# ACADEMIC CURRICULA

## UNDERGRADUATE DEGREE PROGRAMMES

### Bachelor of Technology

**(B.Tech Biomedical Engineering)**

**(Choice Based Flexible Credit System)**

**Academic Year**
**2018-2019**

SRM
INSTITUTE OF SCIENCE & TECHNOLOGY
*(Deemed to be University u/s 3 of UGC Act, 1956)*


## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

**(Deemed to be University u/s 3 of UGC Act, 1956)**

Kattankulathur, Kancheepuram District 603203, Tamil Nadu, India

# B.Tech in Biomedical Engineering

## (a). Mission of the Department

| | |
|---|---|
| Mission Stmt - 1 | *Build on a strong foundation in Basic science and Engineering and educate the students in diverse filed of Biomedical Engineering* |
| Mission Stmt - 2 | *Work towards state of art Biomedical Engineering research and development through an interdisciplinary curriculum.* |
| Mission Stmt - 3 | *Apply knowledge about design in development of enabling technologies for improvement of human health* |

## (b) Program Educational Objectives (PEO)

| | |
|---|---|
| PEO - 1 | *Develop real world biomedical devices and prototype models and test with multi-disciplinary approach.* |
| PEO - 2 | *Design technologically enabled equipments that open up new areas of medical research.* |
| PEO - 3 | *To impose innovative ideas for commercialization of developed products.* |
| PEO - 4 | *Lead and work in a team with varied expertise and meet the changing needs of the profession through life long learning.* |
| PEO - 5 | *To promote entrepreneurship skills in creating jobs in health care domain.* |

## (c) Mission of the Department to Program Educational Objectives (PEO) Mapping

| | Mission Stmt - 1 | Mission Stmt - 2 | Mission Stmt - 3 |
|---|---|---|---|
| PEO - 1 | *H* | *M* | *H* |
| PEO - 2 | *H* | *H* | *M* |
| PEO - 3 | *H* | *M* | *H* |
| PEO - 4 | *H* | *H* | *M* |
| PEO - 5 | *H* | *H* | *M* |

H – High Correlation, M – Medium Correlation, L – Low Correlation

## (d) Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

| | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Graduate Attributes (GA) | | | | | | | | | | | | Program Specific Outcomes (PSO) | | |
| | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| PEO - 1 | *H* | *H* | *H* | *H* | *M* | *H* | *H* | *M* | *H* | *M* | *H* | *M* | *H* | *H* | *H* |
| PEO - 2 | *H* | *M* | *H* | *H* | *H* | *M* | *M* | *M* | *H* | *M* | *H* | *H* | *H* | *H* | *H* |
| PEO - 3 | *H* | *H* | *H* | *H* | *M* | *H* | *H* | *H* | *M* | *H* | *H* | *M* | *M* | *H* | *H* |
| PEO - 4 | *M* | *H* | *H* | *H* | *M* | *M* | *M* | *M* | *H* | *H* | *H* | *M* | *H* | *M* | *H* |
| PEO - 5 | *H* | *M* | *M* | *H* | *M* | *M* | *M* | *M* | *M* | *M* | *M* | *H* | *H* | *M* | *M* |

H – High Correlation, M – Medium Correlation, L – Low Correlation, PSO – Program Specific Outcomes (PSO)

PSO – Program Specific Outcomes (PSO)

| | |
|---|---|
| PSO - 1 | *Ability to apply engineering design to offer health care solutions with consideration of safety, welfare, social, cultural and environmental factors* |
| PSO - 2 | *Ability to model and analyze biological systems with ethical and professional responsibilities in Engineering situations.* |
| PSO - 3 | *Ability to initiate cross disciplinary and industry collaborative research.* |

## (e) Program Structure for B.Tech in Biomedical Engineering

**Humanities & Social Sciences including Management Courses (H)**

| Course Code | Course Title | Hours/ Week L | T | P | C |
|---|---|---|---|---|---|
| 18LEH101J | English | 2 | 0 | 2 | 3 |
| 18LEH102J | Chinese | 2 | 0 | 2 | 3 |
| 18LEH103J | French | | | | |
| 18LEH104J | German | | | | |
| 18LEH105J | Japanese | | | | |
| 18LEH106J | Korean | | | | |
| 18PDH101L | General Aptitude | 0 | 0 | 2 | 1 |
| 18PDH102T | Management Principles for Engineers | 2 | 0 | 0 | 2 |
| 18PDH103J | Social Engineering | 1 | 0 | 2 | 2 |
| 18PDH201L | Employability Skills & Practices | 0 | 0 | 2 | 1 |
| | **Total Learning Credits** | | | | **12** |

**Basic Science Courses (B)**

| Course Code | Course Title | Hours/ Week L | T | P | C |
|---|---|---|---|---|---|
| 18PYB101J | Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics | 3 | 1 | 2 | 5 |
| 18CYB101J | Chemistry | 3 | 1 | 2 | 5 |
| 18MAB101T | Calculus and Linear Algebra | 3 | 1 | 0 | 4 |
| 18MAB102T | Advanced Calculus and Complex Analysis | 3 | 1 | 0 | 4 |
| 18MAB201T | Transforms and Boundary Value Problems | 3 | 1 | 0 | 4 |
| 18MAB202T | Numerical methods for Engineers | 3 | 1 | 0 | 4 |
| 18MAB301T | Probability and Statistics | 3 | 1 | 0 | 4 |
| 18BTB102T | Biology: Human Anatomy and Physiology | 2 | 0 | 0 | 2 |
| | **Total Learning Credits** | | | | **32** |

**Engineering Science Courses (S)**

| Course Code | Course Title | Hours/ Week L | T | P | C |
|---|---|---|---|---|---|
| 18MES101L | Engineering Graphics and Design | 1 | 0 | 4 | 3 |
| 18EES101J | Basic Electrical and Electronics Engineering | 3 | 1 | 2 | 5 |
| 18MES103L | Civil and Mechanical Engineering Workshop | 1 | 0 | 4 | 3 |
| 18CSS101J | Programming for Problem Solving | 3 | 0 | 4 | 5 |
| 18PYS202T | Medical Physics | 3 | 0 | 0 | 3 |
| | **Total Learning Credits** | | | | **19** |

**List of Open Elective Courses (O)**
*Any 4 Courses*

| Course Code | Course Title | Hours/ Week L | T | P | C |
|---|---|---|---|---|---|
| 18BMO121T | Fundamentals of Biomedical Engineering | 3 | 0 | 0 | 3 |
| 18BMO122T | Health Information Systems | 3 | 0 | 0 | 3 |
| 18BMO123T | Basics of Medical Imaging | 3 | 0 | 0 | 3 |
| 18BMO124T | Rehabilitation Engineering | 3 | 0 | 0 | 3 |
| 18BMO125T | Quality control for biomedical devices | 3 | 0 | 0 | 3 |
| 18BMO126T | Biomechanics of Human Movement | 3 | 0 | 0 | 3 |

**Professional Core Courses (C)**

| Course Code | Course Title | Hours/ Week L | T | P | C |
|---|---|---|---|---|---|
| 18BTC205J | Pathology & Microbiology | 3 | 0 | 2 | 4 |
| 18BMC201J | Biomedical Sensors | 3 | 0 | 2 | 4 |
| 18BMC202T | Biomedical Signals and Systems | 3 | 0 | 0 | 3 |
| 18BMC203J | Electric and Electronic Circuits | 3 | 0 | 2 | 4 |
| 18BMC204T | Principles of Medical Imaging | 3 | 0 | 0 | 3 |
| 18BMC205J | Linear and digital Integrated Circuit | 3 | 0 | 2 | 4 |
| 18BMC206J | Biomaterials-Tissue interaction | 3 | 0 | 2 | 4 |
| 18BMC301J | Medical Instrumentation | 3 | 0 | 2 | 4 |
| 18BMC302T | Biomechanics | 3 | 0 | 0 | 3 |
| 18BMC303J | Biomedical Signal Processing | 3 | 0 | 2 | 4 |
| 18BMC304J | Microcontrollers and its application in medicine | 3 | 0 | 2 | 4 |
| 18BMC305T | Biocontrol Systems | 3 | 0 | 0 | 3 |
| 18BMC306J | Medical Image Processing | 3 | 0 | 2 | 4 |
| 18BMC401T | Biomedical Equipments for clinical applications | 3 | 0 | 0 | 3 |
| 18BMC350T | Comprehension | 0 | 1 | 0 | 1 |
| | Total Learning Credits | | | | 52 |

**Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)**

| Course Code | Course Title | Hours/ Week L | T | P | C |
|---|---|---|---|---|---|
| 18BMP101L | MOOC / Industrial Training / Seminar – 1 | 0 | 0 | 2 | 1 |
| 18BMP102L | MOOC / Industrial Training / Seminar – 2 | 0 | 0 | 2 | 1 |
| 18BMP103L | Project (Phase-I) / Internship (4-6 weeks) | 0 | 0 | 6 | 3 |
| 18BMP104L | Project (Phase-II) / Semester Internship | 0 | 0 | 20 | 10 |
| | **Total Learning Credits** | | | | **15** |

**Mandatory Courses (M)**

| Course Code | Course Title | Hours/ Week L | T | P | C |
|---|---|---|---|---|---|
| 18PDM101L | Professional Skills & Practices | 0 | 0 | 2 | 0 |
| 18PDM201L | Competencies in Social Skills | 0 | 0 | 2 | 0 |
| 18PDM202L | Critical & Creative Thinking Skills | 0 | 0 | 2 | 0 |
| 18PDM301L | Analytical & Logical Thinking Skills | 0 | 0 | 2 | 0 |
| 18LEM101T | Constitution of India | 1 | 0 | 0 | 0 |
| 18LEM104J | Value Education | 1 | 0 | 1 | 0 |
| 18GNM101L | Physical & Mental Health using Yoga | 0 | 0 | 2 | 0 |
| 18GNM102L | NCC / NSS / NSO | 0 | 0 | 2 | 0 |
| 18LEM109T | Indian Traditional Knowledge | 1 | 0 | 0 | 0 |
| 18LEM110L | Indian Art Form | 0 | 0 | 2 | 0 |
| 18CYM101T | Environmental Science | 1 | 0 | 0 | 0 |
| | **Total Learning Credits** | | | | **0** |

| List of Professional Elective Courses (E)<br>Any 6 courses | | | | | |
|---|---|---|---|---|---|
| Course | Course | Hours/ Week | | | C |
| Code | Title | L | T | P | |
| *18BME261T* | *Biophotonics and Bioimaging* | *3* | *0* | *0* | *3* |
| *18BME262T* | *Home Medicare Technology* | *3* | *0* | *0* | *3* |
| *18BME263T* | *Cellular and molecular biology* | *3* | *0* | *0* | *3* |
| *18BME264T* | *Biomedical Laser Instruments* | *3* | *0* | *0* | *3* |
| *18BME265T* | *Artificial Organs and Tissue engineering* | *3* | *0* | *0* | *3* |
| *18BME266T* | *Biomedical Nano Technology* | *3* | *0* | *0* | *3* |
| *18BME267T* | *Biometrics* | *3* | *0* | *0* | *3* |
| *18BME361T* | *BioMEMS* | *3* | *0* | *0* | *3* |
| *18BME362T* | *Biotransport Phenomenon* | *3* | *0* | *0* | *3* |
| *18BME363T* | *Human Electro physiology* | *3* | *0* | *0* | *3* |
| *18BME364T* | *Biomedical device design Fundamentals* | *3* | *0* | *0* | *3* |
| *18BME365T* | *Innovation, Translation and Entrepreneurship* | *3* | *0* | *0* | *3* |
| *18BME366T* | *Biomedical microscopy and quantitative imaging* | *3* | *0* | *0* | *3* |
| *18BME367T* | *Hospital Management system* | *3* | *0* | *0* | *3* |
| *18BME368T* | *Soft Tissue and Biofluid mechanics* | *3* | *0* | *0* | *3* |
| *18BME369T* | *Trouble shooting of Medical Devices* | *3* | *0* | *0* | *3* |
| *18BME370T* | *Quality Assurance and regulatory aspects for medical devices* | *3* | *0* | *0* | *3* |
| *18BME371T* | *Neuroengineering* | *3* | *0* | *0* | *3* |
| *18BME372T* | *IOT and Telehealth Technology* | *3* | *0* | *0* | *3* |
| *18BME373T* | *Micro fluidics* | *3* | *0* | *0* | *3* |
| *18BME374T* | *Medical Ethics and Intellectual property rights* | *3* | *0* | *0* | *3* |
| *18BME375T* | *Virtual Instrumentation for Biomedical Engineers* | *3* | *0* | *0* | *3* |
| *18BME376T* | *Health care data analytics* | *3* | *0* | *0* | *3* |
| *18BME461T* | *Biomedical Informatics* | *3* | *0* | *0* | *3* |
| *18BME462T* | *Physiological Modeling* | *3* | *0* | *0* | *3* |
| *18BME463T* | *Biomimetics* | *3* | *0* | *0* | *3* |
| *18BME464T* | *Neural Networks and Genetic Algorithms* | *3* | *0* | *0* | *3* |
| *18BME465T* | *Wearable systems and mobile health care* | *3* | *0* | *0* | *3* |
| *18BME466T* | *Artificial Intelligence in Health care* | *3* | *0* | *0* | *3* |
| *18BME467T* | *Bio inspired Robotics* | *3* | *0* | *0* | *3* |
| *18BME468T* | *Computational tools in Bioengineering and Biomedicine* | *3* | *0* | *0* | *3* |
| *18BME469T* | *Neuro rehabilitation and Human machine interface* | *3* | *0* | *0* | *3* |
| *18BME470T* | *Assistive and Augmentative Technologies* | *3* | *0* | *0* | *3* |
| *18BME471T* | *Machine learning and Deep learning techniques in medicine* | *3* | *0* | *0* | *3* |
| *18BME472T* | *Virtual Reality in Health care* | *3* | *0* | *0* | *3* |
| | **Total credits** | | | | **18** |

## 24. (a) Program Articulation: B.Tech in Biomedical Engineering

| Course Code | Course Name | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Graduate Attributes | | | | | | | | | | | | PSO | | |
| | | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| 18BMC201J | Biomedical Sensors | H | M | M | M | L | M | M | M | M | M | L | H | H | L | M |
| 18BMC202T | Biomedical Signals and Systems | H | M | L | L | M | M | M | M | M | L | L | M | M | M | M |
| 18BMC203J | Electric and Electronic Circuits | H | H | M | H | M | L | L | L | M | L | L | L | M | H | M |
| 18BMC204T | Principles of Medical Imaging | H | M | M | M | M | H | M | M | M | L | L | M | H | M | M |
| 18BMC205J | Linear and digital Integrated Circuit | H | M | M | M | M | M | M | M | H | M | L | M | M | M | M |
| 18BMC206J | Biomaterials-Tissue interaction | H | M | L | L | L | M | M | M | M | M | M | M | H | M | H |
| 18BMC301J | Medical Instrumentation | H | L | H | H | H | H | H | M | H | M | M | M | H | M | H |
| 18BMC302T | Biomechanics | H | H | M | H | H | M | M | M | M | M | M | M | M | M | H |
| 18BMC303J | Biomedical Signal Processing | H | H | M | M | M | M | M | M | M | M | M | M | M | M | H |
| 18BMC304J | Microcontrollers and its application in medicine | H | M | M | M | M | M | M | M | M | M | M | M | M | M | H |
| 18BMC305T | Bio control Systems | H | M | M | M | M | M | M | M | M | M | M | M | M | M | M |
| 18BMC306J | Medical Image Processing | H | M | H | H | H | H | M | M | H | M | M | M | H | M | H |
| 18BMC401T | Biomedical Equipments for clinical applications | H | L | H | H | H | H | H | M | H | M | M | M | H | M | H |
| 18BMC350T | Comprehension | H | H | H | H | H | M | M | M | M | M | M | M | M | H | H |
| 18BMP101L | MOOC / Industrial Training / Seminar - 1 | H | | | | | M | L | | | H | | H | | M | |
| 18BMP102L | MOOC / Industrial Training / Seminar - 2 | H | | | | | M | L | | | H | | H | | M | |
| 18BMP103L | Project (Phase-I) / Internship (4-6 weeks) | H | M | H | H | M | H | H | L | H | H | H | H | H | H | M |
| 18BMP104L | Project (Phase-II) / Semester Internship | H | M | H | H | M | H | H | L | H | H | H | H | H | H | M |
| 18BME261T | Biophotonics and Bioimaging | H | M | L | L | L | M | M | M | M | M | M | M | H | M | H |
| 18BME262T | Home Medicare Technology | H | L | M | M | M | L | M | M | M | M | M | M | H | M | H |
| 18BME263T | Cellular and molecular biology | H | L | L | L | L | M | M | M | M | M | M | M | M | M | M |
| 18BME264T | Biomedical Laser Instruments | H | L | L | L | L | M | M | M | M | M | M | M | M | M | L |
| 18BME265T | Artificial Organs and Tissue engineering | H | L | L | L | L | M | M | M | M | M | M | M | M | M | M |
| 18BME266T | Biomedical Nano Technology | H | L | L | L | M | M | M | M | M | M | M | M | H | M | H |
| 18BME267T | Biometrics | H | L | M | M | M | M | M | M | M | M | M | M | H | M | H |
| 18BME361T | BioMEMS | H | M | M | M | M | M | M | M | M | M | M | M | H | H | H |
| 18BME362T | Biotransport Phenomenon | H | L | L | L | L | M | M | M | M | M | M | M | M | M | M |
| 18BME363T | Human Electro physiology | H | L | L | L | L | M | M | M | M | M | M | M | H | M | H |
| 18BME364T | Biomedical device design Fundamentals | H | H | H | H | H | H | H | H | H | M | M | M | H | H | H |
| 18BME365T | Innovation, Translation and Entrepreneurship | H | M | M | M | M | M | M | M | M | M | M | M | H | M | H |
| 18BME366T | Biomedical microscopy and quantitative imaging | H | M | H | H | H | H | M | M | H | M | M | M | H | M | H |
| 18BME367T | Hospital Management system | H | L | L | L | L | M | M | M | M | M | M | M | H | M | M |
| 18BME368T | Soft Tissue and Biofluid mechanics | H | L | L | L | L | M | M | M | M | M | M | M | H | M | M |
| 18BME369T | Trouble shooting of Medical Devices | H | M | M | M | M | M | M | M | M | M | M | M | H | M | H |
| 18BME370T | Quality Assurance and regulatory aspects for medical devices | H | L | L | L | L | M | M | M | M | M | M | M | M | M | M |
| 18BME371T | Neuroengineering | H | L | L | L | L | M | M | M | M | M | M | M | H | M | H |
| 18BME372T | IOT and Telehealth Technology | H | H | H | H | H | M | M | M | M | M | M | M | H | H | H |
| 18BME373T | Micro fluidics | H | M | M | M | M | M | M | M | M | M | M | M | H | M | M |
| 18BME374T | Medical Ethics and Intellectual property rights | H | L | L | L | L | M | M | M | M | M | M | M | H | M | M |
| 18BME375T | Virtual Instrumentation for Biomedical Engineers | H | M | M | M | M | M | M | M | M | M | M | M | M | M | M |
| 18BME376T | Health care data analytics | H | M | M | M | M | M | M | M | M | M | M | M | M | M | M |
| 18BME461T | Biomedical Informatics | H | M | L | L | L | M | M | M | M | M | M | M | M | M | M |
| 18BME462T | Physiological Modeling | H | M | L | L | L | M | M | M | M | M | M | M | M | M | M |
| 18BME463T | Biomimetics | H | L | L | L | L | M | M | M | M | M | M | M | M | M | M |
| 18BME464T | Neural Networks and Genetic Algorithms | H | H | L | L | L | M | M | M | M | M | M | M | H | M | H |
| 18BME465T | Wearable systems and mobile health care | H | H | M | M | M | M | M | M | M | M | M | M | H | M | H |
| 18BME466T | Artificial Intelligence in Health care | H | M | M | M | M | M | M | M | M | M | M | M | H | M | M |
| 18BME467T | Bio inspired Robotics | H | M | M | M | M | M | M | M | M | M | M | M | H | M | M |
| 18BME468T | Computational tools in Bioengineering and Biomedicine | H | H | M | M | M | M | M | M | M | M | M | M | H | H | H |
| 18BME469T | Neurorehabilitation and Human machine interface | H | M | M | M | M | M | M | M | M | M | M | M | H | M | H |
| 18BME470T | Assistive and Augmentative Technologies | H | M | M | M | M | M | M | M | M | M | M | M | H | M | H |
| 18BME471T | Machine learning and Deep learning techniques in medicine | H | M | M | M | M | M | M | M | M | M | M | M | H | L | H |
| 18BME472T | Virtual Reality in Health care | H | M | M | M | M | M | M | M | M | M | M | M | H | M | H |

