of acoustic radiation fields for diagnostics to be skillful in image generation
5. Establish the principle of operation and modules employed in magnetic resonance imaging
6. Able to develop decision-making capabilities with respect to diagnostic imaging
7. To compare the available processes, validate and interpret the medical images for a given application

| **Module:1** | **X-ray Projection Imaging** | **4 hours** |
|---|---|---|

X-Ray tubes, cooling systems, removal of scatters, Fluoroscopy- construction of image – Intensifier tubes, Angiographic setup, Mammography, Scanning methods, Area detectors - Digital radiology, DSA - Electronic portal imaging - Noise, Artefacts.

| **Module:2** | **X ray Computed Tomography** | **4 hours** |
|---|---|---|

Principles of sectional scanning - CT detectors, Helical CT, Multi-slice CT, Cone beam CT imaging methods - Methods of reconstruction- Iterative, Back projection, convolution and Back-Projection, FDK algorithm - Noise, Artefacts

| **Module:3** | **Radio Isotopic Imaging** | **4 hours** |
|---|---|---|

SPECT- Radiation detectors, Radionuclides for imaging, Gamma ray camera, scanners, Positron Emission tomography - Iterative reconstruction algorithms, SPECT/CT,PET/CT registration

| **Module:4** | **Ultrasonic Systems** | **4 hours** |
|---|---|---|

Wave propagation and interaction in Biological tissues - Acoustic radiation fields, continuous and pulsed excitation - Transducers and imaging systems - Scanning methods, Imaging Modes, Principles and theory of image generation - lap top style units - Applications

| **Module:5** | **Magnetic Resonance Imaging** | **4 hours** |
|---|---|---|

NMR - Principles of MRI, Relaxation processes and their measurements, Pulse sequencing and MRimage acquisition, Image reconstruction, Functional MRI, Diffusion imaging, EPI.

| **Module:6** | **Optical and other imaging modalities** | **3 hours** |
|---|---|---|
| Microscopic imaging principle and applications - Optical coherence tomography, principle, applications - Endoscopic image processing and applications - Electrical source imaging - Electrical impedance tomography - Microwave imaging | | |
| | | |
| **Module:7** | **Image processing for medicine** | **5 hours** |
| Image segmentation - Computational anatomy - Registration of multi-modality images - Synthesis of parametric images - Data visualization - Treatment planning | | |
| | | |
| **Module:8** | **Contemporary Issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

| **Text Book** | |
|---|---|
| 1. | M A Flower, “Webb's Physics of Medical Imaging”, 2016, 2nd Edition, CRC Press, Florida |
| **Reference Books** | |
| 1. | Jerry L. Prince and Jonathan M. Links, “Medical Imaging Signals and Systems”, 2014, 2nd Edition Pearson Education Inc., London |
| 2. | Paul Suetens, “Fundamentals of Medical Imaging”, 2017, 3rd Edition, Cambridge University Press, Cambridge. |
| Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT | |

| **List of Challenging Experiments (Indicative)** | | |
|---|---|---|
| 1. | Enhancement of medical images and Feature extraction from X ray images using gray level histograms and noise removal using median filters | 6 hours |
| 2. | Create a digital head phantom, obtain its projection data and reconstruct using Radon transform | 6 hours |
| 3. | Read the given MRI image and segment the brain tissues to detect any anomaly related to brain | 6 hours |
| 4. | Segment the colon from the CT image of the abdomen for virtual endoscopy. Perform 3D rendering of the colon | 6 hours |
| 5. | Delineate the myocardial wall in the given MR image of heart by edge detection technique | 6 hours |
| | Total Laboratory Hours | 30 hours |
| Mode of Evaluation: Continuous assessments and FAT | | |

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| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |

| Course Code | Course Title | L | T | P | J | C |
|---|---|---|---|---|---|---|
| **ECE6055** | **DIGITAL HEALTH CARE AND MEDICAL STANDARDS** | **2** | **0** | **0** | **4** | **3** |
| **Prerequisite** | **Nil** | **Syllabus Version** | | | | |
| | | 1.0 | | | | |

**Course Objectives:**

1. To gain knowledge in various aspects of health informatics and medical standards.
2. To apply these techniques in proper health care delivery.