*H – High Correlation, M – Medium Correlation, L – Low Correlation*

## (g) Implementation Plan: B.Tech in Biomedical Engineering

| Semester - I | | | | | |
|---|---|---|---|---|---|
| Code | Course Title | Hours/ Week | | | C |
| | | L | T | P | |
| 18LEH10XJ | Chinese / French / German / Japanese/ Korean | 2 | 0 | 2 | 3 |
| 18MAB101T | Calculus and Linear Algebra | 3 | 1 | 0 | 4 |
| 18CYB101J | Chemistry | 3 | 1 | 2 | 5 |
| 18CSS101J | Programming for Problem Solving | 3 | 0 | 4 | 5 |
| 18MES103L | Civil and Mechanical Engineering Workshop | 1 | 0 | 4 | 3 |
| 18PDM101L | Professional Skills and Practices | 0 | 0 | 2 | 0 |
| 18LEM102J | Value Education | 1 | 0 | 1 | 0 |
| 18GNM10XL | NCC / NSS / NSO | 0 | 0 | 2 | 0 |
| | Total Learning Credits | | | | 20 |

| Semester - II | | | | | |
|---|---|---|---|---|---|
| Code | Course Title | Hours/ Week | | | C |
| | | L | T | P | |
| 18LEH101J | English | 2 | 0 | 2 | 3 |
| 18MAB102T | Advanced Calculus and Complex Analysis | 3 | 1 | 0 | 4 |
| 18PYB101J | Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics | 3 | 1 | 2 | 5 |
| 18MES101L | Engineering Graphics and Design | 1 | 0 | 4 | 3 |
| 18EES101J | Basic Electrical and Electronics Engineering | 3 | 1 | 2 | 5 |
| 18PDH101T | General Aptitude | 0 | 0 | 2 | 1 |
| 18LEM101T | Constitution of India | 1 | 0 | 0 | 0 |
| 18GNM101L | Physical and Mental Health using Yoga | 0 | 0 | 2 | 0 |
| | Total Learning Credits | | | | 21 |

| Semester - III | | | | | |
|---|---|---|---|---|---|
| Code | Course Title | Hours/ Week | | | C |
| | | L | T | P | |
| 18MAB201T | Transforms and Boundary Value Problems | 3 | 1 | 0 | 4 |
| 18PYS202T | Medical Physics | 3 | 0 | 0 | 3 |
| 18BTC205J | Pathology & Microbiology | 3 | 0 | 2 | 4 |
| 18BMC201J | Biomedical Sensors | 3 | 0 | 2 | 4 |
| 18BMC202T | Biomedical Signals and Systems | 3 | 0 | 0 | 3 |
| 18BMC203J | Electric and Electronic Circuits | 3 | 0 | 2 | 4 |
| 18PDH103T | Social Engineering | 2 | 0 | 0 | 2 |
| 18PDM201L | Competencies in Social Skills | 0 | 0 | 2 | 0 |
| 18PDM203L | Entrepreneurial Skill Development | | | | |
| 18CYM101T | Environmental Science | 1 | 0 | 0 | 0 |
| | Total Learning Credits | | | | 24 |

| Semester - IV | | | | | |
|---|---|---|---|---|---|
| Code | Course Title | Hours/ Week | | | C |
| | | L | T | P | |
| 18MAB202T | Numerical methods for Engineers | 3 | 1 | 0 | 4 |
| 18BTB102T | Biology: Human Anatomy and Physiology | 2 | 0 | 0 | 2 |
| 18BMC204T | Principles of Medical Imaging | 3 | 0 | 0 | 3 |
| 18BMC205J | Linear and digital Integrated Circuit | 3 | 0 | 2 | 4 |
| 18BMC206J | Biomaterials - Tissue interaction | 3 | 0 | 2 | 4 |
| | Professional Elective – 1 | 3 | 0 | 0 | 3 |
| | Open Elective – 1 | 3 | 0 | 0 | 3 |
| 18PDH102T | Management Principles for Engineers | 2 | 0 | 0 | 2 |
| 18PDM202L | Critical and Creative Thinking Skills | 0 | 0 | 2 | 0 |
| 18PDM204L | Business Basics for Entrepreneurs | | | | |
| | Total Learning Credits | | | | 25 |

| Semester – V | | | | | |
|---|---|---|---|---|---|
| Code | Course Title | Hours/ Week | | | C |
| | | L | T | P | |
| 18MAB301T | Probability and Statistics | 3 | 1 | 0 | 4 |
| 18BMC301J | Medical Instrumentation | 3 | 0 | 2 | 4 |
| 18BMC302T | Biomechanics | 3 | 0 | 0 | 3 |
| 18BMC303J | Biomedical Signal Processing | 3 | 0 | 2 | 4 |
| | Professional Elective – 2 | 3 | 0 | 0 | 3 |
| | Open Elective – 2 | 3 | 0 | 0 | 3 |
| 18BMP101L | MOOC / Industrial Training / Seminar - 1 | 0 | 0 | 2 | 1 |
| 18PDM301L | Analytical and Logical Thinking Skills | 0 | 0 | 2 | 0 |
| 19PDM302L | Entrepreneurship Management | | | | |
| 18LEM110L | Indian Art Form | 0 | 0 | 2 | 0 |
| | Total Learning Credits | | | | 22 |

| Semester - VI | | | | | |
|---|---|---|---|---|---|
| Code | Course Title | Hours/ Week | | | C |
| | | L | T | P | |
| 18BMC304J | Microcontrollers and its application in medicine | 3 | 0 | 2 | 4 |
| 18BMC305T | Biocontrol Systems | 3 | 0 | 0 | 3 |
| 18BMC306J | Medical Image Processing | 3 | 0 | 2 | 4 |
| 18BMC350T | Comprehension | 0 | 1 | 0 | 1 |
| | Professional Elective – 3 | 3 | 0 | 0 | 3 |
| | Professional Elective – 4 | 3 | 0 | 0 | 3 |
| | Open Elective – 3 | 3 | 0 | 0 | 3 |
| 18BMP102L | MOOC / Industrial Training / Seminar - 2 | 0 | 0 | 2 | 1 |
| 18PDH201T | Employability Skills and Practices | 0 | 0 | 2 | 1 |
| 18LEM109T | Indian Traditional Knowledge | 1 | 0 | 0 | 0 |
| | Total Learning Credits | | | | 23 |

| Semester - VII | | | | | |
|---|---|---|---|---|---|
| Code | Course Title | Hours/ Week | | | C |
| | | L | T | P | |
| 18BMC401T | Biomedical Equipments for clinical applications | 3 | 0 | 0 | 3 |
| | Professional Elective – 5 | 3 | 0 | 0 | 3 |
| | Professional Elective – 6 | 3 | 0 | 0 | 3 |
| | Open Elective – 4 | 3 | 0 | 0 | 3 |
| 18BMP103L | Project (Phase-I) / Internship (4-6 weeks) | 0 | 0 | 6 | 3 |
| | Total Learning Credits | | | | 15 |

| Semester - VIII | | | | | |
|---|---|---|---|---|---|
| Code | Course Title | Hours/ Week | | | C |
| | | L | T | P | |
| 18BMP104L | Project (Phase-II) / Semester Internship | 0 | 0 | 20 | 10 |
| | Total Learning Credits | | | | 10 |

| Course Code | 18BTC205J | Course Name | PATHOLOGY AND MICROBIOLOGY | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 2 | 4 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biotechnology | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the structural and functional aspects of living organisms |
| CLR-2 : | Understand the concept of cellular response during pathogenesis |
| CLR-3 : | Illustrate microbial infections and their lifecycle |
| CLR-4 : | Apply the classical and modern methods of diagnosing diseases |
| CLR-5 : | Analyze the various tissue processing techniques |
| CLR-6 : | Analyze the various antimicrobial drugs |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Discuss on the basic concepts of cells and immune system | 1, 2 | 80% | 70% | | | | | | | | | | | | H | | | |
| CLO-2 : | Describe cellular changes during pathogenesis | 2 | 80% | 70% | | | | M | | | | | | | | H | | | |
| CLO-3 : | Explain the lifecycle of various microbial pathogens | 2 | 80% | 70% | | | | | | | | | | | | H | M | | L |
| CLO-4 : | Explain the application of microscopes in diagnosing various microorganisms | 3 | 80% | 70% | | | | | M | | | | | | | H | | | |
| CLO-5 : | Discuss various methods and stains used in histopathological analysis | 3 | 80% | 70% | | | | | H | | | | | | | H | M | | L |
| CLO-6 : | Discuss the methods of treatment in microbial infections | 3 | 80% | 70% | | | | M | | | | | | | | H | | | |

| | | Celld and immunity of mammals | Cellular responses during pathogenesis | Clinical Microbiology | Diagnostic pathology | Infection control and prevention |
|---|---|---|---|---|---|---|
| Duration (hour) | | 15 | 15 | 15 | 15 | 15 |
| S-1 | SLO-1 | Cell structure | Host pathogen interactions – Route of entry | Microbial pathogens – Types, Life cycle | Microscopy | General characters of antimicrobial drugs |
| | SLO-2 | Cytoskeleton | Immune evasion by microbes | Gram positive bacterial pathogens | Light (Bright field & Dark field) | Determining the level of antimicrobial activity |
| S-2 | SLO-1 | Structure and function of Cell Membrane | Host damage | Gram negative bacterial pathogens | Phase contrast and Fluorescent microscopy | Antibacterial drugs |
| | SLO-2 | Structure and function of endoplasmic reticulum | PAMS, MAMS | Mycobacterial infections | Electron microscopy | Anti fungal drugs |
| S-3 | SLO-1 | Structure and function of Ribosomes | Microbial secretory systems | Spirochetes | Histopathology | Anti protozoan drugs |
| | SLO-2 | Structure and function of Lysosomes | PRR and signalling | Anaerobic infections | Autopsy pathology | Antiviral drugs |
| S-4 | SLO-1 | Lab1: Identification of instruments and culture media preparation | Lab4: Differential Leukocyte count | Lab 7: Differential staining (Spore, AFB) | Lab 10: Fungal pathogen detection by lactophenol cotton blue | Lab 13: antibiotic sensitivity test by Kirby-Bauer method |
| | SLO-2 | Lab1: Identification of instruments and culture media preparation | Lab4: Differential Leukocyte count | Lab 7: Differential staining (Spore, AFB) | Lab 10: Fungal pathogen detection by lactophenol cotton blue | Lab 13: antibiotic sensitivity test by Kirby-Bauer method |
| S-5 | SLO-1 | Lab1: Identification of instruments and culture media preparation | Lab4: Differential Leukocyte count | Lab 7: Differential staining (Spore, AFB) | Lab 10: Fungal pathogen detection by lactophenol cotton blue | Lab 13: antibiotic sensitivity test by Kirby-Bauer method |
| | SLO-2 | Lab1: Identification of instruments and culture media preparation | Lab4: Differential Leukocyte count | Lab 7: Differential staining (Spore, AFB) | Lab 10: Fungal pathogen detection by lactophenol cotton blue | Lab 13: antibiotic sensitivity test by Kirby-Bauer method |
| S-6 | SLO-1 | Structure and function of mitochondria | Cellular responses to stress - Hypertrophy | Obligate intracellular bacteria | Surgical pathology | Increase the immune system of host |
| | SLO-2 | Structure and function of nucleus | Metaplasia, Neoplasia | Fungal infections | Enzyme histochemistry | Vaccines – preparation & dosage |
| S-7 | SLO-1 | Cell –cell interactions | Hypersensitivity reactions | Yeast infections | Histokinates | Live vaccines |
| | SLO-2 | Gap junctions | Hypersensitivity reactions | Diseases caused by molds | Block making | Attenuated vaccines |
| S-8 | SLO-1 | Tight junctions, Desmosomes | Cell injury and death | Dimorphic fungi | Microtomes & Knives | Whole cell vaccines |
| | SLO-2 | Extra cellular matrix | Inflammation (Acute & Chronic) | Parasitic infections | Cryostat | Subunit vaccines |
| S-9 | SLO-1 | Lab2: Microscopic observation of prokaryotes and eukaryotes | Lab5: Peripheral blood smear test | Lab 8: Diagnosis of aerobic bacteria by RPR test | Lab 11: Detection of Candida albicans | Lab 14: Demonstration of ELISA based detection of pathogens |
| | SLO-2 | Lab2: Microscopic observation of prokaryotes and eukaryotes | Lab5: Peripheral blood smear test | Lab 8: Diagnosis of aerobic bacteria by RPR test | Lab 11: Detection of Candida albicans | Lab 14: Demonstration of ELISA based detection of pathogens |
| S-10 | SLO-1 | Lab2: Microscopic observation of prokaryotes and eukaryotes | Lab5: Peripheral blood smear test | Lab 8: Diagnosis of aerobic bacteria by RPR test | Lab 11: Detection of Candida albicans | Lab 14: Demonstration of ELISA based detection of pathogens |

| | | | | | | |
|---|---|---|---|---|---|---|
| | SLO-2 | *Lab2: Microscopic observation of prokaryotes and eukaryotes* | *Lab5: Peripheral blood smear test* | *Lab 8: Diagnosis of aerobic bacteria by RPR test* | *Lab 11: Detection of Candida albicans* | *Lab 14: Demonstration of ELISA based detection of pathogens* |
| **S-11** | SLO-1 | *Cell signaling pathways* | *Apoptosis* | *Protozoan diseases* | *Staining* | *Peptide based therapies* |
| | SLO-2 | *GPCR and Tyrosine kinase pathway* | *Causes and biochemical changes of apoptosis* | *Protozoan diseases* | *Fat, iron & FAS stains* | *Antimicrobial peptides* |
| **S-12** | SLO-1 | *Signal Transduction* | *Autophagy* | *Metazoan diseases* | *ELISA* | *Types and therapeutic potential of AMPs* |
| | SLO-2 | *Cell growth factors – EGF* | *Intracellular accumulations of autophagy* | *Metazoan diseases* | *Western blotting* | *Prevention of infections* |
| **S-13** | SLO-1 | *Hepatocyte growth factors* | *Immunodeficiency syndrome* | *DNA virus* | *PCR* | *Maintaining the hygiene* |
| | SLO-2 | *VEGF, PDGF* | *Immunodeficiency syndrome* | *RNA virus* | *Sensor based detection* | *Isolation for the prevention of infection* |
| **S-14** | SLO-1 | *Lab 3: Total WBC count* | *Lab 6: Simple staining and Gram staining* | *Lab 9: Detection of salmonella infection by WIDAL test* | *Lab12: Polymerase chain reaction* | *Lab15:Demonstration of antigen and antibody purification by using FPLC* |
| | SLO-2 | *Lab 3: Total WBC count* | *Lab 6: Simple staining and Gram staining* | *Lab 9: Detection of salmonella infection by WIDAL test* | *Lab12: Polymerase chain reaction* | *Lab15:Demonstration of antigen and antibody purification by using FPLC* |
| **S-15** | SLO-1 | *Lab 3: Total WBC count* | *Lab 6: Simple staining and Gram staining* | *Lab 9: Detection of salmonella infection by WIDAL test* | *Lab12: Polymerase chain reaction* | *Lab15:Demonstration of antigen and antibody purification by using FPLC* |
| | SLO-2 | *Lab 3: Total WBC count* | *Lab 6: Simple staining and Gram staining* | *Lab 9: Detection of salmonella infection by WIDAL test* | *Lab12: Polymerase chain reaction* | *Lab15:Demonstration of antigen and antibody purification by using FPLC* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Robbins and Cotran," Pathologic Basis of Disease" Elsevier Saunders, 9 th edition, 2015.*<br>2. *Harsh Mohan, "Textbook of Pathology ' ,Jaypee publications, 6 th edition,2010.* | 3. *Prescott, Harley and Klein's , "Microbiology", Tata McGraw-Hill, New Delhi, 7th edition, 2008* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *20%* | *20%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *10%* | *10%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | - | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | 1. *Dr.J.Lavanya SRMIST* |

| Course Code | 18BMC201J | Course Name | BIOMEDICAL SENSORS | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 2 | 4 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Know the basics of measurement system |
| CLR-2 : | Learn the working principles of temperature transducers |
| CLR-3 : | Know the operating principles of pressure transducers |
| CLR-4 : | Familiarise the principles of optical transducers |
| CLR-5 : | Learn the working of bridges Circuits |
| CLR-6 : | Learn the concepts of smart sensors |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Explain the concepts of measurement system | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Implement temperature sensors | 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-3 : | Implement pressure sensors | 2 | 80% | 70% | | | M | | M | | | | | | | | M | | L |
| CLO-4 : | Demonstrate the optical transducers | 3 | 80% | 70% | | | | | M | | | | | | | | | | |
| CLO-5 : | Describe the operation of bridges circuits | 3 | 80% | 70% | M | | | | | | | | | | | | M | | L |
| CLO-6 : | know the concepts of smart sensors | 3 | 80% | 70% | M | | | | | | | | | | | | | | |

| | | MEASUREMENT SYSTEM | TEMPERATURE TRANSDUCERS | PRESSURE AND MAGNETIC TRANSDUCERS | OPTICAL TRANSDUCERS AND BRIDGE CIRCUITS | ADVANCES IN SENSING TECHNOLOGIES |
|---|---|---|---|---|---|---|
| Duration (hour) | | 15 | 15 | | 15 | 15 |
| S-1 | SLO-1 | Measurement system | Transducers | Strain Gauge: Principles | photodiodes | Biosensors: Definition |
| | SLO-2 | Block diagram | Block diagram | Types | Working principles | Block diagram |
| S-2 | SLO-1 | Measurement terminologies | Types | Inductive transducer: Principles | phototransistor | Classification of biosensors |
| | SLO-2 | Measurement terminologies | Selection Characteristics | Construction and Working | Working principles | Immobilization of Bio receptor |
| S-3 | SLO-1 | Types of Instruments | RTD | Load cell | LDR | Lab13: Study on Immobilisation techniques |
| | SLO-2 | types of Instruments | Construction and operating principles | Construction and Working | Working principles | Lab13: Study on Immobilisation techniques |
| S-4 | SLO-1 | Selection Criterion | Characteristics | Lab7: Characteristics of strain gauge | Optocouplers | Lab13: Study on Immobilisation techniques |
| | SLO-2 | Selection Criterion | Applications | Lab7: Characteristics of strain gauge | Working principles | Lab13: Study on Immobilisation techniques |
| S-5 | SLO-1 | Static characteristics | Lab4: Characteristics of RTD | Lab7: Characteristics of strain gauge | Photovoltaic cell | Biocatalysts based biosensor: Introduction |
| | SLO-2 | Static characteristics | Lab4: Characteristics of RTD | Lab7: Characteristics of strain gauge | Lab10: Characteristics of optoelectronic transducer | Principle |
| S-6 | SLO-1 | Dynamic characteristics | Lab4: Characteristics of RTD | LVDT | Lab10: Characteristics of optoelectronic transducer | Glucose Biosensor: Principle |
| | SLO-2 | Dynamic characteristics | Lab:4 Characteristics of RTD | Construction and Working | Lab10: Characteristics of optoelectronic transducer | Construction and operation |
| S-7 | SLO-1 | Lab1: Study of static characteristics | Thermistor | Capacitive transducer | Lab10: Characteristics of optoelectronic transducer | Lab14: Measurement of blood glucose |
| | SLO-2 | Lab1: Study of static characteristics | Construction and operating principles | Principles | Working principles | Lab14: Measurement of blood glucose |
| S-8 | SLO-1 | Lab1: Study of static characteristics | Characteristics | Modes of operation | wheat stone bridge | Lab14: Measurement of blood glucose |
| | SLO-2 | Lab1: Study of static characteristics | Applications | Modes of operation | Balance equation | Lab14: Measurement of blood glucose |
| S-9 | SLO-1 | Errors: Sources and types | Lab5: Characteristics of thermistor | Lab8: Characteristics of LVDT | Kelvin Bridge | Bio affinity based biosensor: Principle |
| | SLO-2 | Methods of minimizing errors | Lab5: Characteristics of thermistor | Lab8: Characteristics of LVDT | Balance equation | Construction and operation |
| S-10 | SLO-1 | Lab2: Computation of measurement errors | Lab5: Characteristics of thermistor | Lab8: Characteristics of LVDT | Lab11: Computation of unknown resistance using Bridge circuit | Microbe Biosensor |
| | SLO-2 | Lab2: Computation of measurement errors | Lab5: Characteristics of thermistor | Lab8: Characteristics of LVDT | Lab11: Computation of unknown resistance using Bridge circuit | Construction and operation |
| S-11 | SLO-1 | Lab2: Computation of measurement errors | Thermocouple | Piezoelectric active transducer | Lab11: Computation of unknown resistance using Bridge circuit | Electrochemical Biosensor: Principle |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Lab2: Computation of measurement errors* | *Construction and operating principles* | *Construction and Working* | *Lab11: Computation of unknown resistance using Bridge circuit* | Construction and operation |
| **S-12** | **SLO-1** | *Measurement standards* | *Characteristics* | *Hall effect* | *Maxwell Bridge* | Smart Sensors: Introduction |
| | **SLO-2** | *Types of standards* | *Applications* | *Principles of hall effect sensors* | *Balance equation* | Salient features |
| **S-13** | **SLO-1** | *Calibration* | *Lab6: Characteristics of thermocouple* | *Applications of hall effect sensors* | *Schering Bridge* | Architecture |
| | **SLO-2** | *Types* | *Lab6: Characteristics of thermocouple* | *Applications of hall effect sensors* | *Balance equation* | Applications |
| **S-14** | **SLO-1** | *Lab3: Calibration of measuring devices* | *Lab6: Characteristics of thermocouple* | *Lab9: Characteristics of Piezoelectric transducer* | *Lab12: Computation of unknown Inductance and capacitance using Bridge circuit* | *Lab15: Minor Project* |
| | **SLO-2** | *Lab3: Calibration of measuring devices* | *Lab6: Characteristics of thermocouple* | *Lab9: Characteristics of Piezoelectric transducer* | *Lab12: Computation of unknown Inductance and capacitance using Bridge circuit* | *Lab15: Minor Project* |
| **S-15** | **SLO-1** | *Lab3: Calibration of measuring devices* | *Semiconductor based temperature sensors* | *Lab9: Characteristics of Piezoelectric transducer* | *Lab12: Computation of unknown Inductance and capacitance using Bridge circuit* | *Lab15: Minor Project* |
| | **SLO-2** | *Lab3: Calibration of measuring devices* | *Semiconductor based temperature sensors* | *Lab9: Characteristics of Piezoelectric transducer* | *Lab12: Computation of unknown Inductance and capacitance using Bridge circuit* | *Lab15: Minor Project* |

| | |
|---|---|
| **Learning Resources** | 1. *Sawhney A.K, "A Course in electrical and electronic measurements and instrumentation", Dhanpat Rai & Co (P) Ltd, Educational and Technical Publishers, 19th Revised edition 2011, Reprint 2014.*<br>2. *Patranabis D, "Sensors and transducers", PHI, 2nd edition, 2004*<br>3. *Murty DVS, "Transducer and instrumentation", PHI, 2nd edition, 2010.*<br>4. *U.A. Bakshi, A.V. Bakshi, "Measurements and instrumentation", Technical Publications, 3rd revised edition, 2010.*<br>5. *Paras N, Prasad, "Introduction to biophotonics", John Wiley & Sons, 1st edition, 2003* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *20%* | *20%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *10%* | *10%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | - | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.D.Kathirvelu, SRMIST* |

| Course Code | 18BMC202T | Course Name | BIOMEDICAL SIGNALS AND SYSTEMS | Course Category | C | Professional core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | | Co-requisite Courses | | Progressive Courses | |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/ Standards | Nil | | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the Classification of the continuous time signals and systems and discrete-time signals and systems | | | |
| CLR-2 : | Acquire the knowledge about the Continuous Time Signals and System | | | |
| CLR-3 : | Utilize the knowledge of Convolution and Correlation in biosignals | | | |
| CLR-4 : | . Understand the concepts of z-transform and discrete Fourier transform | | | |
| CLR-5 : | Analyze the discrete time IIR and FIR systems by using suitable structures | | | |
| CLR-6 : | Acquire knowledge in biosignal applications | | | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | | | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO – 1: Professional Achievement | PSO – 2: Project Management Techniques | PSO – 3: Analyze & Reseach |
| CLO-1 : | Analyze the **Discrete time signals and systems** | 3 | 80 | 75 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-2 : | Analyze the Continuous Time Signals and System | 3 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | M | - |
| CLO-3 : | Illustrate the concepts of convolution and correlation in biosignals | 3 | 75 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | M |
| CLO-4 : | Analyze the transforms of Discrete Time Signals and Systems | 3 | 80 | 75 | - | - | M | - | - | - | - | - | - | - | - | - | - | - | M |
| CLO-5 : | Analyze the concept of realization using suitable filter structures | 3 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | - | - | - | M |
| CLO-6: | Explain the application of biomedical signals | 3 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | - | - | - | M |

| | | Basics OF Discrete time and continuous time signals and systems | Analysis of Continuous Time Signals and System | Convolution and Correlation of Discrete Time Signals | Transforms of Discrete Time Signals and Systems | Realization and Biosignal Applications |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | representation of discrete time signals | Fourier transform analysis | linear convolution | Z transform | Introduction to discrete time Infinite impulse response (IIR) |
| | SLO-2 | continuous time signals | Properties | Tutorials | -properties | finite impulse response (FIR) systems |
| S-2 | SLO-1 | standard discrete time signals, | Tutorials | Circular convolution- | region of convergence | Structure for realization of IIR systems-direct form-I |
| | SLO-2 | standard continuous time signals | Tutorials | Tutorials | Tutorials | Tutorials |
| S-3 | SLO-1 | Classification of signals: Continuous time(CT) | Laplace transform analysis | linear convolution via circular convolution | representation of poles and zeros in z transform | direct form-II |
| | SLO-2 | Tutorials | properties | Tutorials | Tutorials | Tutorials |
| S-4 | SLO-1 | Classification of Discrete time (DT) signals | Tutorials | Sectioned convolution-overlap add method | Inverse z transform- residue method | Cascade form |
| | SLO-2 | Tutorials | Tutorials | Tutorials | Tutorials | Tutorials |
| S-5 | SLO-1 | Mathematical operations on CTS- scaling, folding | Poles and zeros | Overlap save method | Partial fraction method | parallel form of IIR system |
| | SLO-2 | time shifting, addition and multiplication | Poles and zeros | Tutorials | Tutorials | Tutorials |
| S-6 | SLO-1 | Mathematical operations on DTS- scaling, folding | Analysis of differential equation- impulse response | Inverse system | Discrete time fourier transform- | Structure for realization of FIR systems-direct form |
| | SLO-2 | time shifting, addition and multiplication | Transfer function | deconvolution | properties | Tutorials |
| S-7 | SLO-1 | Classification of systems: static and dynamic systems | Tutorials | Correlation- autocorrelation | Tutorials | cascade and linear phase realization of FIR systems |
| | SLO-2 | time invariant and time variant | Tutorials | Tutorials | Tutorials | Tutorials |
| S-8 | SLO-1 | linear and nonlinear systems, | Analysis of differential equation-frequency response | cross correlation | Relation between Z transform and DTFT | Neural Firing rate analysis |
| | SLO-2 | causal and non-causal systems, | Tutorials | Tutorials | Introduction to discrete fourier transform | Nerve action potentials |
| S-9 | SLO-1 | stable and unstable systems | Biosignal measurements | Correlation of Biosignals | DFT-properties | Linearized model and system equations for immune response |
| | SLO-2 | Tutorials | Biosignal measurements | ECG,EMG | Tutorials | Linearized model and system equations for immune response |

| | |
|---|---|
| **Learning Resources** | |

| **Learning Assessment** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.U.Snekhalatha, SRMIST* |

| Course Code | 18BMC203J | Course Name | ELECTRIC AND ELECTRONIC CIRCUITS | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 2 | 4 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Analyze real-time circuits using mesh and nodal analysis and network reduction | | | |
| CLR-2 : | To learn various Network theorems for analyzing electrical circuits | | | |
| CLR-3 : | To learn the principles of network theorems in simplifying electrical circuits | | | |
| CLR-4 : | Provide a basis for understanding semiconductor material, how a pn junction is formed and its principle of operation | | | |
| CLR-5 : | Explain the importance of diode in electronic circuits by presenting appropriate diode applications | | | |
| CLR-6 : | Describe the basic structure, operation and characteristics of BJT, and discuss its use as a switch and an amplifier | | | |

**Course Learning Outcomes (CLO):** *At the end of this course, learners will be able to:*

| | | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Apply the concepts of mesh and nodal analysis in solving electric circuits | 1 | 80 | 70 | H | H | - | - | - | - | - | | - | M | - | - | - | M | M | - |
| CLO-2 : | Implement the concepts of network theorems in simplifying electric circuits | 1, 2 | 80 | 70 | H | H | M | - | - | - | - | | - | M | - | - | - | M | M | - |
| CLO-3 : | Evaluate solutions of network theorems for electric circuits | 1,2 | 80 | 70 | H | H | M | - | - | - | - | | - | M | - | - | - | M | M | - |
| CLO-4 : | Understand the operation, characteristics, parameters and specifications of semiconductor diodes | 1 | 80 | 70 | H | H | M | - | - | - | - | | - | M | - | - | - | M | M | - |
| CLO-5 : | Review bipolar transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching. | 1 | 80 | 70 | H | H | - | M | - | - | - | | - | M | - | - | - | M | M | - |
| CLO-6 : | Build a circuit, then make functional measurements to understand the operating characteristics of the circuit | 1 | 80 | 70 | H | H | M | - | - | - | - | | - | M | - | - | - | M | M | - |

| Duration (hour) | | METHODS OF ANALYSING CIRCUITS | NETWORK THEOREMS | NETWORK THEOREMS | SEMICONDUCTOR DIODES | DIODE CIRCUITS AND BIPOLAR JUNCTION TRANSISTORS |
|---|---|---|---|---|---|---|
| | | 15 | 15 | 15 | 15 | 15 |
| S-1 | SLO-1 | Introduction – Circuit Variables and Circuit Elements | Thevenin's Theorem | Superposition Theorem | Basic semiconductor theory: Intrinsic & extrinsic semiconductors | Half wave rectifier operation, Efficiency and ripple factor |
| | SLO-2 | Basic Circuits Laws : Kirchoff's Voltage Law (KVL) | Practice problems | Practice problems | Current flow in semiconductors | Center-Tapped Transformer Full wave rectifier operation, Efficiency and ripple factor |
| S-2 | SLO-1 | Kirchoff's Current Law (KCL) | Practice problems | Practice problems | PN junction theory | Bridge wave rectifier operation, Efficiency and ripple factor |
| | SLO-2 | Practice problems | Practice problems | Practice problems | Forward biased PN junction | Problem solving |
| S-3 | SLO-1 | Lab1: Verification of KVL | Lab 4: Verification of Thevenin's theorem | Lab 7: Verification of Superposition Theorem | Reverse biased PN junction | Lab 12: Diode circuits |
| | SLO-2 | Lab1: Verification of KVL | Lab 4: Verification of Thevenin's theorem | Lab 7: Verification of Superposition Theorem | Relation between Current and Voltage | Lab 12: Diode circuits |
| S-4 | SLO-1 | Lab1: Verification of KVL | Lab 4: Verification of Thevenin's theorem | Lab 7: Verification of Superposition Theorem | Problem solving | Lab 12: Diode circuits |
| | SLO-2 | Lab1: Verification of KVL | Lab 4: Verification of Thevenin's theorem | Lab 7: Verification of Superposition Theorem | Lab 10: PN Junction Diode Characteristics | Lab 12: Diode circuits |
| S-5 | SLO-1 | Mesh analysis | Norton's Theorem | Compensation Theorem | Lab 10: PN Junction Diode Characteristics | Physical structure |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Mesh analysis* | *Practice problems* | *Practice problems* | *Lab 10: PN Junction Diode Characteristics* | *Device operation of Bipolar junction transistor (BJT)* |
| **S-6** | **SLO-1** | *Mesh analysis* | *Practice problems* | *Practice problems* | *Lab 10: PN Junction Diode Characteristics* | *Device operation of Bipolar junction transistor (BJT)* |
| | **SLO-2** | *Practice problems* | *Practice problems* | *Practice problems* | *Calculation of depletion width* | *Current configuration -Voltage characteristics of Common Emitter (CE) BJT* |
| **S-7** | **SLO-1** | *Practice problems* | *Lab 5: Verification of Norton's theorem* | *Lab 8: Verification of Compensation Theorem* | *Calculation of barrier potential* | *Current-Voltage characteristics of CE BJT configuration* |
| | **SLO-2** | *Practice problems* | *Lab 5: Verification of Norton's theorem* | *Lab 8: Verification of Compensation Theorem* | *Derivation: diode current equation* | *Current-Voltage characteristics of Common Base (CB) BJT configuration* |
| **S-8** | **SLO-1** | *Lab 2: Verification of KCL* | *Lab 5: Verification of Norton's theorem* | *Lab 8: Verification of Compensation Theorem* | *Derivation: diode current equation* | *Current-Voltage characteristics of CB BJT configuration* |
| | **SLO-2** | *Lab 2: Verification of KCL* | *Lab 5: Verification of Norton's theorem* | *Lab 8: Verification of Compensation Theorem* | *Effect of Capacitance in PN junction: Transition Capacitance* | *Lab 13: CE and CB configurations – Input and output characteristics* |
| **S-9** | **SLO-1** | *Lab 2: Verification of KCL* | *Maximum Power Transfer Theorem* | *Reciprocity theorem* | *Diffusion Capacitance* | *Lab 13: CE and CB configurations – Input and output characteristics* |
| | **SLO-2** | *Lab 2: Verification of KCL* | *Practice problems* | *Practice problems* | *Problem solving* | *Lab 13: CE and CB configurations – Input and output characteristics* |
| **S-10** | **SLO-1** | *Nodal Analysis* | *Practice problems* | *Practice problems* | *Lab 11: Zener diode characteristics* | *Lab 13: CE and CB configurations – Input and output characteristics* |
| | **SLO-2** | *Nodal Analysis* | *Practice problems* | *Practice problems* | *Lab 11: Zener diode characteristics* | *Current-Voltage characteristics of CC BJT configuration* |
| **S-11** | **SLO-1** | *Nodal Analysis* | *Lab 6: Verification of Maximum Power Transfer Theorem* | *Substitution theorem* | *Lab 11: Zener diode characteristics* | *Current-Voltage characteristics of CC BJT configuration* |
| | **SLO-2** | *Practice problems* | *Lab 6: Verification of Maximum Power Transfer Theorem* | *Practice problems* | *Lab 11: Zener diode characteristics* | *BJT as an amplifier* |
| **S-12** | **SLO-1** | *Lab 3: Mesh Analysis* | *Lab 6: Verification of Maximum Power Transfer Theorem* | *Practice problems* | *Energy band structure of PN Junction Diode* | *BJT as a switch* |
| | **SLO-2** | *Lab 3: Mesh Analysis* | *Lab 6: Verification of Maximum Power Transfer Theorem* | *Practice problems* | *Ideal diode and its current-voltage characteristics* | *Problem solving* |
| **S-13** | **SLO-1** | *Lab 3: Mesh Analysis* | *Millman's theorem* | *Lab 9: Verification of Reciprocity & Substitution theorem* | *Terminal characteristics & parameters* | *Lab 14: Miniproject* |
| | **SLO-2** | *Lab 3: Mesh Analysis* | *Practice problems* | *Lab 9: Verification of Reciprocity & Substitution theorem* | *Diode modeling* | *Lab 14: Miniproject* |
| **S-14** | **SLO-1** | *Source Transformation Technique* | *Tellegen's theorem* | *Lab 9: Verification of Reciprocity & Substitution theorem* | *DC load line and analysis* | *Lab 14: Miniproject* |
| | **SLO-2** | *Source Transformation Technique : Practice problems* | *Practice problems* | *Lab 9: Verification of Reciprocity & Substitution theorem* | *Problem solving* | *Lab 14: Miniproject* |
| **S-15** | **SLO-1** | *Star-Delta Transformation* | *Duals and Duality* | *Lab 9: Verification of Reciprocity & Substitution Theorem* | *Problem solving* | *Lab 14: Miniproject* |
| | **SLO-2** | *Star-Delta Transformation: Practice problems* | *Practice problems* | *Lab 9: Verification of Reciprocity & Substitution Theorem* | *Problem solving* | *Lab 14: Miniproject* |

| | | |
|---|---|---|
| **Learning Resources** | *1.David A. Bell, Electronic Devices and Circuits, 5th ed., Oxford University Press, 2015.*<br>*2.Jegatheesan R, Analysis of Electric Circuits, McGraw Hill, 2014.*<br>*3.Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, 11th ed., Pearson Education, 2013*<br>*4.William H. Hayt, Jack E. Kemmerly, Steven M. Durbin, Engineering circuit analysis, 8th ed., McGraw Hill, 2012*<br>*5. Mahmood Nahvi & Joseph Edminister, "Schaum's Outline of Electric circuits", McGraw-Hill Education, 5th edition 2011.* | |

| **Learning Assessment** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Mr.P. Muthu, SRMIST* |

| Course Code | 18BMC204T | Course Name | Principles of Medical Imaging | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the physics of X –ray production |
| CLR-2 : | Learn the components of Computed tomography and different generations |
| CLR-3 : | Gain knowledge in PET and SPECT imaging |
| CLR-4 : | Understand the physics of MRI imaging |
| CLR-5 : | Gain knowledge about the reconstruction of images in MRI |
| CLR-6 : | Learn about different types of scanners – A, B & M mode and Duplex ultrasound scanners |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning 1: Level of Thinking (Bloom) | Learning 2: Expected Proficiency (%) | Learning 3: Expected Attainment (%) | PLO 1: Engineering Knowledge | PLO 2: Problem Analysis | PLO 3: Design & Development | PLO 4: Analysis, Design, Research | PLO 5: Modern Tool Usage | PLO 6: Society & Culture | PLO 7: Environment & Sustainability | PLO 8: Ethics | PLO 9: Individual & Team Work | PLO 10: Communication | PLO 11: Project Mgt. & Finance | PLO 12: Life Long Learning | PLO 13: PSO - 1 | PLO 14: PSO - 2 | PLO 15: PSO – 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | Describe the production of X ray and the working principle of X –ray machine | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Differentiate the generations of CT | 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-3 : | Illustrate the working principle of PET and SPECT scanner | 2 | 80% | 70% | | | M | | M | | | | | | | | M | | L |
| CLO-4 : | Differentiate and analyze the various image compression and registration algorithms | 3 | 80% | 70% | | | | | M | | | | | | | | | | |
| CLO-5 : | Describe the working principle of MRI and its different components | 3 | 80% | 70% | M | | | | | | | | | | | | M | | L |
| CLO-6 : | Illustrate the working of Different ultrasound scanners | 3 | 80% | 70% | M | | | | | | | | | | | | | | |

| | | X-ray Imaging and Digital Radiography | Computed Tomography | Nuclear imaging | Magnetic resonance imaging | Ultrasound imaging |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Nature of X-rays | Computed Tomography | Radio isotopes in medical diagnosis | Principles of NMR | Diagnostic Ultrasound |
| | SLO-2 | Properties of X -rays | basic principle | Physics of Radioactivity | Free induction decay | Physics of Ultrasonic Waves |
| S-2 | SLO-1 | Production of X-rays | Contrast scale – CT number | Radiation Detectors – Ionization chamber | T1 and T2 relaxation | Generation and detection of ultrasound |
| | SLO-2 | Stationary X –ray anode tube | CT – system components | Scintillation detector | Fourier transformation of FID | Medical Ultrasound |
| S-3 | SLO-1 | Rotating anode tube | Scanning system | Semiconductor detectors | Bloch equation | Basic Pulse-echo Apparatus |
| | SLO-2 | X –ray machine | Different generation of CT | Solid state detectors | Image Reconstruction Techniques | A scanner and applications |
| S-4 | SLO-1 | High frequency generator | X – ray source | Pulse Height Analyzer | Sequential point method, Sequential line method | B scanner and applications |
| | SLO-2 | Collimators and grids | X –ray detectors and types | Uptake Monitoring Equipment | Sequential plane method | Echocardiograph (M-mode) |
| S-5 | SLO-1 | Automatic exposure control – photo cell method | Data acquisition system | Radio-isotope Rectilinear Scanner | Discrimination based on relaxation rates | Block diagram of echo cardiograph circuit |
| | SLO-2 | Ionization method | Processing unit | The Gamma Camera | Saturation recovery | Doppler scanner |
| S-6 | SLO-1 | Visualization of X-rays – X- ray film | Iterative reconstruction | Multi crystal gamma camera | Inversion recovery | Principles of Elastography, Shear wave elastography |
| | SLO-2 | Fluorescent screen | Back projection reconstruction | Block diagram and description of Multi crystal gamma camera | Spin echo imaging technique | Real time ultrasonic imaging systems |
| S-7 | SLO-1 | X –ray image intensifier tube | Filtered back projection | Emission computed tomography | Generic pulse sequence used in MRI | Multi-element Linear Array Scanners |
| | SLO-2 | X –ray image intensifier system | Block diagram of the image computer | Single-photon Emission Computed Tomography – Principle | Basic NMR Components | Linear array scanner |
| S-8 | SLO-1 | Dental X-ray Machines | Viewing system | SPECT system – simplified diagram and description | NMR Detection system, NMR gradient control system | Phased array system |
| | SLO-2 | Portable and Mobile X-ray Units | Storing and documentation | Positron Emission Tomography - Principle | Biological Effects of NMR Imaging Advantages of NMR Imaging System | Area array system |
| S-9 | SLO-1 | Digital Radiography | Gantry geometry | PET – Gantry and detector module | fMRI basic physics, Image acquisition procedure | Duplex scanner |
| | SLO-2 | Flat panel detectors | Patient dose in CT scanners | Data acquisition system for PET scanner | MR spectroscopy basic block diagram and applications | Intravascular imaging |

| | | |
|---|---|---|
| **Learning Resources** | 1. R.S.Khandpur., 'Handbook of Biomedical instrumentation', Tata McGraw Hill Publishing Co Ltd., 3rd edition, 2014.<br>2. Jerrold T. Bushberg, John M. Boone., "The essential physics of medical imaging", Lippincott Williams & Wilkins, 3rd edition, 2011. | 3. M. A. Flower (Editor)., "Webb's Physics of medical imaging, Second Edition", CRC Press, Taylor & Francis Group, ISBN: 978-0-7503-0573-0, 2nd edition, 2016. Nadine Barrie Smith, Andrew Webb, "Introduction to medical imaging: Physics, Engineering and clinical applications", Cambridge University Press, 1st edition, 2010.<br>4. K. Kirk Shung, Michael Smith, Benjamin M.W. Tsui., "Principles of medical imaging", Academic Press, 1st edition, 2012. |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *20%* | *20%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *10%* | *10%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | - | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1., Dr. S. P. Angeline Kirubha, SRMIST* |

| Course Code | 18BMC205T | Course Name | LINEAR AND DIGITAL INTEGRATED CIRCUITS | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 2 | 4 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

**Course Learning Rationale (CLR):** The purpose of learning this course is to:

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the operation and analysis of op-amp oscillators, single chip oscillators and frequency generators | | | |
| CLR-2 : | Identify the active filter types, filter response characteristics, filter parameters and IC voltage regulators | | | |
| CLR-3 : | Gain knowledge on data converter terminology, its performance parameters, and various circuit arrangements for A/D and D/A conversions. | | | |
| CLR-4 : | Familiarize mathematical operations | | | |
| CLR-5 : | Able to design simple combinational logics using basic gates and MSI circuits | | | |
| CLR-6 : | Familiarize with basic sequential logic components: flip-flops, registers, counters and their usage, and able to design and analyze sequential logic circuits and Finite State Machines | | | |

**Course Learning Outcomes (CLO):** At the end of this course, learners will be able to:

| | | | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Elucidate and design the linear and non-linear applications of an opamp and special application ICs | 1, 2 | 80 | 70 | M | M | L | - | - | - | - | - | - | - | - | M | M | - | - |
| CLO-2 : | Classify and comprehend the working principle of data converters and active filters | 1, 2 | 80 | 70 | M | L | - | - | - | - | - | - | - | - | - | L | L | - | - |
| CLO-3 : | Illustrate the function of application specific ICs such as Voltage regulators and ADC and DAC | 1,2 | 80 | 70 | - | M | - | L | - | - | - | - | - | - | - | - | L | L | - |
| CLO-4 : | Understand, analyze, design and troubleshoot various combinational logic circuits | 2 | 80 | 70 | M | M | L | M | M | - | - | - | - | - | - | - | - | L | M |
| CLO-5 : | Understand, analyze, design and troubleshoot various clocked sequential logic circuits. | 2,3 | 80 | 70 | - | - | M | M | M | - | - | - | - | - | - | - | - | L | M |
| CLO-6 : | Analyze, design and implement various digital logic circuits using PLDs | 3 | 80 | 70 | - | M | - | M | - | - | - | - | - | - | - | - | - | L | M |

| Duration (hour) | | Applications of Op-amp | Oscillators and Filters | Analog and digital converters | Combinational Systems | Sequential System |
|---|---|---|---|---|---|---|
| | | 15 | 15 | 15 | 12 | 12 |
| S-1 | SLO-1 | Basic op-amp circuits: Inverting & Noninverting voltage amplifiers | Waveform Generators: Sine-wave Generators - Design | Digital to Analog Conversion: DAC Specifications | Binary arithmetic units | Flip-flop and Latch: SR latch, |
| | SLO-2 | Voltage follower | Implementation & Solving problems | Solving problems | Adder | JK flip-flop, T flip-flop, D flip-flop |
| S-2 | SLO-1 | Summing, scaling & averaging amplifiers, | Square Wave generators- Design | Weighted Resistor DAC | Design of Half adder | Master-slave RS flip-flop |
| | SLO-2 | AC amplifiers | Implementation & Solving problems | Solving problems | Design of Full adder | Master-slave JK flip-flop |
| S-3 | SLO-1 | Linear Applications: Instrumentation Amplifiers | Triangle wave generators | R-2R Ladder DAC | Subtractor | Registers & Counters |
| | SLO-2 | Instrumentation Amplifiers, Solving Problems | Saw-tooth Wave generators | Solving problems | Design subtractor using logic gates | Shift registers (SISO, SIPO, PISO, PIPO) |
| S-4 | SLO-1 | Lab 1: Comparators | Lab 4: Waveform generators: using opamp & 555 Timer | Lab 7: Flash Type ADC | LAB 10: Implement combinational logic functions using standard ICs | LAB 13: Design and implement Synchronous Counters |
| | SLO-2 | Lab 1: Comparators | Lab 4: Waveform generators: using opamp & 555 Timer | Lab 7: Flash Type ADC | LAB 10: Implement combinational logic functions using standard ICs | LAB 13: Design and implement Synchronous Counters |
| S-5 | SLO-1 | Lab 1: Comparators | Lab 4: Waveform generators: using opamp & 555 Timer | Lab 7: Flash Type ADC | LAB 10: Implement combinational logic functions using standard ICs | LAB 13: Design and implement Synchronous Counters |
| | SLO-2 | Lab 1: Comparators | Lab 4: Waveform generators: using opamp & 555 Timer | Lab 7: Flash Type ADC | LAB 10: Implement combinational logic functions using standard ICs | LAB 13: Design and implement Synchronous Counters |
| S-6 | SLO-1 | V-to-I Converters | Comparison between Passive and Active Networks | Inverted R-2R Ladder DAC | n-bit parallel adder & subtractor | Universal shift register |
| | SLO-2 | I-to-V converter | Active Network Design | Monolithic DAC | look ahead carry generator | Synchronous counters, Modulus-n Counter |
| S-7 | SLO-1 | Differentiators | Filter Approximations | Analog to Digital conversion: ADC specifications | Decoder | Mealy and Moore model |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Integrators* | *Design of LPF & Solving problems* | *Solving problems* | *Encoder* | *Mealy and Moore model* |
| **S-8** | **SLO-1** | *Non-linear Applications: Precision Rectifiers* | *Design of HPF & Solving problems* | *Ramp Type ADC* | *Multiplexer* | *Synchronous (Clocked) sequential circuits* |
| | **SLO-2** | *Wave Shaping Circuits (Clipper and Clampers)* | *Design of BPF& Solving problems* | *Solving problems* | *Demultiplexer* | *Synchronous (Clocked) sequential circuits* |
| **S-9** | **SLO-1** | *Lab 2: Wave shaping circuits* | *Lab 5: Design of LPF, HPF, BPF and Band Reject Filters* | *Lab 8: Simulation experiments using EDA SLO-2 tools* | *LAB 11: Verify characteristic table of flipflops* | *LAB 14:Design of parallel Adder* |
| | **SLO-2** | *Lab 2: Wave shaping circuits* | *Lab 5: Design of LPF, HPF, BPF and Band Reject Filters* | *Lab 8: Simulation experiments using EDA SLO-2 tools* | *LAB 11: Verify characteristic table of flipflops* | *LAB 14:Design of parallel Adder* |
| **S-10** | **SLO-1** | *Lab 2: Wave shaping circuits* | *Lab 5: Design of LPF, HPF, BPF and Band Reject Filters* | *Lab 8: Simulation experiments using EDA SLO-2 tools* | *LAB 11: Verify characteristic table of flipflops* | *LAB 14:Design of parallel Adder* |
| | **SLO-2** | *Lab 2: Wave shaping circuits* | *Lab 5: Design of LPF, HPF, BPF and Band Reject Filters* | *Lab 8: Simulation experiments using EDA SLO-2 tools* | *LAB 11: Verify characteristic table of flipflops* | *LAB 14:Design of parallel Adder* |
| **S-11** | **SLO-1** | *Log and Antilog Amplifiers* | *Voltage Regulators: Basics of Voltage Regulator* | *Successive Approximation ADC* | *Code converters* | *Design of combinational circuits using PLD's* |
| | **SLO-2** | *Analog voltage multiplier circuit and its applications* | *Specifications and characteristic parameters* | *Solving problems* | *Magnitude comparators* | *Design of combinational circuits using PLD's* |
| **S-12** | **SLO-1** | *Operational Trans-Conductance Amplifier (OTA)* | *Linear Voltage Regulators using Op-amp* | *Dual Slope ADC* | *Applications* | *RAM Memory decoding* |
| | **SLO-2** | *Comparators : operation* | *IC Regulators (78xx, 79xx, LM 317, LM 337, 723),* | *Flash Type ADC* | *Parity generators (Odd parity)* | *ROM* |
| **S-13** | **SLO-1** | *Comparators applications* | *Switching Regulators -operation* | *Solving problems on Flash Type ADC* | *Parity generators (Even parity)* | *Programmable Array Logic (PAL)* |
| | **SLO-2** | *Sample and Hold circuit.* | *Types* | *Monolithic ADC* | *Implementation of combinational logic by standard IC's.* | *Programmable Array Logic (PAL)* |
| **S-14** | **SLO-1** | *Lab 3: Waveform generators: using opamp & 555 Timer* | *Lab 6: R-2R ladder DAC* | *Lab 9: Simulation experiments using EDA SLO-2 tools* | *LAB 12: Construct and verify 4-bit ripple counter, Mod-10/Mod-12 ripple counters* | *LAB 15: Design of subractor* |
| | **SLO-2** | *Lab 3: Waveform generators: using opamp & 555 Timer* | *Lab 6: R-2R ladder DAC* | *Lab 9: Simulation experiments using EDA SLO-2 tools* | *LAB 12: Construct and verify 4-bit ripple counter, Mod-10/Mod-12 ripple counters* | *LAB 15: Design of subractor* |
| **S-15** | **SLO-1** | *Lab 3: Waveform generators: using opamp & 555 Timer* | *Lab 6: R-2R ladder DAC* | *Lab 9: Simulation experiments using EDA SLO-2 tools* | *LAB 12: Construct and verify 4-bit ripple counter, Mod-10/Mod-12 ripple counters* | *LAB 15: Design of subractor* |
| | **SLO-2** | *Lab 3: Waveform generators: using opamp & 555 Timer* | *Lab 6: R-2R ladder DAC* | *Lab 9: Simulation experiments using EDA SLO-2 tools* | *LAB 12: Construct and verify 4-bit ripple counter, Mod-10/Mod-12 ripple counters* | *LAB 15: Design of subractor* |

| | | |
|---|---|---|
| ***Learning Resources*** | *1. Morris Mano M, Michael D. Ciletti, Digital Design with an Introduction to the Verilog HDL, 5th ed., Pearson Education, 2014*<br>*2. Charles H Roth (Jr), Larry L. Kinney, Fundamentals of Logic Design, 5th ed., Cengage Learning India Edition, 2010*<br>*3. Thomas L. Floyd, Digital Fundamentals, 10th ed., Pearson Education, 2013* | *4. Roy Choudhury, Shail Jain, Linear Integrated Circuits, 4th ed., New Age International Publishers, 2014*<br>*5. Robert F. Coughlin, Frederick F. Driscoll, Operational-Amplifiers and Linear Integrated Circuits, 6th ed., Prentice Hall, 2001*<br>*gio Franco, Design with operational amplifier and analog integrated circuits, McGraw Hill, 1997* |