**Expected Course Outcome:**

The students will be able to

1. Understand the basic concepts in Biomedical Informatics.
2. Apply the various aspects of health informatics and medical standards.
3. Develop clinical decision support systems.
4. Comprehend the basics of bioinformatics and the resources in the field.
5. Analyze various bioinformatics tools and explore the databases available in NCBI.
6. Design and implement the construction standards in a hospital.
7. Apply the standards in proper health care delivery.

| Module:1 | Biomedical Informatics | 5 hours |
|---|---|---|

Historical highlights and Evolution, Hospital Information System, its characteristics and functional online and offline modules, Health Informatics, Medical Informatics, Clinical Informatics, Nursing Informatics, Public Health Informatics, Imaging informatics.

| Module:2 | Electronic Patient Record and Standards | 4 hours |
|---|---|---|

Electronic Patient Record, Medical data formats, Medical Standards, HL7, DICOM, LOINC, PACS, Medical Standards for Vocabulary, ICD 10, DRG, MeSH, UMLS, SNOMED. Healthcare Standards - JCAHO, HIPAA

| Module:3 | Electronic Decision Support Systems | 4 hours |
|---|---|---|

Biomedical decision making. Probabilistic clinical reasoning. Medical Knowledge and Decision Support, Methods for decision support, Clinical decision-support systems, Strategies for medical knowledge acquisition, Predictive tools for clinical decision support.

| Module:4 | Bioinformatics | 4 hours |
|---|---|---|

Introduction to Bioinformatics. Biological information resources. Genome sequence acquisition and analysis, Retrieval of biological data. Data acquisition, databases, structure and annotation. Data mining and data characteristics.

| Module:5 | Bioinformatics Tools | 4 hours |
|---|---|---|

NCBI, Human Genome Project, GenBank, Sequence alignment, BLAST, FASTA, CLUSTALW, Phylogenetic analyses.

| Module:6 | Norms for Hospitals | 4 hours |
|---|---|---|

Design and construction standards for the hospitals, BIS –India, JCIA, AIA and NHS, general guidelines and standard for out-patient area, in-patient area and diagnostic area in the hospitals.

| Module:7 | Standards for Hospitals | 3 hours |
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|---|---|---|
| Voluntary & Mandatory standards, General standards, Mechanical standards, Electrical Standards, Standard for centralized medical gas system, Standards for biomedical waste. | | |
| | | |
| **Module:8** | **Contemporary issues:** | **2 hours** |
| | | |
| | **Total Lecture hours:** | **30 hours** |

**Text Book**

1. Edward H. Shortliffe, James J. Cimino, "Biomedical Informatics: Computer Applications in Health Care and Biomedicine (Health Informatics)", 2014, 4th edition, Springer, New York.

**Reference Book(s)**

1. Kenneth R. Ong, "Medical Informatics: An Executive primer", 2015, 1st edition, HIMSS Publishing, Chicago.
2. Lazakidou, Athina A., "Web-Based Applications in Healthcare and Biomedicine, Annals of Information Systems", 2010, 7th edition, Springer, New York.

Mode of Evaluation: CAT, Digital Assignment, Quiz, Online courses (MOOC), paper publications, Hackathon/Makeathon and FAT

**List of Projects:**

1. Design an integrated Electronic Health Record System for a 600 bed super speciality hospital and define the criteria to assess the usability of the system.
2. Propose a model for a multi-speciality hospital adhering to the typical design and construction standards.
3. Design a comprehensive HL7 messaging system in a hospital for patients admitted with different ailments and undergoing different procedures.
4. Plan and propose a Pharmacy Inventory System for a hospital by networking it to all the possible departments in a hospital.
5. Perform BLAST or FASTA on a nucleotide or protein sequence in NCBI and execute the Multiple Sequence Alignment between the paired sequences.

Mode of Evaluation: Review I, II, III

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|---|---|---|---|
| Recommended by Board of Studies | | 14.09.2017 | |
| **Academic Council:** | **No: 47** | **Date** | **05.10.2017** |