***Learning Assessment***

| | *Bloom's Level of Thinking* | *Continuous Learning Assessment (50% weightage)* | | | | | | | | *Final Examination (50% weightage)* | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *CLA – 1 (10%)* | | *CLA – 2 (15%)* | | *CLA – 3 (15%)* | | *CLA – 4 (10%)#* | | | |
| | | *Theory* | *Practice* | *Theory* | *Practice* | *Theory* | *Practice* | *Theory* | *Practice* | *Theory* | *Practice* |
| *Level 1* | *Remember* | *20 %* | *20%* | *15 %* | *15%* | *15 %* | *15%* | *15 %* | *15%* | *15 %* | *15%* |
| | *Understand* | | | | | | | | | | |
| *Level 2* | *Apply* | *20 %* | *20%* | *20 %* | *20%* | *20 %* | *20%* | *20 %* | *20%* | *20 %* | *20%* |
| | *Analyze* | | | | | | | | | | |
| *Level 3* | *Evaluate* | *10 %* | *10%* | *15 %* | *15%* | *15 %* | *15%* | *15 %* | *15%* | *15 %* | *15%* |
| | *Create* | | | | | | | | | | |
| | *Total* | *100 %* | | *100 %* | | *100 %* | | *100 %* | | *100 %* | |

*# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,*
*SLO – Session Learning Outcome*

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Mr.P. Muthu, SRMIST* |

| Course Code | 18BMC206J | Course Name | BIOMATERIALS- TISSUE INTERACTION | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 2 | 4 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | BME | Data Book / Codes/Standards | Nil | | |

| Course Learning Rationale (CLR): | To study the learners to acquire knowledge to the basic properties of biomaterials and various biomaterials used in biomedical applications. |
|---|---|
| CLR-1 : | Attain the knowledge on basics properties of biomaterials |
| CLR-2 : | Study the phenomena various metals used in implant applications |
| CLR-3 : | Acquire knowledge importance of ceramics and polymer used biomedical diagnostics |
| CLR-4 : | Familiarize with biological system, prosthetic and medical implants |
| CLR-5 : | Obtain the concept of different types biomaterials applied in-vitro and in-vivo biomedical implant application |
| CLR-6 : | Have an Gain the knowledge about biomaterials used in various biomedical implant application |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| CLO-1 : | Understand the basic principle and properties of biomaterials | 1, 2 | 80% | 70% | L | | | | L | | | | | | | L | | | M |
| CLO-2 : | Analyze various types of metals used in implant applications. | 2 | 80% | 70% | L | | | | M | | | | | | | M | | | M |
| CLO-3 : | Explain the process of importance of ceramics and polymer used biomedical diagnostics | 2 | 80% | 70% | L | | | | M | | | M | | | | L | | | M |
| CLO-4 : | Select appropriate class of polymers using knowledge of, prosthetic and medical implants. | 3 | 80% | 70% | M | | | | | | | | | | | L | M | M | |
| CLO-5 : | Understand the concepts different types biomaterials applied in-vitro and in-vivo biomedical implant application. | 3 | 80% | 70% | M | | | | | | | | | | | M | M | M | |
| CLO-6 : | Apply the various biomaterials used in implants and artificial organs | 3 | 80% | 70% | M | | M | H | | | | M | | | | | | M | M |

| | | Introduction to biomaterials and its properties | Metallic and Ceramics implants materials | Polymeric Implant materials | Soft and Hard Tissue Replacements | Biomaterials in Tissue interaction |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Introduction to Biomaterials | Metallic implant materials | Polymer Materials: Synthetic polymer | Sutures, skin, Tapes, and Adhesives | Scaffolds for tissue engineering |
| | SLO-2 | Performance of biomaterials | Stainless steel, Co alloy properties and application | Polymers in biomedical use | Maxillofacial implants | Classes of potential scaffold materials |
| S-2 | SLO-1 | Characterization of biomaterials | T i based alloys properties and application | Polyethylene and polypropylene | Cardiovascular Grafts and Stents. | The criteria for an ideal scaffold |
| | SLO-2 | Mechanical properties | Dental metals: Dental Amalgam, Gold | Perfluorinted polymers | Heart Valve Implants. | Polymer scaffolds |
| S-3 | SLO-1 | Stress–Strain Behavior | Shape memory alloys: | Acrylic polymers and Hydrogel | | Polymer scaffolds applications |
| | SLO-2 | Mechanical Failure | Application of Nickel titanium materials | Polyurethane | Hard Tissue replacement: Wires, Pins, and Screws | Bioactive ceramic scaffolds |
| S-4 | SLO-1 | Lab1 Study of metallurgical Microscope | Lab 4 Preparation and characterization of Hydroxyapatite | Lab7 Physical Characterization of Coated/Uncoated Surfaces Contact Angle measurement polycaprolactone (PCL). | Lab 10 Chemical Characterization of modified/unmodified surfaces(PVA) | Lab 13 Preparation and characterization of Poly (2-hydroxyethyl methacrylate) hydrogels |
| | SLO-2 | Lab1 Specimen preparation for identification of metals/alloys B1 Hand Polishing | Lab 4 Preparation and characterization of Hydroxyapatite | Lab7 Physical Characterization of Coated/Uncoated Surfaces Contact Angle measurement polycaprolactone (PCL). | Lab 10 Chemical Characterization of modified/unmodified surfaces(PVA) | Lab 13 Preparation and characterization of Poly (2-hydroxyethyl methacrylate) hydrogels |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | *B2 Etching* | | | | |
| **S-5** | *SLO-1* | *Lab1 Study of metallurgical Microscope* | *Lab 4 Preparation and characterization of Hydroxyapatite* | *Lab7 Physical Characterization of Coated/Uncoated Surfaces Contact Angle measurement polycaprolactone (PCL).* | *Lab 10 Chemical Characterization of modified/unmodified surfaces(PVA)* | *Lab 13 Preparation and characterization of Poly (2-hydroxyethyl methacrylate) hydrogels* |
| | *SLO-2* | *Lab1 Specimen preparation for identification of metals/alloys B1 Hand Polishing B2 Etching* | *Lab 4 Preparation and characterization of Hydroxyapatite* | *Lab7 Physical Characterization of Coated/Uncoated Surfaces Contact Angle measurement polycaprolactone (PCL).* | *Lab 10 Chemical Characterization of modified/unmodified surfaces(PVA)* | *Lab 13 Preparation and characterization of Poly (2-hydroxyethyl methacrylate) hydrogels* |
| **S-6** | *SLO-1* | *Static failure* | *Other metallic materials and properties ,Applications* | *Polyamides* | *Lower Extremity Implants: Hip Joint Replacements* | *Bioactive ceramic scaffolds and its applications* |
| | *SLO-2* | *Dynamic failure.* | *Other metallic materials and properties ,Applications* | *Biodegradable synthetic polymer* | *Knee Joint Replacements* | *Substrate Scaffold Materials* |
| **S-7** | *SLO-1* | *Friction and wear failure* | *New generation of bimetallic materials: Properties and application* | *Silicone rubber* | *Introduction to Kidney implant* | *A guide to basic cell culture and applications in biomaterials and tissue engineering* |
| | *SLO-2* | *viscoelastic properties* | *Corrosion metallic implants: Electrochemical Aspects* | *Plasma polymerization and Polymer sterilization* | *Artificial Lung implant* | *sterilization of scaffolds, Sterilization methods* |
| **S-8** | *SLO-1* | *Thermal Properties* | *Structure and properties of ceramic materials* | *Composite materials: Structure* | *Liver implant,* | *Cell culture protocols* |
| | *SLO-2* | *Surface properties: Contact angle* | *Impact of fabrication on microstructure and properties :Alumina and its properties* | *Mechanics of composite and application of composite materials* | *Artificial Pancreas* | *Basic techniques for assessment of cell viability* |
| **S-9** | *SLO-1* | *Lab2 Determination of hardness using Micro Vickers Tester* | *Lab 5 Preparation and characterization of titanium oxide* | *Lab8 Physical Characterization of Coated/Uncoated Surfaces Contact Angle measurement poly lactic acid (PLA).* | *Lab 11 Chemical Characterization of modified/unmodified any biodegradable polymers* | *Lab 14 Preparation and characterization of any ceramics* |
| | *SLO-2* | *Lab2 Determination of hardness using Micro Vickers Tester* | *Lab 5 Preparation and characterization of titanium oxide* | *Lab 8 Physical Characterization of Coated/Uncoated Surfaces Contact Angle measurement poly lactic acid (PLA)* | *Lab 11 Chemical Characterization of modified/unmodified any biodegradable polymers* | *Lab 14 Preparation and characterization of any ceramics* |
| **S-10** | *SLO-1* | *Lab2 Determination of hardness using Micro Vickers Tester* | *Lab 5 Preparation and characterization of titanium oxide* | *Lab 8 Physical Characterization of Coated/Uncoated Surfaces Contact Angle measurement poly lactic acid (PLA).* | *Lab 11 Chemical Characterization of modified/unmodified any biodegradable polymers* | *Lab 14 Preparation and characterization of any ceramics* |
| | *SLO-2* | *Lab2 Determination of hardness using Micro Vickers Tester* | *Lab 5 Preparation and characterization of titanium oxide* | *Lab 8 Physical Characterization of Coated/Uncoated Surfaces Contact Angle measurement poly lactic acid (PLA)* | *Lab 11 Chemical Characterization of modified/unmodified any biodegradable polymers* | *Lab14 Preparation and characterization of any ceramics* |
| **S-11** | *SLO-1* | *Ceramics and Glasses and Polymers and Elastomers* | *Zirconia and its properties* | *Porous Implants materials* | *Optical implants Contact lenses* | *maintenance of cells in vitro, cryopreservation* |
| | *SLO-2* | *Adhesion, Problem for surface properties* | *Calcium phosphate and its properties* | *Fibrous and Particulate Composites in Orthopedic Implants* | *Ear implant* | *Regeneration stimulated electrically* |
| **S-12** | *SLO-1* | *Electrical properties* | *Glass ceramics.Yitria ceramics and its properties* | *Design criteria for bio composites* | *Blood flow in artificial devices* | *Immunochemical techniques in tissue engineering and biomaterial science* |
| | *SLO-2* | *Piezoelectricity, Density of various materials* | *Other ceramics* | *Inflammation and wound healing* | *Artificial Nose* | *Basic immunological principles* |
| **S-13** | *SLO-1* | *Porosity of various materials* | *Hydroxyapatite ceramics and its properties* | *Normal wound healing* | *Regeneration and Potential Future Uses for Stem Cells* | *Common immunochemical techniques used in biomaterials* |
| | *SLO-2* | *Diffusion properties* | *Manufacture of Implants in ceramics* | *Body response to implants, Biocompatibility* | *Ethical consideration* | *Immunochemical applications in biomaterial science and tissue engineering research* |
| **S-14** | *SLO-1* | *Lab 3 Determination of coating thickness using Image analyzer* | *Lab 6 study the corrosion behaviour of coated and uncoated substrate* | *Lab 9 preparation of simulated body fluid solution* | *Lab 12 In-vitro Study in any metallic medical implants* | *Lab 15 Model Exam* |
| | *SLO-2* | *LAB 3 Determination of coating thickness using Image analyzer* | *Lab 6 study the corrosion behaviour of coated and uncoated substrate* | *Lab 9 preparation of simulated body fluid solution* | *Lab 12 In-vitro Study in any metallic medical implants* | *Lab 15 Model Exam* |
| **S-15** | *SLO-1* | *Lab 3 Determination of coating thickness using Image analyzer* | *Lab 6 study the corrosion behaviour of coated and uncoated substrate* | *Lab 9 preparation of simulated body fluid solution* | *Lab 12 In-vitro Study in any metallic medical implants* | *Lab 15 Model Exam* |
| | *SLO-2* | *Lab 3 Determination of coating thickness using Image analyzer* | *Lab 6 study the corrosion behaviour of coated and uncoated substrate* | *Lab 9 preparation of simulated body fluid solution* | *Lab 12 In-vitro Study in any metallic medical implants* | *Lab 15 Model Exam* |

| | |
|---|---|
| **Learning Resources** | 1. Joon park, R.S Lakes, *"Biomaterials An Introduction "Springer*, 2007<br>2. Sujata V. Bhat "Biomaterials" springer 2002<br>3. Larry L. Hench and Julian R. Jones, Biomaterials, artificial organs and tissue engineering, CRC Press 2010 |

| **Learning Assessment** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1., Dr S.Gnanavel, SRMIST* |

| Course Code | 18BMC301J | Course Name | MEDICAL INSTRUMENTATION | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 2 | 4 |

| Pre-requisite Courses | Basic Electronic Devices and Circuits, Linear Integrated Circuits | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the basic function of physiological system and basic instrument for picking up biological signals |
| CLR-2 : | Analyze various biological signal acquired from physiological system using various instruments |
| CLR-3 : | Get an idea about various blood pressure and blood flow measurement techniques |
| CLR-4 : | Understand various technique used for measurement in the respiratory system |
| CLR-5 : | Identify the various instruments used for the therapeutic and patient safety |
| CLR-6 : | Understanding the overall bioelectronics instruments used for physiological measurement |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Describe the function of physiological system and basic man instrument system used for analyzes | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Identify the various biological signal and its abnormalities .Applying procedure to obtain biological signal | 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-3 : | Apply the blood pressure and flow measurement technique | 2 | 80% | 70% | | | M | | M | | | | | | | | M | | L |
| CLO-4 : | Analyze the various technique used for measurement of respiratory system | 3 | 80% | 70% | | | | | M | | | | | | | | | | |
| CLO-5 : | Apply the various instrument used for the emergency therapeutic application and patient safety | 3 | 80% | 70% | M | | | | | | | | | | | | M | | L |
| CLO-6 : | Outline the job opportunities in biomedical device in India | 3 | 80% | 70% | M | | | | | | | | | | | | | | |

| | | Introduction to Bioinstrumentation system | Biosignal acquisition from physiological system | Blood Pressure and blood flow measurement | Measurements in the Respiratory system | Biomedical instrument for therapeutic and patient safety |
|---|---|---|---|---|---|---|
| Duration (hour) | | 15 | 15 | 15 | 15 | 15 |
| S-1 | SLO-1 | Physiological systems of the human body | Cardiovascular system: Basic anatomy and physiology of heart | Measurement of blood pressure: indirect Methods | Introduction of respiratory system | Need for cardiac pacemaker |
| | SLO-2 | Biometrics | Electrophysiology of the Heart | Measurement of blood pressure: indirect Methods | Gas exchange and distribution | External pacemaker |
| S-2 | SLO-1 | Introduction to the Man-Instrument system | Electrocardiography waveform and its characteristics | Measurement of blood pressure: Direct methods | Measurement of Respiratory volumes and capacities | Implantable pacemaker |
| | SLO-2 | Components of Man-Instrument system | ECG lead configurations | Measurement of blood pressure: Direct methods | Spirometry | Implantable pacemaker |
| S-3 | SLO-1 | Problem encountered in measuring in a living system | 12 lead ECG machine circuit | Blood flow measuring techniques: electromagnetic blood flow meter, Ultrasonic blood flow meter | Spirometry | Recent developments in Implantable pacemaker |
| | SLO-2 | Intelligent medical instrumentation system | Various Arrhythmias occurring in ECG signal | NMR blood flow meter, Laser Doppler blood flow meter | Pneumotachometers: different types | Pacing system analyzer |
| S-4 | SLO-1 | Lab1: Study of block diagram of man instrument system | Lab4: Real time ECG recording | Lab 7: Measurement of blood flow | Lab 10: Pulmonary analysis using spirometer | Lab 13: Study of pacemakers |
| | SLO-2 | Lab1: Study of block diagram of man instrument system | Lab4: Real time ECG recording | Lab 7: Measurement of blood flow | Lab 10: Pulmonary analysis using spirometer | Lab 13: Study of pacemakers |
| S-5 | SLO-1 | Lab1: Study of block diagram of man instrument system | Lab4: Real time ECG recording | Lab 7: Measurement of blood flow | Lab 10: Pulmonary analysis using spirometer | Lab 13: Study of pacemakers |
| | SLO-2 | Lab1: Study of block diagram of man instrument system | Lab4: Real time ECG recording | Lab 7: Measurement of blood flow | Lab 10: Pulmonary analysis using spirometer | Lab 13: Study of pacemakers |
| S-6 | SLO-1 | Resting and action potential | Introduction to basic Anatomy and function of brain | Cardiac output measuring techniques: dye dilution method | Pneumotachometers: different types | DC Defibrillator |
| | SLO-2 | Propagation of Action potential | Bioelectric potential from the brain | Thermal dilution method | Pneumotachometers: different types | DC Defibrillator |
| S-7 | SLO-1 | Nernst equation, Goldman equation, Hodgkin-Huxley model | 10-20 system of placement of electrode | Cardiac output from aortic pressure waveform | Respiratory gas analyzers: Infrared gas analyzer | Types of implantable Defibrillators |
| | SLO-2 | Sources of Bioelectric potentials | EEG Machine block diagram description | Impedance technique | Oxygen analyzers | Pacer-Cardioverter-defibrillator |
| S-8 | SLO-1 | Bio potential measurement: electrode electrolyte | Computerized analysis of EEG | Ultrasound method | Thermal conductivity analyser | Defibrillator analysers |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | *interface,* | | | | |
| | ***SLO-2*** | *polarizable and non-polarizable electrodes, The electrode skin interface and motion artifact* | *Magnetoencephalography* | *Bioreactance method, CO2 rebreathing method* | *Nitrogen gas analyzer* | *Left ventricular assist device* |
| ***S-9*** | ***SLO-1*** | *Lab2: Study of sources of Biopotentials* | *Lab5: Real time EEG monitoring* | *Lab 8: Measurement of cardiac output* | *Lab 11: Study of pneumotachometers* | *Lab 14: Study of defibrillators* |
| | ***SLO-2*** | *Lab2: Study of sources of Biopotentials* | *Lab5: Real time EEG monitoring* | *Lab 8: Measurement of cardiac output* | *Lab 11: Study of pneumotachometers* | *Lab 14: Study of defibrillators* |
| ***S-10*** | ***SLO-1*** | *Lab2: Study of sources of Biopotentials* | *Lab5: Real time EEG monitoring* | *Lab 8: Measurement of cardiac output* | *Lab 11: Study of pneumotachometers* | *Lab 14: Study of defibrillators* |
| | ***SLO-2*** | *Lab2: Study of sources of Biopotentials* | *Lab5: Real time EEG monitoring* | *Lab 8: Measurement of cardiac output* | *Lab 11: Study of pneumotachometers* | *Lab 14: Study of defibrillators* |
| ***S-11*** | ***SLO-1*** | *Biopotential electrodes:Surface,and Micro electrodes* | *Electromyography(EMG):Basics of EMG* | *Heart rate measurement* | *Measurement of respiration rate: displacement method,* | *Electric shock hazards* |
| | ***SLO-2*** | *Biopotential electrodes:Needle electrodes* | *Recording of EMG* | *Heart rate measurement* | *Thermistor method,* | *Microshock and Macroshock* |
| ***S-12*** | ***SLO-1*** | *Biochemical electrodes: pH* | *Electrooculography(EOG):Origin and measurement* | *Invitro-oximetry, invivo-oximetry* | *Impedance pneumography* | *Threshold of perception and Leakage current* |
| | ***SLO-2*** | *Biochemical electrodes: pO2, pCO2* | *Electroretinography(ERG): Origin and measurement* | *Ear oximeter* | *$CO_2$ method* | *Safety codes for electromedical equipment* |
| ***S-13*** | ***SLO-1*** | *Transcutaneous electrodes,* | *Phonocardiography(PCG):Origin of heartsound, Measurement of PCG* | *Pulse oximeter* | *Apnea detector* | *Electrical safety analyzer* |
| | ***SLO-2*** | *Ion sensitive field effect Transistor* | *Biofeedback instrumentation* | *Skin reflectance oximeter, Intravascular oximeter* | *Bedside and Central Monitoring system* | *Testing of biomedical equipments* |
| ***S-14*** | ***SLO-1*** | *Lab 3: Study of biopotential electrodes* | *Lab 6: Real time EMG monitoring* | *Lab 9: Measurement of heart rate* | *Lab12: Measurement of respiration rate* | *Lab15:Model exam* |
| | ***SLO-2*** | *Lab 3: Study of biopotential electrodes* | *Lab 6: Real time EMG monitoring* | *Lab 9: Measurement of heart rate* | *Lab12: Measurement of respiration rate* | *Lab15:Model exam* |
| ***S-15*** | ***SLO-1*** | *Lab 3: Study of biopotential electrodes* | *Lab 6: Real time EMG monitoring* | *Lab 9: Measurement of heart rate* | *Lab12: Measurement of respiration rate* | *Lab15:Model exam* |
| | ***SLO-2*** | *Lab 3: Study of biopotential electrodes* | *Lab 6: Real time EMG monitoring* | *Lab 9: Measurement of heart rate* | *Lab12: Measurement of respiration rate* | *Lab15:Model exam* |

| | | |
|---|---|---|
| **Learning Resources** | *1.R.S.Khandpur, 'Handbook of Biomedical instrumentation', Tata McGraw Hill Publishing Co Ltd., 3rd edition, 2014.*<br>*2. John G.Webster, "Medical Instrumentation application and design", Wiley India Pvt Ltd, India, 4thedition, 2015*<br>*3. Joseph J Carr and John M Brown, "Introduction to biomedical equipment technology", Pearson Education, New Delhi, 4th edition, 2004.* | *4. Leslie Cromwell, Fred J.Weibell, Erich A. Pfeiffer, "Bio-Medical Instrumentation and measurements", Pearson Education, PHI Learning Private limited, India, 2nd edition, 2007.*<br>*5. Hodgkin, A. L.; Huxley, A. F. (1952),"A quantitative description of membrane current and its application to conduction and excitation in nerve", The Journal of Physiology 117 (4): 500–544.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *20%* | *20%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *10%* | *10%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | - | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.A.K.Jayanthy, SRMIST* |

| Course Code | 18BMC302T | Course Name | BIOMECHANICS | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the fundamentals of kinetic and kinematic concepts of human motion | | | |
| CLR-2 : | Get an idea about the skeletal and muscular movements | | | |
| CLR-3 : | Get an idea about the Functional anatomy of the upper extremity | | | |
| CLR-4 : | Get an idea about the Functional anatomy of the lower extremity | | | |
| CLR-5 : | Understand the biomechanics of spine and gait | | | |
| CLR-6 : | Get an overall idea about the various functional and movement characteristics of upper extremity and lower extremity | | | |

**Course Learning Outcomes (CLO):** *At the end of this course, learners will be able to:*

| | | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Apply the common kinematic and kinetic concepts to various human motion | 1, 2 | 80 | 70 | M | M | L | - | - | - | - | - | - | - | - | M | M | - | - |
| CLO-2 : | Identify the mechanical properties of bone and muscle tissues | 1, 2 | 80 | 70 | M | L | - | - | - | - | - | - | - | - | - | L | L | - | - |
| CLO-3 : | Analyze the functional and movement characteristics of upper extremity bones and joints | 1,2 | 80 | 70 | - | M | - | L | - | - | - | - | - | - | - | L | L | L | - |
| CLO-4 : | Analyze the functional and movement characteristics of lower extremity bones and joints | 2 | 80 | 70 | M | M | L | M | M | - | - | - | - | - | - | L | - | L | M |
| CLO-5 : | Analyze the biomechanics of spine and human locomotion | 2,3 | 80 | 70 | - | - | M | M | M | - | - | - | - | - | - | L | - | L | M |
| CLO-6 : | Outline the factors involved in analyzing the performance of lower and upper extremity bones and joints | 3 | 80 | 70 | - | M | - | M | - | - | - | - | - | - | - | - | - | L | M |

| Duration (hour) | | Kinematic and Kinetic concepts of human motion | Skeletal and muscular movements | Functional Anatomy for the upper extremity | Functional Anatomy for the lower extremity | Biomechanics of spine and gait |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Forms of Motion | Mechanical properties of body tissues-Structural Analysis | Shoulder complex- Functional Characteristics of the Joints of the Shoulder | Pelvis and Hip Complex | Vertebral column |
| | SLO-2 | Standard Reference Terminology | Mechanical properties of body tissues-Structural Analysis | Shoulder complex- Functional Characteristics of the Joints of the Shoulder | Pelvis and Hip Complex | Vertebral column |
| S-2 | SLO-1 | Joint Movement Terminology | Biomechanical Characteristics of Bone-Bone tissue function | Movement Characteristics of the Shoulder Complex | Structure of Hip joint | Structural and movement characteristics of spine |
| | SLO-2 | Joint Movement Terminology | Composition of bone tissue | Movement Characteristics of the Shoulder Complex | Muscular actions of Hip | Structural and movement characteristics of spine |
| S-3 | SLO-1 | Qualitative analysis of human movement | Bone Modeling and Remodeling | Loads on the shoulder | Loads on the hip | Movements of spine |
| | SLO-2 | Qualitative analysis of human movement | Bone Modeling and Remodeling | Loads on the shoulder | Loads on the hip | Movements of spine |
| S-4 | SLO-1 | Tools for measuring Kinematic quantities | Mechanical properties of bone-Strength and stiffness of bone | Elbow and Radioulnar joints- Functional Characteristics of the Joints of the Elbow | Structure of Knee joint | Posture and spinal stabilization |
| | SLO-2 | Tools for measuring Kinematic quantities | Mechanical properties of bone-Strength and stiffness of bone | Elbow and Radioulnar joints- Functional Characteristics of the Joints of the Elbow | Structure of Knee joint | Posture and spinal stabilization |
| S-5 | SLO-1 | Basic concepts related to kinetics | Maxwell and voight model | Movement Characteristics of the Elbow | Movement Characteristics of the Knee | Loads on spine |
| | SLO-2 | Basic concepts related to kinetics | Maxwell and voight model | Movement Characteristics of the Elbow | Movement Characteristics of the Knee | Common injuries of spine |
| S-6 | SLO-1 | Mechanical loads on the human body | Loads applied on bone | Loads on the elbow | Loads on the knee | Gait cycle |

| | | | | | | |
|---|---|---|---|---|---|---|
| | SLO-2 | *Mechanical loads on the human body* | *Stress fractures* | *Loads on the elbow* | *Loads on the Knee* | *Gait cycle* |
| S-7 | SLO-1 | *Effects of loading* | *Stress-Strain Relationship* | *Functional Characteristics of the joints Of the wrist and hand* | *Ankle and foot* | *Contribution of lower extremity musculature to movements* |
| | SLO-2 | *Effects of loading* | *Soft tissue mechanics* | *Functional Characteristics of the joints Of the wrist and hand* | *Ankle and foot* | *Contribution of lower extremity musculature to movements* |
| S-8 | SLO-1 | *Tools for Measuring Kinetic quantities* | *Muscle tissue Properties* | *Combined movements of wrist and hand* | *Combined movements of Ankle and foot* | *Forces acting on the joints in the lower extremity* |
| | SLO-2 | *Tools for Measuring Kinetic quantities* | *Muscle tissue Properties* | *Combined movements of wrist and hand* | *Combined movements of Ankle and foot* | *Forces acting on the joints in the lower extremity* |
| S-9 | SLO-1 | *Vector Composition* | *Force generation in the muscle* | *Common injuries of upper extremity* | *Common injuries of lower extremity* | *Case study* |
| | SLO-2 | *Vector Resolution* | *Biomechanical Analysis of joints* | *Common injuries of upper extremity* | *Common injuries of lower extremity* | *Case study* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Joseph Hamill & Kathleen M. Knutzen, "Biomechanical Basis of Human Movement", Lippincott Williams & Wilkins, a Wolters Kluwer business, 3rd Edition, 2009*<br>*2. Susan J Hall, "Basic Biomechanics", Tata Mcgraw hill, 6th Edition, 2012.* | *3. Peter M. McGinnis, "Biomechanics of sports and exercise", Human kinetics, 3rd Edition, 2013.*<br>*4.Fung Y C, Biomechanics: "Mechanical Properties of Living Tissues", Springer, 2nd Edition, 1993.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr. Ashokkumar D, SRMIST* |

| Course Code | 18BMC303J | Course Name | BIOMEDICAL SIGNAL PROCESSING | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 2 | 4 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the basic of signal processing techniques |
| CLR-2 : | Apply the concept of IIR filter design |
| CLR-3 : | Understand the concepts of FIR filter design and its application |
| CLR-4 : | Analyze the various signal processing algorithms in ECG. |
| CLR-5 : | Gain knowledge in Heart rate variability analysis |
| CLR-6 : | Analyze the speech signal and other biosignals using suitable signal processing techniques |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Describe the DIT-FFT and DIF-FFT algorithm | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Implement the IIF filter design in real time biosignals | 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-3 : | Analyze the FIR fitler design and its application | 2 | 80% | 70% | | | M | | M | | | | | | | | M | | L |
| CLO-4 : | Apply the various signal processing algorithms in analysis of ECG. | 3 | 80% | 70% | | | | | M | | | | | | | | | | |
| CLO-5 : | Analyze the signal processing methods used in HRV analysis | 3 | 80% | 70% | M | | | | | | | | | | | | M | | L |
| CLO-6 : | Apply the advanced techniques in various biosignals. | 3 | 80% | 70% | M | | | | | | | | | | | | | | |

| | | Basics of Signal Processing | IIR Filter design | FIR Filter design and its application | Analysis of ECG | Advanced techniques in Biosignal processing |
|---|---|---|---|---|---|---|
| Duration (hour) | | 15 | 15 | 15 | 15 | 15 |
| S-1 | SLO-1 | Sampling | IIR Filter-Introduction | FIR filter-advantages and disadvantages | P-Wave detection | Speech signal analysis-Cepstrum |
| | SLO-2 | Aliasing | Impulse invariant method | Characteristics | Estimation of R-R Interval | Analysis of complex cepstrum |
| S-2 | SLO-1 | FFT-Decimation in time radix-2 algorithm | Bilinear transformation method | Frequency method sampling method | QRS complex detection-Template subtraction method | Homomorphic filtering of speech signals |
| | SLO-2 | Butterfly diagram | Problems | Type I and Type II | Template correlation method | Application |
| S-3 | SLO-1 | Implementation of DIT- FFT algorithm | Butterworth filter- magnitude response | FIR filter design using windowing techniques-Rectangular window | Pan Tompkins algorithm for QRS detection-block diagram | Spectral distortion using a warped frequency scale |
| | SLO-2 | Implementation of DIT -FFT algorithm | Chebyshev filter-Magnitude response | Filter design using Hamming window | Algorithm and waveforms | LPC and MFCC co-efficient |
| S-4 | SLO-1 | Lab1: Basic signal operations | Lab4: Design of digital Butterworth IIR filter | Lab 7: FIR Filter using hamming windowing techniques | Lab 10: Analysis of ECG | Lab 13: Analysis of speech signals |
| | SLO-2 | Lab1: Basic signal operations | Lab4: Design of digital Butterworth IIR filter | Lab 7: FIR Filter using hamming windowing techniques | Lab 10: Analysis of ECG | Lab 13: Analysis of speech signals |
| S-5 | SLO-1 | Lab1: Basic signal operations | Lab4: Design of digital Butterworth IIR filter | Lab 7: FIR Filter using hamming windowing techniques | Lab 10: Analysis of ECG | Lab 13: Analysis of speech signals |
| | SLO-2 | Lab1: Basic signal operations | Lab4: Design of digital Butterworth IIR filter | Lab 7: FIR Filter using hamming windowing techniques | Lab 10: Analysis of ECG | Lab 13: Analysis of speech signals |
| S-6 | SLO-1 | FFT-Decimation in Frequency radix-2 algorithm | Design of butterworth filter using bilinear transformation technique | Filter design using Hanning window | Heart rate variability –Physiological origin | Synchronized averaging of PCG envelopes |
| | SLO-2 | Butterfly diagram | Design of butterworth filter using bilinear transformation technique | Filter design using Hanning window | Generation of HRV | Envelogram |
| S-7 | SLO-1 | Implementation of DIF- FFT algorithm | Design of butterworth filter using impulse invariant method | Magnitude response of hanning window | Clinical significance of HRV | Signal averaged ECG-Clinical significance |
| | SLO-2 | Implementation of DIF -FFT algorithm | Design of butterworth filter using impulse invariant method | Phase response of hanning window | Factors Influences on HRV | Advantages and disadvantage |
| S-8 | SLO-1 | Different types of bioelectric signals | Design of Chebyshev filter using bilinear transformation technique | Filter design using Blackman window | Time domain methods of HRV | Normal and Ectopic ECG beats classification |
| | SLO-2 | Characteristics | Design of Chebyshev filter using bilinear transformation technique | Filter design using Blackman window | Frequency domain Methods | Analysis of Exercise ECG |
| S-9 | SLO-1 | Lab2: DFT and FFT computations | Lab5: Design of digital Low pass Chebyshev IIR | Lab 8: FIR Filter using Hanning windowing | Lab 11: Analysis of Heart rate variability | Lab 14: Classification of Normal and abnormal |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | *filter* | *techniques* | | *ECG* |
| | **SLO-2** | *Lab2: DFT and FFT computations* | *Lab5: Design of digital Low pass Chebyshev IIR filter* | *Lab 8: FIR Filter using Hanning windowing techniques* | *Lab 11: Analysis of Heart rate variability* | *Lab 14: Classification of Normal and abnormal ECG* |
| **S-10** | **SLO-1** | *Lab2: DFT and FFT computations* | *Lab5: Design of digital Low pass Chebyshev IIR filter* | *Lab 8: FIR Filter using Hanning windowing techniques* | *Lab 11: Analysis of Heart rate variability* | *Lab 14: Classification of Normal and abnormal ECG* |
| | **SLO-2** | *Lab2: DFT and FFT computations* | *Lab5: Design of digital Low pass Chebyshev IIR filter* | *Lab 8: FIR Filter using Hanning windowing techniques* | *Lab 11: Analysis of Heart rate variability* | *Lab 14: Classification of Normal and abnormal ECG* |
| **S-11** | **SLO-1** | *Bio impedance signals* | *Design of Chebyshev filter using impulse invariant method* | *Time domain filters -Moving averaging filters* | *Non-linear analysis of HRV* | *Adaptive segmentation of EEG signals –SEM method* |
| | **SLO-2** | *Characteristics* | *Design of Chebyshev filter using impulse invariant method* | *Algorithm* | *Pit falls in understanding HRV* | *ACF distance method* |
| **S-12** | **SLO-1** | *Bio acoustic signals* | *Frequency warping* | *Synchronized averaging filters* | *Adaptive filter –Introduction* | *Adaptive segmentation –procedure* |
| | **SLO-2** | *Characteristics* | *Prewarping effect* | *Algorithm* | *Adaptive noise canceller –block diagram* | *Adaptive segmentation –procedure* |
| **S-13** | **SLO-1** | *Bio mechanical signal* | *Frequency transformation-digital domain* | *Synchronized averaging filters* | *LMS adaptive filter algorithm* | *Spectral Analysis-Power spectral density* |
| | **SLO-2** | *Characteristics* | *Frequency transformation-digital domain* | *Algorithm* | *LMS adaptive filter algorithm* | *Cross Spectral density* |
| **S-14** | **SLO-1** | *Lab 3: Representation of biosignals* | *Lab 6: Design of digital high pass Chebyshev IIR filter* | *Lab 9: FIR Filter using blackman windowing techniques* | *Lab12: Adaptive filtering techniques* | *Lab15:Spectral analysis of signals* |
| | **SLO-2** | *Lab 3: Representation of biosignals* | *Lab 6: Design of digital high pass Chebyshev IIR filter* | *Lab 9: FIR Filter using blackman windowing techniques* | *Lab12: Adaptive filtering techniques* | *Lab15:Spectral analysis of signals* |
| **S-15** | **SLO-1** | *Lab 3: Representation of biosignals* | *Lab 6: Design of digital high pass Chebyshev IIR filter* | *Lab 9: FIR Filter using blackman windowing techniques* | *Lab12: Adaptive filtering techniques* | *Lab15:Spectral analysis of signals* |
| | **SLO-2** | *Lab 3: Representation of biosignals* | *Lab 6: Design of digital high pass Chebyshev IIR filter* | *Lab 9: FIR Filter using blackman windowing techniques* | *Lab12: Adaptive filtering techniques* | *Lab15:Spectral analysis of signals* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Ramesh Babu," Digital signal processing" Laxmi Publications, 2005.*<br>2. *Rangaraj.M.Rangayyan, "Biomedical signal processing ' ,Wiley-IEEE press, 2nd edition,2015.* | 3. *Reddy D.C, "Biomedical signal processing: Principles and Techniques", Tata McGraw-Hill, New Delhi, 2nd edition, 2005* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *20%* | *20%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *10%* | *10%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | - | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.U.Snekhalatha, SRMIST* |

| Course Code | 18BMC304J | Course Name | MICROCONTROLLER AND ITS APPLICATION IN MEDICINE | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 2 | 4 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the fundamental concepts of 8086 microprocessors |
| CLR-2 : | Explain the basic concepts of 8051 microcontroller |
| CLR-3 : | Obtain knowledge on interfacing devices |
| CLR-4 : | Have an insight on Microcontroller |
| CLR-5 : | Familiarize about ARM microcontroller |
| CLR-6 : | Acquire knowledge on applications of microprocessor and microcontroller in biomedical domain. |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Describe the fundamental concepts of 8086 microprocessors | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Implement the concepts of 8051 microcontroller | 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-3 : | Analyze the features of interfacing devices | 2 | 80% | 70% | | | M | | M | | | | | | | | M | | L |
| CLO-4 : | Apply the concepts of RISC Processor | 3 | 80% | 70% | | | | | M | | | | | | | | | | |
| CLO-5 : | Develop programming skill | 3 | 80% | 70% | M | | | | | | | | | | | | M | | L |
| CLO-6 : | Program for Biomedical appplications | 3 | 80% | 70% | M | | | | | | | | | | | | | | |

| | | 8086 Processor | 8051 Microcontroller | Interfacing devices | ARM Microcontroller | Applications in Medicine |
|---|---|---|---|---|---|---|
| Duration (hour) | | 15 | 15 | 15 | 15 | 15 |
| S-1 | SLO-1 | Evolution of Microprocessor | Introduction to Microcontroller | Introduction to 8251 | Reduced Instruction Set Computer (RISC) Design Physiology | Mobile phone based bio signal recording |
| | SLO-2 | Evolution of Microprocessor | Difference between Microprocessor and Microprocessor | 8251 : Architecture | Difference between RISC and Complex Instruction Set Computer (Processor | Mobile phone based bio signal recording |
| S-2 | SLO-1 | signal description of 8086 | signal description of 8051 | 8251 : Architecture | Major Design rules | Mobile phone based bio signal recording |
| | SLO-2 | signal description of 8086 | signal description of 8051 | 8251: Processing Mode | Major Design rules | Design of pulse oximeter circuit using ARM microcontroller |
| S-3 | SLO-1 | Architecture | Architecture | Interfacing to external memory | ARM Design Physiology | Design of pulse oximeter circuit using ARM microcontroller |
| | SLO-2 | Architecture | Architecture | Interfacing to external memory | ARM core data flow model | Design of pulse oximeter circuit using ARM microcontroller |
| S-4 | SLO-1 | Lab1: 16 Bit addition | Lab4: 8 bit addition using 8051 microcontroller | Lab 7: Generate Sawtooth Waveform | Lab 10: Assembly language program to compute sum of n consecutive numbers and to find the factorial of the result | Lab 13: Mini Project |
| | SLO-2 | Lab1: 16 Bit addition | Lab4: 8 bit addition using 8051 microcontroller | Lab 7: Generate Sawtooth Waveform | Lab 10: Assembly language program to compute sum of n consecutive numbers and to find the factorial of the result | Lab 13: Mini Project |
| S-5 | SLO-1 | Lab1: Block transfer of data type | Lab4: 8 bit subtraction using 8051 microcontroller | Lab 7: Generate Triangular Waveform | Lab 10: Assembly language program to compute sum of n consecutive numbers and to find the factorial of the result | Lab 13: Mini Project |
| | SLO-2 | Lab1: Block transfer of data type | Lab4: 8 bit subtraction using 8051 microcontroller | Lab 7: Generate Triangular Waveform | Lab 10: Assembly language program to compute sum of n consecutive numbers and to find the factorial of the result | Lab 13: Mini Project |
| S-6 | SLO-1 | Addressing modes | Addressing modes | Timer interfacing | ARM core data flow model | Design of EOG based home appliances using PIC microcontroller |
| | SLO-2 | Addressing modes | Addressing modes | Timer interfacing | Processor Modes | Design of EOG based home appliances using PIC microcontroller |
| S-7 | SLO-1 | Minimum mode operation | Register set of 8051 | Basic techniques for reading & writing from I/O port pins | Registers | Design of EOG based home appliances using PIC microcontroller |
| | SLO-2 | Minimum mode operation | Instruction set : Data transfer | Basic techniques for reading & writing from I/O port pins | ARM Instruction set | Analysis of EMG signal using microcontroller |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-8** | **SLO-1** | *Maximum mode operation* | *Instruction set : Arithmetic, Logical* | *Interfacing 8051 to ADC* | *ARM Instruction set* | *Analysis of EMG signal using microcontroller* |
| | **SLO-2** | *Maximum mode operation* | *Instruction set : String Manipulating Instructions, control transfer* | *Interfacing 8051 to ADC* | *ARM Instruction set* | *Analysis of EMG signal using microcontroller* |
| **S-9** | **SLO-1** | *Lab2: Sum of n numbers* | *Lab5: One and two complement of a number* | *Lab 8: Generate Sine Waveform* | *Lab 11: Assembly language program to compute factorial of a number and to compute the parity of the result* | *Lab 14: Mini Project* |
| | **SLO-2** | *Lab2 Sum of n numbers* | *Lab5: One and two complement of a number* | *Lab 8: Generate Sine Waveform* | *Lab 11: Assembly language program to compute factorial of a number and to compute the parity of the result* | *Lab 14: Mini Project* |
| **S-10** | **SLO-1** | *Lab2: Sum of n numbers* | *Lab5: One and two complement of a number* | *Lab 8: Generate Square Waveform* | *Lab 11: Assembly language program to compute factorial of a number and to compute the parity of the result* | *Lab 14: Mini Project* |
| | **SLO-2** | *Lab2: Sum of n numbers* | *Lab5: One and two complement of a number* | *Lab 8: Generate Square Waveform* | *Lab 11: Assembly language program to compute factorial of a number and to compute the parity of the result* | *Lab 14: Mini Project* |
| **S-11** | **SLO-1** | *Instruction set : Data transfer* | *Special Function Registers* | *Stepper motor* | *Exceptions* | *Analysis of EEG signal using microcontroller* |
| | **SLO-2** | *Instruction set : Arithmetic, Logical* | *Special Function Registers* | *Stepper motor* | *Exceptions* | *Analysis of EEG signal using microcontroller* |
| **S-12** | **SLO-1** | *Instruction set : String Manipulating Instructions* | *Special Function Registers* | *Keyboard Interfacing* | *Thumb Instruction set* | *Analysis of EEG signal using microcontroller* |
| | **SLO-2** | *Instruction set : Control Transfer Instructions* | *8086 Interrupt* | *Keyboard Interfacing* | *Thumb Instruction set* | *Design of heart rate monitoring circuit using ARM microcontroller* |
| **S-13** | **SLO-1** | *8086 Interrupt* | *8086 Interrupt* | *Liquid crystal display (LCD)* | *Thumb Instruction set* | *Design of heart rate monitoring circuit using ARM microcontroller* |
| | **SLO-2** | *8086 Interrupt* | *Memory interfacing* | *Liquid crystal display (LCD)* | *Thumb Instruction set* | *Design of heart rate monitoring circuit using ARM microcontroller* |
| **S-14** | **SLO-1** | *Lab 3: Sorting even and odd numbers in an array* | *Lab 6: Fibonacci series* | *Lab 9: Stepper motor Interface* | *Lab12: Assembly language program to determine the bigger number of two given number* | *Lab 15: Mini Project* |
| | **SLO-2** | *Lab 3: Sorting even and odd numbers in an array* | *Lab 6: Fibonacci series* | *Lab 9: Stepper motor Interface* | *Lab12: Assembly language program to determine the bigger number of two given number* | *Lab 15: Mini Project* |
| **S-15** | **SLO-1** | *Lab 3: Sorting even and odd numbers in an array* | *Lab 6: Fibonacci series* | *Lab 9: Stepper motor Interface* | *Lab12: Assembly language program to determine the bigger number of two given number* | *Lab 15: Mini Project* |
| | **SLO-2** | | | | | |

| | |
|---|---|
| **Learning Resources** | 1. *A.K.Ray, K.M.Bhurchandi, "Advanced Microprocessor and Peripherals", Tata McGraw Hill, 3rdedition, 2013*<br>2. *Douglas V. Hall, "Microprocessor and Interfacing:Programming and Hardware",Glencoe, 2nd edition, 2006.*<br>3. *Andrew N.Sloss,DonimicSymes, Chris Wright, "ARM System Developer's Guide", Elsevier, 1st edition, 2007.*<br>4. *Muhammad Ali Mazidi and JanicaGilliMazidi, 'The 8051 microcontroller and embedded systems', Pearson Education, 5th Indian reprint, 2003.* |

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *20%* | *20%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *10%* | *10%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | - | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1.Dr.T.Rajalakshmi, SRMIST* |

| Course Code | 18BMC305T | Course Name | BIOCONTROL SYSTEMS | Course Category | C | Professional core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Learn about mathematical modeling of mechanical and electrical systems |
| CLR-2 : | Acquire knowledge about the transient and steady state error and analysis |
| CLR-3 : | Identify and analyze stability of a system in time domain using root locus technique |
| CLR-4 : | Know about different frequency domain analytical techniques |
| CLR-5 : | Acquire the knowledge of various controllers used in control systems |
| CLR-6 : | Learn about the biomedical applications of control systems |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Determine Transfer function of a system by mathematical modeling, block diagram reduction and signal flow graphs | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Identify the standard test inputs, time domain specifications and calculate steady state error | 1, 2 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | M | M | - | - |
| CLO-3 : | Plot a root locus curve and analyze the system stability using Routh array | 2 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | M | M | | - |
| CLO-4 : | Analyze the frequency domain specifications from bode plot | 1 | 80 | 70 | - | - | | M | - | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Plot polar plots | 1 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | M | - | - | - |
| CLO-6 : | Modelling of lung mechanics | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | H | - | - | - |

| Duration (hour) | | Mathematical Modelling | Time Response Analysis | Stability Analysis | Frequency Response Analysis | State Space Variable Analysis and Biomedical Applications |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Control system terminology-classification of control systems, SISO and MIMO control systems | Standard test signals- step, ramp, parabolic and impulse | Poles and zeros of a system | Frequency domain analysis | Introduction to state space |
| | SLO-2 | Feedback and its effects on overall gain, stability, noise and sensitivity | Derivation of expression for standard test signals | Pole zero plot and concept of s plane | Frequency domain specifications | General state space representation |
| S-2 | SLO-1 | Open loop and closed loop control systems with physiological system examples | Type and order of a system | Characteristic equation | Estimation of frequency domain specifications | Applying the state space representation |
| | SLO-2 | Advantages and disadvantages of OLCS and CLCS systems | Transfer function of First order system for Step and ramp input signal | Concept of stability from pole zero location | Correlation between time and frequency domain | Applying the state space representation |
| S-3 | SLO-1 | Transfer function of a system and basics of Laplace transform | Transfer function of First order system Impulse and parabolic input signal | Need for Stability analysis and available techniques | Bode plot approach and stability analysis | Converting a transfer function to state space |
| | SLO-2 | Transfer function of translational mechanical systems | General transfer function of second order system | Necessary and sufficient Conditions for stability | Rules for sketching bode plot | Converting a transfer function to state space |
| S-4 | SLO-1 | Transfer function of translational mechanical systems | Identification of damping factor and classification based on it | Routh Hurwitz Technique | Bode plot of typical systems | Converting from state space to a transfer function |
| | SLO-2 | Transfer function of rotational mechanical systems | Step response of critically damped second order system | Significance of Routh Hurwitz Technique | Bode plot of typical systems | Converting from state space to a transfer function |
| S-5 | SLO-1 | Transfer function of electrical systems | Step response of under damped second order system | Computation of Routh array | Bode plot of typical systems | Controllers-P, PI and PID controllers |
| | SLO-2 | Transfer function of electrical systems | Step response of over damped second order system | Routh array of stable systems | Bode plot of typical systems | Controllers-P, PI and PID controllers |
| S-6 | SLO-1 | Analogous systems | Step response of undamped second order system | Routh array of Unstable systems | Nyquist stability criterion | Physiological control system analysis |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Analogous systems* | *Transfer function-Time constant form and pole zero form* | *Routh array of Unstable systems* | *Nyquist stability criterion* | *A simple example* |
| **S-7** | **SLO-1** | *Block diagram reduction technique* | *Time domain specifications* | *Root locus technique* | *Sketching of polar plot* | *Linear model of physiological system-Example1* |
| | **SLO-2** | *Block diagram reduction technique* | *Evaluation of time domain specifications* | *Rules for construction of root locus* | *Sketching of polar plot* | *Linear model of physiological system-Example2* |
| **S-8** | **SLO-1** | *Signal flow graph* | *Transient and steady state error analysis* | *Root locus plot of typical systems* | *Sketching of polar plot* | *Distributed parameter Vs Lumped paramter models* |
| | **SLO-2** | *Signal flow graph* | *Static and dynamic Error coefficients* | *Root locus plot of typical systems* | *Sketching of polar plot* | *Distributed parameter Vs Lumped paramter models* |
| **S-9** | **SLO-1** | *Conversion of block diagram to signal flow graph* | *Static error constants and evaluation of steady state error* | *Root locus plot of typical systems* | *Polar plot and significance* | *Lung mechanics model with proportional control* |
| | **SLO-2** | *Conversion of block diagram to signal flow graph* | *Dynamic error constants and evaluation of steady state error* | *Effect of adding poles and zeros to a system* | *Polar plot and significance* | *Lung mechanics model with proportional control* |

| | | |
|---|---|---|
| **Learning Resources** | *1.* Nagrath.J and Gopal.M,, "Control System Engineering", 5th Edition, New Age, 2007.<br>2. Benjamin C Kuo, "Automatic Control System", 9th edition, John Wiley & Sons, 2010. | 3. Gopal.M, "Control System Principles and Design", 2nd Edition, TMH, 2002.<br>4. Michael C K Khoo, "Physiological Control Systems: Analysis, Simulation and Estimation", John Wiley & Sons, 2000. |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *Dr.A.K.Jayanthy* |

| Course Code | 18BMC306J | Course Name | MEDICAL IMAGE PROCESSING | Course Category | C | Professional core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | | Co-requisite Courses | | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the basic image operations and image transforms |
| CLR-2 : | Apply various image enhancement techniques in medical images |
| CLR-3 : | Understand the concepts of Image restoration and reconstruction techniques |
| CLR-4 : | Analyze the various types of image segmentation algorithms |
| CLR-5 : | Gain knowledge in Image compression methods |
| CLR-6 : | The learner gains knowledge in fusion of two different modality images |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning 1 Level of Thinking (Bloom) | Learning 2 Expected Proficiency (%) | Learning 3 Expected Attainment (%) | PLO 1 Engineering Knowledge | PLO 2 Problem Analysis | PLO 3 Design & Development | PLO 4 Analysis, Design, Research | PLO 5 Modern Tool Usage | PLO 6 Society & Culture | PLO 7 Environment & Sustainability | PLO 8 Ethics | PLO 9 Individual & Team Work | PLO 10 Communication | PLO 11 Project Mgt. & Finance | PLO 12 Life Long Learning | PSO 13 PSO - 1 | PSO 14 PSO - 2 | PSO 15 PSO - 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | Describe the elements of visual perception and various types of image transforms | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Implement the image enhancement techniques for improving the quality of images | 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-3 : | Analyze the various image restoration and reconstruction methods used for medical images | 2 | 80% | 70% | | | M | | M | | | | | | | | M | | L |
| CLO-4 : | Apply the different image segmentation algorithms for various medical applications | 3 | 80% | 70% | | | | | M | | | | | | | | | | |
| CLO-5 : | Differentiate and analyze the various image compression techniques | 3 | 80% | 70% | M | | | | | | | | | | | | M | | L |
| CLO-6 : | Illustrate the concepts of image fusion | 3 | 80% | 70% | M | | | | | | | | | | | | | | |

| | | Fundamental Image operations and Transforms | Image Enhancement methods | Image Restoration and Reconstruction Techniques | Image Segmentation Techniques | Image Compression and Image Fusion methods |
|---|---|---|---|---|---|---|
| Duration (hour) | | 15 | 15 | 15 | 15 | 15 |
| S-1 | SLO-1 | Fundamentals steps in Digital Image processing | Basic Intensity transformation functions - image negative, intensity slicing techniques | Image restoration-Mean filters | Point detection- Detection of isolated points | Image compression-Introduction |
| | SLO-2 | Components of an Image processing system | Contrast stretching, log transformation and power law transformation | Order-statistic and Adaptive filters | Line detection | Types of redundancies |
| S-2 | SLO-1 | Elements of Visual Perception- structure of human eye and image formation | Histogram equalization | Image degradation model | Basic edge detection | Huffman coding technique |
| | SLO-2 | Brightness range adaptation and discrimination | Histogram equalization | properties | Marr-Hildreth edge detector | Procedure |
| S-3 | SLO-1 | Image sensing and acquisition-using a single sensor | Histogram specification | Inverse filtering | Canny edge detector | Arithmetic coding technique |
| | SLO-2 | Using sensor strips | Histogram matching | Minimum mean square error (wiener) filtering | Algorithm | Run length coding technique |
| S-4 | SLO-1 | Lab1: Basic operations on images | Lab4: Intensity transformation and histogram equalization | Lab 7: Image restoration using adaptive filters | Lab 10: Edge detection techniques | Lab 13: Image compression |
| | SLO-2 | Lab1: Basic operations on images | Lab4: Intensity transformation and histogram equalization | Lab 7: Image restoration using adaptive filters | Lab 10: Edge detection techniques | Lab 13: Image compression |
| S-5 | SLO-1 | Lab1: Basic operations on images | Lab4: Intensity transformation and histogram equalization | Lab 7: Image restoration using adaptive filters | Lab 10: Edge detection techniques | Lab 13: Image compression |
| | SLO-2 | Lab1: Basic operations on images | Lab4: Intensity transformation and histogram equalization | Lab 7: Image restoration using adaptive filters | Lab 10: Edge detection techniques | Lab 13: Image compression |
| S-6 | SLO-1 | Basic concepts in Image sampling and quantization | Smoothening linear filters | Image reconstruction from projections- Transmission tomography | Thresholding- Foundation | Predictive coding- lossless |
| | SLO-2 | Spatial and intensity resolution | Non linear filters | Refection and emission tomography | Basic global thresholding | Lossy predictive coding |
| S-7 | SLO-1 | Some basic relationships between pixels- Neighbors of pixel | Sharpening spatial filters | Radon transform- derivation | Optimum global thresholding using otsu's method | Image fusion-Introduction |
| | SLO-2 | Adjacency, connectivity and distance measures | First order Derivative filters | Properties | Alogrithm | Pixel based image fusion techniques |
| S-8 | SLO-1 | Image Arithmetic operations | Second order derivative filters | Inverse radon transform- convolution back projection | Region based segmentation- Region growing | Wavelet transform based image fusion |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Logical operations* | *Un sharp masking and high boost filtering* | *Filter back projection* | *Region splitting and merging algorithm* | *Wavelet transform based image fusion* |
| **S-9** | **SLO-1** | *Lab2: Image Arithmetic and logical operations* | *Lab5: Filtering using averaging filter, unsharp masking and high boost filtering* | *Lab 8: Image reconstruction using radon transform* | *Lab 11: Global and otsu's thresholding* | *Lab 14: Image fusion* |
| | **SLO-2** | *Lab2: Image Arithmetic and logical operations* | *Lab5: Filtering using averaging filter, unsharp masking and high boost filtering* | *Lab 8: Image reconstruction using radon transform* | *Lab 11: Global and otsu's thresholding* | *Lab 14: Image fusion* |
| **S-10** | **SLO-1** | *Lab2: Image Arithmetic and logical operations* | *Lab5: Filtering using averaging filter, unsharp masking and high boost filtering* | *Lab 8: Image reconstruction using radon transform* | *Lab 11: Global and otsu's thresholding* | *Lab 14: Image fusion* |
| | **SLO-2** | *Lab2: Image Arithmetic and logical operations* | *Lab5: Filtering using averaging filter, unsharp masking and high boost filtering* | *Lab 8: Image reconstruction using radon transform* | *Lab 11: Global and otsu's thresholding* | *Lab 14: Image fusion* |
| **S-11** | **SLO-1** | *Image transforms-DFT and its properties* | *Color image processing-Introduction* | *Digital implementation of filter back projection-Block diagram* | *Segmentation using morphological watersheds-dam construction* | *PCA based image fusion techniques* |
| | **SLO-2** | *DCT and its properties* | *Color models* | *Different filters* | *Watershed segmentation algorithm* | *PCA based image fusion techniques* |
| **S-12** | **SLO-1** | *DST and its properties* | *Conversion of RGB to HSI model* | *Digital implementation of filter back projection-Algorithm* | *Clustering based segmentation techniques* | *Transform based fusion techniques- DCT* |
| | **SLO-2** | *Hadamard transform and its properties* | *Conversion of HSI to RGB Model* | *Implementation procedure* | *Algorithms* | *Transform based fusion techniques- DCT* |
| **S-13** | **SLO-1** | *Haar transform and its properties* | *Pseudo color image processing- slicing technique* | *Fourier reconstruction of MRI images-projection geometry mode* | *Basic Active Contour Model* | *Image registration-Introduction* |
| | **SLO-2** | *Haar transform and its properties* | *Filtering approach* | *Fourier geometry mode.* | *Formulation (Feature extraction techniques)* | *Types of image registration* |
| **S-14** | **SLO-1** | *Lab 3: Image transforms in frequency domain* | *Lab 6: Color image processing* | *Lab 9: Fourier reconstruction of MRI images* | *Lab 12:Image segmentation by watershed algorithm* | *Lab 15: Image registration* |
| | **SLO-2** | *Lab 3: Image transforms in frequency domain* | *Lab 6: Color image processing* | *Lab 9: Fourier reconstruction of MRI images* | *Lab 12:Image segmentation by watershed algorithm* | *Lab 15: Image registration* |
| **S-15** | **SLO-1** | *Lab 3: Image transforms in frequency domain* | *Lab 6: Color image processing* | *Lab 9: Fourier reconstruction of MRI images* | *Lab 12:Image segmentation by watershed algorithm* | *Lab 15: Image registration* |
| | **SLO-2** | *Lab 3: Image transforms in frequency domain* | *Lab 6: Color image processing* | *Lab 9: Fourier reconstruction of MRI images* | *Lab 12:Image segmentation by watershed algorithm* | *Lab 15: Image registration* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Rafael C., Gonzalez and Richard E. Woods,"Digital Image Processing", Pearson Education Asia, Third Edition, 2007*<br>2. *Anil.k.Jain, "Fundamentals of Digital image processing", Prentice Hall of India, 2nd edition 1997.* | 3. *Joseph V.Hajnal, Derek L.G.Hill, David J Hawkes, "Medical image registration", Biomedical Engineering series, CRC press,2001.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *20%* | *20%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* | *20%* |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *10%* | *10%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* | *15%* |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | - | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *Dr.U.Snekhalatha* |

| Course Code | 18BMC401T | Course Name | BIOMEDICAL EQUIPMENTS FOR CLINICAL APPLICATIONS | Course Category | C | Professional Core | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | | Co-requisite Courses | | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the fundamentals of diagnostic and therapeutic equipments |
| CLR-2 : | Get an idea about functioning of different types of physiotherapy and electrotherapy equipments |
| CLR-3 : | Acquire an idea about the the instruments dealing with bone |
| CLR-4 : | Get an idea about the respiratory care equipments |
| CLR-5 : | Get an idea about diagnosis procedure of hearing problems and Hearing aids |
| CLR-6 : | Get an overall idea about laparoscope |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning: 1 Level of Thinking (Bloom) | 2 Expected Proficiency (%) | 3 Expected Attainment (%) | PLO 1 Engineering Knowledge | 2 Problem Analysis | 3 Design & Development | 4 Analysis, Design, Research | 5 Modern Tool Usage | 6 Society & Culture | 7 Environment & Sustainability | 8 Ethics | 9 Individual & Team Work | 10 Communication | 11 Project Mgt. & Finance | 12 Life Long Learning | 13 PSO - 1 | 14 PSO - 2 | 15 PSO – 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | Outline the importance of therapeutic and diagnostic devicesmedical device | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Analyze the types of pacemakers | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Apply the principle of ultrasound in diagnostic and therapeutic application | 2 | 80 | 70 | - | M | - | - | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | Outline the importance of respiratory care equipments | 1 | 80 | 70 | - | - | H | - | - | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Understand the importance and design procedure of hearing aids | 1 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | M | - | - | - |
| CLO-6 : | Understand the concept of surgical diathermy | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | L | - | - | - |

| Duration (hour) | | Coronary Care Equipments | Physiotherapy, Electrotherapy and Phototherapy Equipments | Instruments Dealing With Bones and Respiratory Care | Sensory Diagnosis and Hearing Aid Equipments | Surgical and Therapeutic Equipments |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Cardiac pacemakers: different modes of operation | Short wave diathermy | Introduction to Respiratory care equipments | Mechanism of hearing | Surgical diathermy unit |
| | SLO-2 | external pacemaker | Short wave diathermy | humidifier | Mechanism of hearing | Surgical diathermy unit |
| S-2 | SLO-1 | implantable pacemakers, | Advantages of Microwave diathermy over shortwave diathermy | nebulizer | sound conduction system | Endoscopy basic components |
| | SLO-2 | pacemaker standard codes | Microwave diathermy | aspirators | sound conduction system | Endoscopy basic components |
| S-3 | SLO-1 | Defibrillator: AC defibrillator | Ultrasound application in medical diagnostic | Working of Ventilators | basic audiometer | Endoscopy different types |
| | SLO-2 | DC defibrillator | Working details of Ultrasonic therapy unit | Ventilators types | pure tone audiometer | Endoscopy different types |
| S-4 | SLO-1 | Implantable defibrillator | Electro diagnostic apparatus | capnography | Speech audiometer | Laparoscope |
| | SLO-2 | types | Electro diagnostic apparatus | capnography | bekesyaudiometer system | Laparoscope |
| S-5 | SLO-1 | automated external defibrillator (AED) | Electro therapeutic apparatus | Anesthesia machine | bekesyaudiometer system | gastro scope |
| | SLO-2 | automated external defibrillator (AED) | Electro therapeutic apparatus | Anesthesia machine | Evoked response audiometry system | bronchoscope |
| S-6 | SLO-1 | Pacer- cardioverter defibrillator, | Interferential current therapy, ) | Baby incubator | Evoked response audiometry system | Cryogenic techniques |
| | SLO-2 | Pacer- cardioverter defibrillator | Interferential current therapy, ) | BMD measurements: Single X-ray absorptiometry (SXA) | Hearing aids | Cryogenic techniques |

| | | | | | | |
|---|---|---|---|---|---|---|
| S-7 | SLO-1 | *defibrillator analysers* | *Transcutaneous electrical nerve stimulation (TENS)* | *BMD measurements: Single X-ray absorptiometry (SXA)* | *Hearing aids* | *Cryogenic technique application* |
| | SLO-2 | *Heart lung machine (HLM)* | *bladder stimulator* | *Dual X-ray absorptiometry (DXA)* | *galvanic skin response* | *Operating microscope* |
| S-8 | SLO-1 | *Heart lung machine (HLM)* | *Spinal cord stimulator,* | *Dual X-ray absorptiometry (DXA)* | *galvanic skin response* | *arthroscopy* |
| | SLO-2 | *Functional details of oxygenators* | *deep brain stimulation* | *Quantitative ultrasound bone densitometer* | *Tonometry* | *Modern lithotripter system* |
| S-9 | SLO-1 | *types of oxygenators* | *Photo therapy unit* | *Quantitative ultrasound bone densitometer* | *Measurement of basal skin response* | *laser lithotripsy* |
| | SLO-2 | *types of oxygenators* | *Photo therapy unit* | *Comparison of DXA and Bone densitometer* | *galvanic skin response* | *Hospital visit* |

| | | |
|---|---|---|
| **Learning Resources** | *1. R.S.Khandpur, 'Handbook of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd., 3rd edition, 2014.*<br>*2. Albert M.Cook and Webster.J.G, "Therapeutic Medical Devices", Prentice Hall Inc., New Jersey, 1st edition, 1982*<br>*3. Sydney Lou Bonnick, Lori Ann Lewis, "Bone Densitometry and Technologists", Springer, 3rd edition, 2013*<br>*4. Marc. Safran, Bobby. Chhabra. A., Mark. Miller.D., "Primer of Arthroscopy",Elsevier Health Sciences, 2nd edition, 2010* | *5. Leslie Cromwell, Fred J.Weibell, Erich A.Pfeiffer, "Bio-Medical Instrumentation and Measurements",Pearson Education, PHI Learning Private limited, India, 2nd edition, 2007 "*<br>*6. John G.Webster, "Specifications of Medical Instrumentation Application and Design",Wiley India Pvt Ltd, India, 4th edition, 2015.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *Mrs. G.Anitha* |

| Course Code | 18BME261T | Course Name | Bio photonics and Bio imaging | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | To Know the concepts of spectroscopy | | | |
| CLR-2 : | To Know the concepts of various biosensors | | | |
| CLR-3 : | Outline the various applications of biosensors in medicine | | | |
| CLR-4 : | To understand the concepts of various microscopes used in medicine | | | |
| CLR-5 : | Acquire knowledge on the treatment mechanism of Phototherapy | | | |
| CLR-6 : | To understand the special techniques like optical holography | | | |

**Course Learning Outcomes (CLO):** *At the end of **this** course, learners will be able to:*

| | | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Implement spectroscopy for biological imaging | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Implement the various applications of biosensors in medicine | 1, 2 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | M | M | - | - |
| CLO-3 : | Implement Microscopy in medical diagnosis | 2 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | M | M | | - |
| CLO-4 : | Identify the principle behind modern imaging techniques | 1 | 80 | 70 | - | - | | M | - | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Describe the medical applications of phototherapy | 1 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | M | - | - | - |
| CLO-6 : | Analyze the physics behind optical holography | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | H | - | - | - |

| Duration (hour) | | LIGHT - MATTER INTERACTION & PRINCIPLE OF OPTICS | OPTICAL BIOSENSORS | BIO-IMAGING | PHOTODYNAMIC THERAPY | OPTICAL HOLOGRAPHY |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Concepts of Light matter interaction | Biosensors: Definition | Introduction of optical imaging | Basics of radiation therapy | Fundamentals – Object wave |
| | SLO-2 | Interactions Between Light and a Molecule | Block diagram & description | Needs of optical imaging | Basic principles | Photography |
| S-2 | SLO-1 | Interaction of light with bulk matter | Principles of Optical Bio sensing | Microscopy: Principles | Mechanism of Photodynamic Photo oxidation | Holography |
| | SLO-2 | Fate of Excited State | Bio recognition | Types of microscopy: Transmission microscopy | Photosensitizers For Photodynamic Therapy | Interference during recording |
| S-3 | SLO-1 | Spectroscopy: Principles | Optical Transduction | Fluorescence microscopy | Photosensitizers For Photodynamic Therapy | Diffraction during reconstruction |
| | SLO-2 | System description | Fluorescence Sensing, Fluorescence Energy Transfer Sensors | Scanning microscopy | Mechanism of photodynamic action | Imaging techniques –In line hologram |
| S-4 | SLO-1 | Types of spectroscopy | Molecular Beacons, Optical Geometries of Bio sensing | Inverted and Upright Microscopes | Three Principal Mechanisms of Photodynamic Therapy | Off axis hologram, Fourier hologram |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Conventional Spectrometers* | *Immobilization of bio-recognition elements* | *Confocal Microscopy* | *Light Irradiation For Photodynamic Therapy* | *Fraunhofer hologram, Reflection hologram* |
| **S-5** | **SLO-1** | *Fourier Transform Spectrometers* | *Fiber optic Biosensors* | *Multi-photon- microscopy* | *Light sources* | *Optical properties of holographic imaging* |
| | **SLO-2** | *Michelson interferometer* | *Operating principles of Fiber optic Biosensors* | *Optical Coherence Tomography* | *Laser dosimetry* | *Hologram of an object* |
| **S-6** | **SLO-1** | *Electronic absorption spectroscopy* | *Types of optical biosensor: Fiber optic Biosensor* | *Total Internal Reflection Fluorescence Microscopy* | *Light delivery* | *Image equation, Angular magnification* |
| | **SLO-2** | *Types of Electronic Transitions* | *Planar waveguide Biosensor* | *Near-Field Optical Microscopy* | *Two-Photon Photodynamic Therapy* | *longitudinal magnification, Image aberrations* |
| **S-7** | **SLO-1** | *Electronic luminescence spectroscopy* | *Evanescent Wave Biosensors* | *Fluorescence Resonance Energy Transfer (FRET) Imaging* | *PUVA technique* | *Properties of light source -spectral bandwidth* |
| | **SLO-2** | *Electronic luminescence spectroscopy* | *Principle of Evanescent Wave Biosensors* | *Fluorescence Lifetime Imaging Microscopy (FLIM)* | *PUVA technique* | *Image plane holograms* |
| **S-8** | **SLO-1** | *Vibrational spectroscopy* | *Interferometric biosensor* | *Advantages and disadvantages of optical imaging* | *Applications of PDT* | *Image luminance- Without pupil* |
| | **SLO-2** | *Principle of Vibrational spectroscopy* | *Surface plasmon resonance Biosensor* | *Applications of Bio imaging, Fluorophores as Bio imaging Probes* | *Applications of PDT* | *With pupil, Image plane holograms* |
| **S-9** | **SLO-1** | *Fluorescence spectroscopy* | *Applications of optical Biosensors in medicine* | *Green Fluorescent Protein, Cellular Imaging* | *Advantages of PDT* | *Speckles- diffuser* |
| | **SLO-2** | *Fluorescence Correlation Spectroscopy* | *Advantages and Disadvantages* | *Tissue Imaging, In Vivo Imaging* | *Disadvantages of PDT* | *Resolution, Incoherent illumination* |

| | | |
|---|---|---|
| Learning Resources | *1. Wilson J and Hawkes J.F.B, "Optoelectronics – An Introduction", Prentice Hall of India Pvt. Ltd., NewDelhi, 3rd edition, 2003.*<br>*2. Leon Goldman, M.D., & R.James Rockwell, Jr., Lasers in Medicine, Gordon and Breach Science Publishers Inc., 1975.* | *3. Tuan Vo Dirh, Biomedical Photonics – Handbook, CRC Press, Bocaraton, 2003.*<br>*4. Paras N, Prasad, "Introduction to Biophotonics", John Wiley & Sons, First Edition, 2003.*<br>*5. Gerhard K. Ackermann, Jürgen Eichler, "Holography: A Practical Approach", WILEY-VCH Verlag GmbH & Co, first edition, 2008.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1.Dr.P.Vinupritha,SRMIST* |

| Course Code | 18BME262T | Course Name | HOME MEDICARE TECHNOLOGY | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Utilize the Home health Nursing practice |
| CLR-2 : | Utilize homecare care working with different clients |
| CLR-3 : | Utilize the various medical devices used at home |
| CLR-4 : | Utilize the advancement in medical technologies |
| CLR-5 : | Utilizte the use of wireless technology in health care |
| CLR-6 : | Utilize the various mode of healthcare technology at home |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLO-1 : | Applying Home health Nursing practice | 3 | 80 | 75 |
| CLO-2 : | Illustrate the homecare care working with different clients | 3 | 80 | 70 |
| CLO-3 : | Analyze the various medical devices used at home | 3 | 75 | 70 |
| CLO-4 : | Identify the advancement in medical health technologies | 3 | 80 | 75 |
| CLO-5 : | Analyze the use of wireless technology in health care | 3 | 80 | 70 |
| CLO-6 : | Describe the various type of healthcare technology at home | 3 | 80 | 70 |

| Program Learning Outcomes (PLO) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| L | - | - | - | - | - | - | - | - | - | - | - | L | - | L |
| L | - | - | - | - | - | - | - | - | - | - | - | L | - | L |
| M | - | - | - | - | - | - | - | - | - | - | - | L | - | L |
| M | - | - | - | - | - | - | - | - | - | - | - | L | - | L |
| M | - | - | - | - | - | - | - | - | - | - | - | L | - | L |
| L | - | - | - | - | - | - | - | - | - | - | - | L | - | L |

| Duration (hour) | | Introduction to Home health Nursing | Working With Clients | Medical Devices At Home | Advancement In Medical Technologies | Wireless Technology |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Home health care – purpose | Basic human needs | Medical devices at home | Advances and trends in health care technologies | Wireless communication basics |
| | SLO-2 | Organization of homecare system | Communication and interpersonal skills | Medical devices at home | Advances and trends in health care technologies | Wireless communication basics |
| S-2 | SLO-1 | Historical development of home care | Caregiver observation | ECG monitors | Driver impacting the growth of medical Technologies | Types of wireless network |
| | SLO-2 | Environmental influences of home care | Caregiver observation | ECG monitors | Driver impacting the growth of medical Technologies | Types of wireless network |
| S-3 | SLO-1 | Home care Organization | Recording and reporting, confidentiality. | Smart watch | Impact of Moore"s law of medical imaging- | Body area network |
| | SLO-2 | Legal and ethical issues in home care | Recording and reporting, confidentiality. | Smart watch | Impact of Moore"s law of medical imaging | Body area network |
| S-4 | SLO-1 | Case management and leadership strategies | Working with elderly – aging and body systems. | Wireless infant monitoring system | E-health and personal healthcare | Emergency rescue |
| | SLO-2 | Organisation of home care system | Working with elderly – aging and body systems. | Wireless infant monitoring system | E-health and personal healthcare | Emergency rescue |
| S-5 | SLO-1 | Home care organization | Working with children | PCG monitors, | Defining the future of health Technology | Remote recovery |
| | SLO-2 | Home care organization | Working with children | PCG monitors, | Defining the future of health Technology | Remote recovery |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-6** | **SLO-1** | *Role of home care nurse and orientation* | *Need for home care* | *Medical alert services.* | *Inventing the future -tools for self-health* | *Personalized ambient monitoring* |
| | **SLO-2** | *Role of home care nurse and orientation strategies* | *Need for home care* | *Medical alert services.* | *Inventing the future -tools for self-health* | *Personalized ambient monitoring* |
| **S-7** | **SLO-1** | *Environmental influences on home care* | *Mobility transfers and ambulation* | *Activity monitors* | *Future of Nano fabrication molecular scale devices* | *Future trends in healthcare technology.* |
| | **SLO-2** | *Environmental influences on home care* | *Mobility transfers and ambulation* | *Automatic wireless healthcare monitoring system* | *Future of Nano fabrication molecular scale devices* | *Future trends in healthcare technology.* |
| **S-8** | **SLO-1** | *Infection control in home* | *Range of motion exercises* | *The ventilator dependent patient* | *Future of telemedicine* | *Multi model interaction and technologies for care at home* |
| | **SLO-2** | *Infection control in home* | *Range of motion exercises,* | *Device for patient with congestive heart failure* | *Future of telemedicine* | *Multi model interaction and technologies for care at home* |
| **S-9** | **SLO-1** | *Patient education in home.* | *Skin care and comfort measures* | *Device for Patient with chronic Obstructive pulmonary disease* | *Future of medical computing* | *Cost of home healthcare* |
| | **SLO-2** | *Patient education in home.* | *Skin care and comfort measures* | *Device for patient with Diabetic* | *Future of medical computing* | *Direction for emerging technology* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Robyn Rice, "Home care nursing practice: Concepts and Application", 4th edition, Elsevier, 2006.*<br>*2. 2. LodewijkBos, "Handbook of Digital Homecare: Successes and Failures", Springer, 2011.* | 3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph. D,Bronzino,"Clinical Engineering", CRC Press, 2010.<br>4. Kenneth J. Turner, "Advances in Home Care Technologies: Results of the match Project", Springer, 2011. |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr. D. Ashok Kumar, SRMIST* |
| | | *2. Mrs.Lakshmi Prabha.P, SRMIST* |

| Course Code | 18BME263T | Course Name | CELLULAR AND MOLECULAR BIOLOGY | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | |
|---|---|
| **CLR-1 :** | *Have an idea about the basics of cells* |
| **CLR-2 :** | *Know the basic aspects of cell structure and functions* |
| **CLR-3 :** | *Learn the principles of cell signaling and cell regulation* |
| **CLR-4 :** | *To understand the concept of molecular biology* |
| **CLR-5 :** | *Understand the concept behind DNA and RNA* |
| **CLR-6 :** | *Learn about cell replication and repair* |

| Course Learning Outcomes (CLO): | At the end of ***this*** course, learners will be able to: | Learning 1 Level of Thinking (Bloom) | Learning 2 Expected Proficiency (%) | Learning 3 Expected Attainment (%) | PLO 1 Engineering Knowledge | PLO 2 Problem Analysis | PLO 3 Design & Development | PLO 4 Analysis, Design, Research | PLO 5 Modern Tool Usage | PLO 6 Society & Culture | PLO 7 Environment & Sustainability | PLO 8 Ethics | PLO 9 Individual & Team Work | PLO 10 Communication | PLO 11 Project Mgt. & Finance | PLO 12 Life Long Learning | PLO 13 PSO - 1 | PLO 14 PSO - 2 | PLO 15 PSO – 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLO-1 :** | *Explain the basics of cell and its structure* | *1, 2* | *80* | *70* | *M* | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CLO-2 :** | *Describe the basic concepts of cell structure and its function* | *1, 2* | *80* | *70* | - | - | - | *M* | - | - | - | - | - | - | - | *M* | *M* | - | - |
| **CLO-3 :** | *Implement the various processes of cell signaling and cell regulation* | *2* | *80* | *70* | - | - | - | *M* | - | - | - | - | - | - | - | *M* | *M* | | - |
| **CLO-4 :** | *Understand the concept of molecular biology* | *1* | *80* | *70* | - | - | | *M* | - | - | - | - | - | - | - | *M* | - | *M* | - |
| **CLO-5 :** | *Explain the structures and paring of DNA and RNA* | *1* | *80* | *70* | - | - | - | *M* | - | - | - | - | - | - | - | *M* | - | - | - |
| **CLO-6 :** | *Apply the recent advancements in cell repair and replication* | *1,2* | *80* | *70* | - | - | - | - | - | - | - | - | - | - | - | *H* | - | - | - |

| Duration (hour) | | *AN OVERVIEW OF CELLS* | *CELL STRUCTURE AND FUNCTION* | *CELL SIGNALING –CELL REGULATION* | *INTRODUCTION TO MOLECULAR BIOLOGY– DNA AND RNA* | *REPLICATION AND REPAIR* |
|---|---|---|---|---|---|---|
| | | ***9*** | ***9*** | ***9*** | ***9*** | ***9*** |
| **S-1** | **SLO-1** | *Origin and evolution of cells* | *Introduction to Nucleus* | *General principles of cell signaling* | *Scope and history* | *Replication in prokaryote and eukaryote* |
| | **SLO-2** | *Origin and evolution of cells* | *Endoplasmic reticulum* | *Modes of cell* | *Structure of DNA* | *Types and function of DNA* |
| **S-2** | **SLO-1** | *Evolution of metabolism* | *Golgi apparatus and Lysosomes* | *Cell signaling* | *Nucleoside* | *Polymerases* |
| | **SLO-2** | *Origin of Prokaryotes* | *Golgi apparatus and Lysosomes* | *Pathways of intracellular signal transduction* | *Nucleotide* | *Proof reading activity* |
| **S-3** | **SLO-1** | *Origin of Eukaryotes* | *Bioenergetics and Metabolism* | *Function of cell surface receptors* | *Base pairing* | *5´- 3´ exonuclease activity* |
| | **SLO-2** | *Development of multicellular organisms* | *Mitochondria* | *G-protein coupled receptor pathway (GPCR) pathway* | *Base stacking* | *Topoisomerase activity* |
| **S-4** | **SLO-1** | *Development of multicellular organisms* | *Chloroplasts* | *Cyclic adenosine 3',5'-monophosphate ( cAMP) pathway* | *Double helix* | *Telomeric DNA replication and Plasmid replication* |
| | **SLO-2** | *Cells as experimental models* | *Peroxisomes* | *Receptor protein tyrosine kinase pathway* | *Features of Watson and crick model* | *Theta model* |
| **S-5** | **SLO-1** | *Tools of cell biology* | *The cytoskeleton and cell movement* | *Mitogen-activated protein kinase (MAPK) pathway* | *Major and minor groove* | *Strand replacement model* |
| | **SLO-2** | *Tools of cell biology* | *Cell surface* | *Cell division : Cell cycle* | *Supercoiling* | *Rolling circle model* |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-6** | **SLO-1** | *Molecular composition* | *Transport of small molecules* | *Mitosis - Stages of mitosis* | *Twist* | *DNA repair* |
| | **SLO-2** | *Biosynthesis of cellular constituents* | *Endocytosis* | *Meiosis - Meiosis I and Meiosis II* | *Writhe and linking number* | *Nucleotide excision repair* |
| **S-7** | **SLO-1** | *Central role of enzymes as biocatalysts* | *Cell –cell interactions* | *Cell death: Necrosis* | *Forms of DNA* | *Mismatch repair* |
| | **SLO-2** | *Central role of enzymes as biocatalysts* | *Cell –cell interactions* | *Programmed cell death* | *A, B, Z - Structure and function of RNAs* | *Photo-reactivation* |
| **S-8** | **SLO-1** | *Metabolic energy* | *Adhesion junctions* | *Apoptosis* | *mRNA* | *Recombination repair* |
| | **SLO-2** | *Metabolic energy* | *Tight junctions* | *Extrinsic pathway, Intrinsic pathway* | *rRNA* | *Recombination repair* |
| **S-9** | **SLO-1** | *Cell membrane* | *Gap junctions* | *Cell differentiation: Stem cells-embryonic stem cells* | *tRNA* | *SOS repair* |
| | **SLO-2** | *Cell membrane* | *Plasmodesmata* | *Adult stem cells, therapeutic applications of stem cells* | *Secondary structures in RNA* | *SOS repair* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Channarayappa, "Cell biology," Universities Press, 2010*<br>2. *Rastogi, S.C, "Cell biology," New Age International publishers, 2005.* | |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | 1. *Dr.P..Vinupritha, SRMIST* |

| Course Code | 18BME264T | Course Name | BIOMEDICAL LASER INSTRUMENTS | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Know the functioning of a laser system | | | |
| CLR-2 : | Learn about the working principle of laser | | | |
| CLR-3 : | Learn the optical characteristics of tissue | | | |
| CLR-4 : | Familiarise the applications of laser in Urology, Gynecology and dentistry | | | |
| CLR-5 : | Learn the non- thermal applications of laser in medicine | | | |
| CLR-6 : | Acquire knowledge on laser safety and management | | | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLO-1 : | Have a deep understanding on technical aspects of a LASER system | 3 | 80 | 75 |
| CLO-2 : | Learn about the working principle of laser | 3 | 80 | 70 |
| CLO-3 : | Describe the optical properties of tissues | 3 | 75 | 70 |
| CLO-4 : | Describe the applications of laser in Urology, Gynecology and dentistry | 3 | 80 | 75 |
| CLO-5 : | Explain the non- thermal applications of laser in medicine | 3 | 80 | 70 |
| CLO-6 : | Implement the aspects of laser safety | 3 | 80 | 70 |

| Program Learning Outcomes (PLO) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO -1 | PSO -2 | PSO -3 |
| CLO-1 : | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | - | M | - | - | - | - | - | - | - | - | - | - | | M | |
| CLO-4 : | - | M | - | - | - | - | - | - | - | - | - | - | M | | |
| CLO-5 : | - | -M | - | - | - | - | - | - | - | - | - | - | M | | |
| CLO-6 : | - | - | - | - | - | - | - | M | - | - | - | - | L | | |

| Duration (hour) | | LASER SYSTEM | TYPES OF LASER | MECHANISM OF LASER TISSUE INTERACTION | LASER APPLICATIONS | NON THERMAL APPLICATIONS OF LASER AND LASER SAFETY MANAGEMENT |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Absorption and Emission of Radiation by atoms | Classification of Laser | Photochemical interaction | Disorders in Eye | Optical coherence tomography |
| | SLO-2 | Ions and Molecules | Solid state Laser Construction | Bio stimulation | Diagnostic and Therapeutic Applications of laser in ophthalmology | System description |
| S-2 | SLO-1 | Laser - Definition | Working principle | Thermal interaction | Dermatological disorders | Applications of Optical coherence tomography |
| | SLO-2 | Properties of laser | Atomic laser Construction | Heat generation | Applications of Lasers in dermatology | Laser Induced Fluorescence (LIF)-Imaging, |
| S-3 | SLO-1 | Characteristics of Laser | Working principle | Heat transport | Diagnostic Applications of Lasers in cardiology | FLIM Raman Spectroscopy and Imaging |
| | SLO-2 | Construction and working principle of laser system | Molecular Laser Construction | Heat effects | Therapeutic Applications of Lasers in cardiology | FLIM – Holographic and speckle |
| S-4 | SLO-1 | Mono-chromaticity, Coherence | Working principle | LASER induced interstitial thermotherapy (LITT) | Lasers in Surgery | Laser hazards |
| | SLO-2 | Directionality, Brightness | Dye Laser Construction | Photoabalation | Tissue welding and Soldering | Laser hazards |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-5** | **SLO-1** | *Pumping mechanism* | *Working principle* | *Model, cytotoxicity of UV radiation* | *Lasers in urology- Lithotripsy* | *Laser hazards classification* |
| | **SLO-2** | *Optical pumping* | *Semiconductor Laser Construction* | *Plasma induced ablation* | *Therapeutic applications of Lasers in urology* | *Laser hazards classification* |
| **S-6** | **SLO-1** | *Electrical pumping* | *Working principle* | *Model, analysis of plasma parameters* | *Laparoscopy- System description* | *Laser hazards to eye and skin* |
| | **SLO-2** | *Laser pumping, Levels of laser* | *Gas Laser Construction* | *Photo distribution* | *Applications of laser in Gynecology* | *Viewing laser radiation* |
| **S-7** | **SLO-1** | *Resonators* | *Working principle* | *Plasma formation* | *Applications of laser in Gynecology* | *Non beam hazards* |
| | **SLO-2** | *Q-switching* | *Chemical Laser Construction* | *Shock wave generation* | *Applications of laser in laryngeal surgery* | *Non beam hazards* |
| **S-8** | **SLO-1** | *Methods of Q-switching* | *Working principle* | *Shock wave generation* | *Applications of laser in Otology* | *Laser safety control* |
| | **SLO-2** | *Gain switching* | *Metal-vapor lasers construction* | *Cavitation* | *Applications of laser in neurology* | *Laser signage* |
| **S-9** | **SLO-1** | *Mode locking and its types* | *Working principle* | *Jet formation.* | *Applications of Lasers in dentistry* | *Laser risk management* |
| | **SLO-2** | *Cavity damping* | *Free-electron laser construction and working* | *Jet formation.* | *Applications of Lasers in Orthopedics* | *Good laser safety practices* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Leon Goldman, M.D., & R.James Rockwell, Jr., Lasers in Medicine, Gordon and Breach Science Publishers Inc., 1975.*<br>2. *Abraham Katzir, Lasers and Optical Fibers in Medicine, Academic Press Edition,1998.*<br>3. *Markolf H.Niemz, _Laser Tissue Interaction-Fundamentals and Applications", Springer, Third edition, 2007.* | 4. *Tuan Vo Dirh, Biomedical Photonics – Handbook, CRC Press, Bocaraton, 2003.*<br>5. *Glasser, O., Medical Physics -- Vol 1, 2, 3 Adam Hilgar Brustol Inc, 1987.*<br>6. *G.David Baxter, Therapeutic Lasers – Theory and practice, Churchill Livingstone Publications* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr. P.Vinupritha, SRMIST* |

| Course Code | 18BME265T | Course Name | ARTIFICIAL ORGANS AND TISSUE ENGINEERING | Course Category | E | Professional Electives | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Basic Biology and Biomaterials | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | To study the learners to acquire knowledge to the basic properties of biomaterials and various biomaterials used in biomedical applications. |
|---|---|
| CLR-1 : | learn the fundamentals of various organs |
| CLR-2 : | Study the different biomaterials used in artificial organs |
| CLR-3 : | Acquire basic knowledge of various types of artificial organs |
| CLR-4 : | Familiarize with basic biological system in human system |
| CLR-5 : | Obtain the concept of different types biomaterials applied in-vitro test tissue engineering application |
| CLR-6 : | Have an Gain the knowledge about technology transfer and ethical problem |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning 1 Level of Thinking (Bloom) | Learning 2 Expected Proficiency (%) | Learning 3 Expected Attainment (%) | PLO 1 Engineering Knowledge | PLO 2 Problem Analysis | PLO 3 Design & Development | PLO 4 Analysis, Design, Research | PLO 5 Modern Tool Usage | PLO 6 Society & Culture | PLO 7 Environment & Sustainability | PLO 8 Ethics | PLO 9 Individual & Team Work | PLO 10 Communication | PLO 11 Project Mgt. & Finance | PLO 12 Life Long Learning | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | Understand the basic Knowledge of artificial organs | 1, 2 | 80% | 70% | L | | | | L | | | | | | | L | | | M |
| CLO-2 : | Analyze various types of materials used in implant applications. | 2 | 80% | 70% | L | | | | M | | | | | | | M | | | M |
| CLO-3 : | Explain the process of importance of Tissue organization | 2 | 80% | 70% | L | | | | M | | | | | | | L | | | M |
| CLO-4 : | Select appropriate class of polymers using scaffold applications | 3 | 80% | 70% | M | | | | | | | | | | | L | M | M | |
| CLO-5 : | Understand the concepts different types biomaterials applied in-vitro and in-vivo biomedical implant application. | 3 | 80% | 70% | M | | | | | | | | | | | M | M | M | |
| CLO-6 : | Apply the various biomaterials used in implants and artificial organs | 3 | 80% | 70% | M | | M | H | | | | | | | | | | M | M |

| | | Basics of artificial organ | Types of Artificial organs | Basics concepts of tissue engineering | Types and application of tissue engineering | Recent advancement of tissue engineering |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Introduction -artificial organ | Introduction to Biomaterials in Ophthalmology | Introduction to Tissue engineering | Scaffolds for tissue engineering | Immunochemical techniques in tissue engineering and biomaterial science |
| | SLO-2 | Immunological considerations | Anatomy of eye | Cell source | Classes of potential scaffold materials | Basic immunological principles |
| S-2 | SLO-1 | Blood transfusion | Viscoelastic solution | Types of cell Sources | The criteria for an ideal scaffold | Common immunochemical techniques used in biomaterials |
| | SLO-2 | Artificial kidney | Contact lenses | Three-dimensional interactions | Polymer scaffolds | Immunochemical applications in biomaterial science and tissue engineering research |
| S-3 | SLO-1 | Cardiovascular organ | Optical implants | Cells as therapeutic Agents with examples, Cell numbers and growth rates. | Polymer scaffolds applications | Clinical applications of tissue engineering |
| | SLO-2 | Vascular organ | Scleral buckling materials for retinal detachment | Tissue organization | Bioactive ceramic scaffolds | Cell source, Stable 3D constructs |
| S-4 | SLO-1 | Cardiac pacemakers | Artificial exchange systems: Blood viscosity | Tissue Components, | Bioactive ceramic scaffolds and its applications | Cartilage |
| | SLO-2 | Introduction to Kidney organ | Effects of shear on blood cells | Tissue types, Functional subunits. | Substrate Scaffold Materials | Tendons, ligaments and bone |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-5** | **SLO-1** | *Artificial Kidney* | *Blood–air interactions* | *Tissue Dynamics, Dynamic states of tissues* | *Nano Composites* | *Regeneration in the cardiovascular system* |
| | **SLO-2** | *Artificial Lung* | *Blood flow in artificial devices* | *Homeostasis in highly prolific tissues and Tissue repair. Angiogenesis* | *Control of architecture* | *3D printing techniques in cardiac stent and bone scaffold* |
| **S-6** | **SLO-1** | *Liver implant* | *Exchangers* | *Measurement of cell characteristics - cell morphology* | *A guide to basic cell culture and applications in biomaterials and tissue engineering* | *Regulatory classification of biomaterials and medical devices* |
| | **SLO-2** | *Artificial Pancreas* | *Hemodialysis* | *Cell number and viability* | *sterilization of scaffolds* | *Classification of medical devices* |
| **S-7** | **SLO-1** | *Bone, Bone Marrow, and Hands* | *Soft Tissue Applications* | *Cell-fate processes, cell motility,* | *Sterilization methods* | *Differences between FDA and EU regulations* |
| | **SLO-2** | *Skin and Hair organ* | *Bulk space fillers* | *Cell function.* | *Cell culture protocols* | *How do companies get through the FDA Process?* |
| **S-8** | **SLO-1** | *Artificial ear* | *Maxillofacial implants* | *Cell-extracellular matrix interactions -* | *Basic techniques for assessment of cell viability* | *Technology transfer and Technology transfer paths* |
| | **SLO-2** | *Artificial Nose* | *Fluid transfer implants* | *Binding to the ECM, Modifying the ECM, .* | *culture environment* | *Efficient technology transfer and Factors affecting rapid technology transfer* |
| **S-9** | **SLO-1** | *Regeneration and Potential Future Uses for Stem Cells* | *Functional load-carrying and supporting implants* | *Malfunctions in ECM signaling* | *maintenance of cells in vitro, cryopreservation* | *Ethical issues, The ethical problem and Moral uncertainties* |
| | **SLO-2** | *Ethical consideration* | *Microencapsulation of live animal cells* | *Direct Cell-Cell contact - Cell junctions in tissues, malfunctions in direct cell-cell contact Signaling.* | *Regeneration stimulated electrically* | *Principles of distributive justice, Sources of conflict and Specific ethical concerns about biomaterials* |
| **Learning Resources** | | Learning Resources<br>1. Larry L. Hench and Julian R. Jones, Biomaterials, artificial organs and tissue engineering, CRC Press 2010<br>2. Sujata V. Bhat "Biomaterials" springer 2002 | | | | |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1., Dr.Gnanavel, SRMIST* |

| Course Code | 18BME266T | Course Name | Biomedical Nano technology | Course Category | E | Professional Electives | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | To study the learners to acquire knowledge to the basic properties of biomaterials and various biomaterials used in biomedical applications. |
|---|---|
| CLR-1 : | Attain the knowledge on different synthesis method and application of Nano material |
| CLR-2 : | Study the phenomena various characterization techniques used in Nano material method |
| CLR-3 : | Acquire knowledge importance of nanotechnology based biomedical diagnostics |
| CLR-4 : | Familiarize with biological system, prosthetic and medical implants in nanotechnology |
| CLR-5 : | Have an Gain the knowledge about nano material used in biomedical application |
| CLR-6 : | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Explain the familiarity with different synthesis method and application of Nano material in medical application | 1, 2 | 80% | 70% | L | | | | L | | | | | | | L | | | M |
| CLO-2 : | Analyze the phenomena taking various characterization techniques used in Nano material method | 2 | 80% | 70% | L | | | | M | | | | | | | M | | | M |
| CLO-3 : | Explain the process of importance of nanotechnology based biomedical diagnostics | 2 | 80% | 70% | L | | | | M | | | | | | | L | | | M |
| CLO-4 : | Select appropriate class of Nano materials using knowledge of, prosthetic and medical implants in nanotechnology | 3 | 80% | 70% | M | | | | | | | | | | | L | M | M | |
| CLO-5 : | Understand the concepts of biomedical application of different organic particles | 3 | 80% | 70% | M | | | | | | | | | | | M | M | M | |
| CLO-6 : | | 3 | 80% | 70% | M | | M | H | | | | | | | | | | M | M |

| | | Nano materials preparation techniques | Characterization techniques of Nano Material | Nanotubes and its applications | Biomedical implants in nanotechnology | Organic - Inorganic nanoparticles and is applications |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Introduction - synthesis Nano material | Introduction to Nano scale phenomena | Introduction to carbon Nano tube and its types | Introduction to prosthesis and implants | Introduction to Nano-bio conjugates |
| | SLO-2 | Types of bulk synthesis Material | Nano particle determination | Carbon Nano tube for biomedical application | Nano materials used in Neural implant | Nano-bio conjugates and their significance |
| S-2 | SLO-1 | Top Town approaches | Introduction to characterization techniques | Introduction to Improved diagnosis by in vivo imaging | Recent and advancement in Neural implant | Introduction -Nano Biodegradable material |
| | SLO-2 | Bottom up approaches | X-Ray diffraction method | Types of In vivo imaging and its application | Nano materials and coating used in HIP implant | Nano Biodegradable material for biomedical application |
| S-3 | SLO-1 | Insert Gas condensation techniques | Particles size determination | Detection of tumors for Nano materials | Recent and advancement in Hip implant | synthesis methods of Magnetic nanoparticles |
| | SLO-2 | Application of gas condensation techniques | Principle of Scanning electron microscopy | Nano particle using drug delivery system | Knee implant coating in Nano technology | Magnetic nanoparticles for biomedical application |
| S-4 | SLO-1 | Types of Physical Vapour deposition Method | Construction and working of SEM | Different types in drug delivery system | Recent advancement in Knee implant | Multi-functional inorganic Nano particles |
| | SLO-2 | Sputtering Techniques | Application of SEM | Nano particle using genetic defect diagnostics | Nano materials and coating used in Dental implant | Multi-functional inorganic Nano particles for biomedical application |
| S-5 | SLO-1 | Evaporation techniques | Energy dispersive X-ray spectroscopy | Introduction to Nano robotic medical devices | Recent advancement in Dental implant | Carbon nano tube (CNT) based inorganic Nano particles |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Chemical evaporation techniques* | *EDS Using elemental analysis* | *Application of Nano robotic medical devices* | *Nano Technology in ocular implant* | *Biomedical application of CNT based inorganic Nano particles.* |
| **S-6** | **SLO-1** | *Laser ablation method* | *Principle and working of Transmission electron microscope* | *Cantilever Sensors in biomedical application.* | *Recent advancement in Ocular implant* | *Carbon nano tube (CNT) based organic Nano particles* |
| | **SLO-2** | *Pulsed laser deposition* | *Application of TEM* | *Introduction to Nano material in medical imaging* | *Nano Technology in ear implant* | *Biomedical application of CNT based organic Nano particles.* |
| **S-7** | **SLO-1** | *Introduction to chemical synthesis* | *Principle and working of atomic force microscope* | *Magnetic resonance imaging based contrast reagent used in Nano particles* | *Recent advancement in ear implant* | *Introduction to Nano biosensor* |
| | **SLO-2** | *Sol gel process and micro emulsion method* | *Application of AFM* | *Organic Nano particles and Its applications* | *Artificial skin in Nano material* | *Nano Biosensor: Fabrication methods* |
| **S-8** | **SLO-1** | *Hydrothermal process and wet chemical* | *Fourier transform infrared (FTIR) spectroscopy and its application* | *Nanoprobes for CT images* | *Introduction to regenerative medicine in Nano technology* | *Nano Materials based in breathing gas sensor* |
| | **SLO-2** | *Spray pyrolysis Techniques* | *Application of Scanning probe microscopy (SPM)* | *Different types of nanoprobe in CT image* | *Tissue engineering in nanotechnology* | *Fabrication of breathing gas sensor* |
| **S-9** | **SLO-1** | *Spin coating methods* | *Contact angle measurement* | *PET based contrast reagent used as a Nano particle.* | *Nano fiber scaffold technology* | *Glucose Nano sensor for Diabetic diagnostics* |
| | **SLO-2** | *Electrochemical deposition method* | *Nano indentation techniques* | *SPET based contrast reagent used as a Nano particle.* | *Nano fiber scaffold technology in Biomedical application* | *Nano oxygen sensor and its application.* |

| | |
|---|---|
| **Learning Resources** | 1.W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate(Eds.), "Handbook of NanoScienceEngineering and Technology", CRC Press, 2013<br>2.K. Barriham, D.D. Vvedensky, "Low dimensional semiconductor structure fundamental and device applications", Cambridge University Press, 2010..<br>REFERENCE BOOKS / OTHER READING MATERIAL<br>1.Cao,G,Nanostructures Nanomaterials Synthesis: Properties Applications", Imperial College Press, 2011. Brian, R Eggins; Wiley; New York, Chichester, 3rdedition,2012<br>2.Allen J Bard and Larry R Faulkner; Wiley, "Electrochemical Methods: Fundamentals and Applications", New YorkChichester, 4th edition, 2009<br>3. David Wild; "The Immunoassay Handbook", Elsevier, 4thedition, 2013. |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1., Dr.Gnanavelu, SRMIST* |

| Course Code | 18BME267T | Course Name | BIOMETRICS | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | | Co-requisite Courses | | Progressive Courses | |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | | Data Book / Codes/ Standards | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the basics of biometric systems |
| CLR-2 : | Acquire the knowledge about the finger print and hand geometry recognition |
| CLR-3 : | Utilize the knowledge in face recognition system |
| CLR-4 : | Identitfy the applications of biometrics in gait recognition. |
| CLR-5 : | Analyze the concepts of voice biometrics |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning 1: Level of Thinking (Bloom) | Learning 2: Expected Proficiency (%) | Learning 3: Expected Attainment (%) | PLO 1: Engineering Knowledge | PLO 2: Problem Analysis | PLO 3: Design & Development | PLO 4: Analysis, Design, Research | PLO 5: Modern Tool Usage | PLO 6: Society & Culture | PLO 7: Environment & Sustainability | PLO 8: Ethics | PLO 9: Individual & Team Work | PLO 10: Communication | PLO 11: Project Mgt. & Finance | PLO 12: Life Long Learning | PSO – 1: Professional Activ… | PSO – 2: Project Management Techniques | PSO – 3: Analyze & Reseach |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | Analyze the performance and characteristics of biometric systems | 3 | 80 | 75 | M | | | | | | | | | | | | M | | |
| CLO-2 : | Explain the image processing techniques used in finger print technology | 3 | 80 | 70 | M | | | | | | | | | | | | | M | |
| CLO-3 : | Illustrate the concepts of face recognition system in 2D and 3D imaging | 3 | 75 | 70 | M | | | | | | | | | | | | | | M |
| CLO-4 : | Implement the gait algorithm in gait recognition process and perform on line signature verification using image processing techniques | 3 | 80 | 75 | | | M | | | | | | | | | | | | M |
| CLO-5 : | Analyze the concept of palm print identification system | 3 | 80 | 70 | | | | M | | | | | | | | | | | M |
| CLO-6: | Explain the application of voice biometrics technology | 3 | 80 | 70 | | | | M | | | | | | | | | | | M |

| | | Fundamentals of biometrics | Finger print and Hand geometry recognition | Face Recognition | Gait Recognition and Palm print identification | Voice biometrics |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Introduction to biometrics | Introduction to finger print technology | Face recognition -Introduction | Gait -Introduction | Voice biometrics-Technology |
| | SLO-2 | Definition and Evolution | General description | | Human ID gait challenge problem | |
| S-2 | SLO-1 | Operation of biometric systems | Finger print sensing-optical sensors | Techniques-Eigen faces, Linear discriminant analysis | Base line gait Algorithm | Identity information in the speech signal |
| | SLO-2 | Block diagram description | Solid state sensor and ultrasound sensors | Independent component analysis , Local feature analysis | Base line gait Algorithm | Language generation and speech production |
| S-3 | SLO-1 | Biometric functionalities | Feature extraction-segmentation | Face recognition databases-FRGC,FERET | Recognition Approaches-Temporal alignment | Feature extraction and Tokenization-short term analysis |
| | SLO-2 | Verification vs identification | Enhancement, minutiae extraction | PIE, AR,Yale face database | Shape based approach | parameterization |
| S-4 | SLO-1 | Performance of biometric systems | Finger print matching-correlation based methods | Advanced correlation filters | Palm print identification system-block diagram | Phonetic and word Tokenization |
| | SLO-2 | | Rigid feature based techniques | Kernel class dependent analysis | Image preprocessing techniques | Prosodic Tokenization |
| S-5 | SLO-1 | Biometric system errors-failure to acquire | Performance evaluation-finger print verification competition | Support vector machine for classification | Feature extraction | Text dependent speaker recognition-classification |
| | SLO-2 | Failure to enroll | Finger print vendor technology evaluation | Algorithm | Feature matching | Databases and benchmarks |
| S-6 | SLO-1 | Benefits of biometrics | Synthetic finger print generation | Tensor faces method-multilinear analysis of training images | Online signature verification | Text –independent speaker recognition-short term spectral systems |
| | SLO-2 | Parameters of good biometrics | Securing finger print based biometric systems | multilinear analysis of testing images | Architecture | Idiolectal systems |
| S-7 | SLO-1 | Application of biometrics-Forensics | Hand geometry: Historical perspective | 3D sensor and data for face recognition | Data acquisition and preprocessing | Phonotactic systems |
| | SLO-2 | Government, commercial | Modern hand reader | | Feature extraction and enrolment | Prosodic systems |
| S-8 | SLO-1 | Characteristics of biometrics | Processing steps –hand capture, processing | 3D Face image processing-smoothing | Similarity computation | Applications of voice biometrics-voice authentication |
| | SLO-2 | Commonly used biometrics characteristics | Classification, template adaptation | Local feature extraction | Matching | Speaker detection |
| S-9 | SLO-1 | Accuracy in biometric systems | Performance metrics | Representation and features for 3d face recognition- Global and local set point model | Resources for online signature verification systems-Reference systems | Strength of voice biometrics |

| | | | | | | |
|---|---|---|---|---|---|---|
| | SLO-2 | *Legal consideration in use of biometric systems* | *Standardization* | *Deformation model* | *On-line signature databases* | *Weakness* |

| | |
|---|---|
| **Learning Resources** | 1. *Anil K jain, Patrick Flynn, Arun A. (Eds.), Handbook of Biometrics, Springer, 2008.*<br>2. *John D. Woodward, Jr. Nicholas M. Orlans Peter T. Higgins, "Biometrics", dreamtech, 2003*<br>3. *J. Wayman, A. Jain, D. Maltoni and D. Maio (Eds.), Biometric Systems: Technology, Design and Performance Evaluation, Springer, 200* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1.Dr.U.Snekhalatha, SRMIST* |

| Course Code | 18BME361T | Course Name | BIOMEMS | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the fundamental principles of microsensors and microactuators | | | |
| CLR-2 : | Get an idea about the materials used in MEMS and fabrication processes | | | |
| CLR-3 : | Acquire an idea about the micromachining | | | |
| CLR-4 : | Get an idea about the biomedical application of MEMS in POCT | | | |
| CLR-5 : | Get an idea about the research based development in the area of BioMEMS | | | |
| CLR-6 : | Understand the different biomedical application of MEMS | | | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Analyze the working principle of MEMS & Microsystems in healthcare domain | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Explain the micro system fabrication processes and materials used for MEMS | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Differentiate the various Micromanufacturing techniques | 2 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | Illustrate the concepts of BioMEMS in POCT | 1 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | - | - | M | - |
| CLO-5 : | Illustrate the concepts of BioMEMS with suitable examples | 1 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-6 : | Outline the research areas in the field of BioMEMS | 1,2 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | - | - | - | - |

| Duration (hour) | | MEMS and Microsystem | MEMS Materials and Fabrication Processes | Overview of Micro-manufacturing | BioMEMS-1 | BioMEMS-2 |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | MEMS and microsystems- Introduction | Substrates and wafers | Micro-Machining- Introduction | Introduction to BioMEMS | Microcantilever BioMEMS |
| | SLO-2 | Typical MEMS and microsystem products | Silicon as a substrate material | Micromachining Techniques | Home Pregnancy Test | Basic Principles of Sensing Biomechanical Interactions |
| S-2 | SLO-1 | Difference between MEMS and Microsystems | Silicon compounds, Silicon piezoresistor | Bulk Micromanufacturing (BM) | Lab on a Chip | Detection Modes of Biomechanical Interactions- Static Mode |
| | SLO-2 | **A**pplication of Microsystems in healthcare industry | Gallium arsenide, Quartz | Steps in Bulk Micromanufacturing | Lab on a cellphone | Detection Modes of Biomechanical Interactions- Dynamic Mode |
| S-3 | SLO-1 | Working Principles for Microsensor | Piezoelectric crystals, Polymers | Construction of a Microcantilever using BM | Mobile Point of Care Monitors | Fabrication and Functionalization of Microcantilevers |
| | SLO-2 | Types of microsensors: Chemical Sensors | ***Packaging materials*** | Types of Etching process in bulk micromanufacturing | DNA Sensors | Fabrication and Functionalization of Microcantilevers |
| S-4 | SLO-1 | Biomedical Sensors & Biosensor | Photolithography | Types of Etching process in bulk micromanufacturing | Drug Delivery- Insulin Delivery | Tissue scaffold fabrication using MEMS approaches |
| | SLO-2 | Optical Sensors | Ion implantation | Surface Micromachining (SM) | Artificial Retinal Prosthesis | Tissue scaffold fabrication using MEMS approaches |
| S-5 | SLO-1 | Pressure Sensors | Diffusion | Construction of a Microcantilever using SM | Endoscopic Wireless Pill | Applications of MEMS-fabricated tissue scaffold |
| | SLO-2 | Pressure Sensors | Oxidation | Steps in Surface Micromachining | Medtronic Reveal | Applications of MEMS-fabricated tissue scaffold |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-6** | **SLO-1** | *Thermal Sensor* | *Chemical vapor deposition (CVD)* | *Steps in Surface Micromachining* | *Microsystem Approaches to PCR* | *Paper-Based Microfluidic Devices* |
| | **SLO-2** | *Acoustic Wave Sensors* | *Types of CVD* | *LIGA* | *Microsystem Approaches to PCR* | *Paper-Based Microfluidic Devices* |
| **S-7** | **SLO-1** | *Working Principle for Microactuator* | *Physical vapor deposition (PVD)* | *Steps in LIGA process* | *Implantable Microelectrodes* | *Lens-Based Glucose Sensor* |
| | **SLO-2** | *Actuation using Thermal Forces* | *Types of PVD* | *Difference between LIGA, SM, BM* | *The Michigan Probes* | *Lens-Based Glucose Sensor* |
| **S-8** | **SLO-1** | *Actuation using Shape-Memory Alloys, Piezo-Electric Crystals* | *Epitaxy* | *Difference between LIGA, SM, BM* | *The Utah Electrode Array* | *Catheter based sensors* |
| | **SLO-2** | *Actuation using Electrostatic Forces, Magnetic field* | *Types of Epitaxy* | *Applications of LIGA* | *Microfabricated Cochlear Implants* | *Catheter based sensors* |
| **S-9** | **SLO-1** | *Application of Microactuations* | *Etching* | *Applications of Surface Micromachining* | *Microfabricated Electrocorticography Arrays* | *Microneedles* |
| | **SLO-2** | *Application of Microactuations* | *Types of Etching* | *Applications of Bulk Micromachining* | *Microelectrodes for Visual Prostheses* | *Types of Microneedles* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Tai-Ran Hsu, "MEMS & Microsystems- Design, Manufacture and Nanoscale Engineering John Wiley & Sons, 2nd Edition, 2008*<br>*2. Nitaigour PremchandMahalik, "MEMS", Tata McGraw Hill, 2nd Reprint, 2008*<br>*3. Steven S.Saliterman, "Fundamentals of BioMEMS & Medical Microdevices", International Society for Optical Engineering, 1st Edition, 2006*<br>*4. Ellis Meng, "Biomedical Microsystems", CRC Press, 1st Edition, 2011*<br>*5. Simona Badilescu and Muthukumaran Packirisamy, "BioMEMS Science and Engineering Perspectives", CRC Press, 1st Edition, 2011*<br>*6. Albert Folch, "Introduction to BioMEMS", CRC Press, 1st Edition, 2013* | *7. Wanjun Wang & Steven A.Soper, "BioMEMS- Technologies and applications", CRC Press, 1st Edition, 2007*<br>*8. Walter Karlen and Krzysztof Iniewski, "Mobile Point-of-Care Monitors and Diagnostic Device Design", CRC Press, 1st Edition, 2015*<br>*9. Chao-Min Cheng, Chen-MengKuan & Chien-Fu Chen, "In-Vitro Diagnostic Devices: Introduction to Current Point of Care Diagnostic Devices", Springer, 1st Edition, 2016*<br>*10. Mel L. Mendelson, "Learning Bio-Micro-Nanotechnology", CRC Press, 1st Edition, 2013* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Ms Oinam Robita Chanu, SRMIST* |

| Course Code | 20BME363T | Course Name | HUMAN ELECTROPHYSIOLOGY | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Anatomy and Physiology | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand cell elcrophysiology |
| CLR-2 : | Know about neuronal communication |
| CLR-3 : | Learn about electrophysiology at neuromuscular junctions |
| CLR-4 : | Understand the cardiac electrophysiology |
| CLR-5 : | Understand the importance of neural control with other body systems |
| CLR-6 : | Explore the latest technologies with Electrophysiology studeies |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Describe the physiology of cellular communication | 1, 2 | 80% | 70% | | | | | | | | | | | | | | | |
| CLO-2 : | Explain how neuron communicate and about perception | 2 | 80% | 70% | | | | | | | | | | | | | | | |
| CLO-3 : | Elaborate on hoe skeletal muscles working with neural system | 2 | 80% | 70% | | | | | | | | | | | | | | | |
| CLO-4 : | Describe how human systems are controlled by the electrical signals from btrain | 3 | 80% | 70% | | | | | | | | | | | | | | | |
| CLO-5 : | Explain the cardiac electrophysiology | 3 | 80% | 70% | | L | | | | | | | | | | | | | |
| CLO-6 : | Undertake basic electrophysiological studies using EEG and other acquired signals. | 3 | 80% | 70% | | | M | L | L | | | | | | | | | L | |

| | | Cell electrophysiology | Neural communication and perception | Neuromuscular physiology | Electrophysiology of human systems | Electrophysiology studies |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Physiology- levels of organization in the body | Synapse | Autonomic nervous system | Heart anatomy review | Electrophysiology studies (EPS) |
| | SLO-2 | Concept of homeostasis | Process involved in synapse | Somatic nervous system | Electrical activity of heart | Facts -EPS |
| S-2 | SLO-1 | Homeostasis control systems | Intracellular communication | Neuromuscular junction | Pacemaker activity | Need for EPS |
| | SLO-2 | Cell structure overview | Signal transduction | Chemical linkage | Refractory periods | Risks involved |
| S-3 | SLO-1 | Plasma membrane structure | Organization of nervous system | Skeletal muscles | ECG- Spread of electrical activity | Procedure involved |
| | SLO-2 | Plasma membrane functions | Organization of nervous system- Overview | Skeletal muscles structure and functions | ECG- diagnostic applications | Procedure involved ctd. |
| S-4 | SLO-1 | Membrane transport overview | Brain review | Molecular basis of muscular contraction | Cardiac output | Pacing Maneuvers |
| | SLO-2 | Assisted , unassisted transports | Spinal cord review | Skeletal muscle mechanics | Cardiac output and its control | Pace mapping |
| S-5 | SLO-1 | Membrane potential | Peripheral nervous system | Muscle mechanics ctd. | Blood pressure (BP) | Vagal Maneuvers (VM) |
| | SLO-2 | Membrane potential causes | Receptor physiology | Shortening of skeletal muscles | Reflexes responsible for BP | Indications of VM |
| S-6 | SLO-1 | Neural communication- Introduction | Pain | Skeletal muscle mechanism | Respiratory mechanics | Technologies for VM |
| | SLO-2 | Graded potentials | Pain perception | Fiber types | Adjustments in ventilation | Special considerations |
| S-7 | SLO-1 | Action potential | Eye revisited | Nervous control of motor movements | Nervous control of respiration | Supra ventricular tachycardia (SVT) |
| | SLO-2 | Action potential-generation | Visual perception | Nervous control of motor movements ctd. | Nervous control of respiration ctd. | Causes, types SVT |
| S-8 | SLO-1 | Action potential-Propagation | Ear and hearing | Smooth muscle | Nervous control of digestive system | Symptoms of SVT |
| | SLO-2 | All or none law | Ear and equilibrium | Phasic contraction | Defecation reflex | Treatments for SVT |
| S-9 | SLO-1 | Myelination | Chemical sensing | Cardiac muscles | Nervous control of excretory system | Latest trends in EPS |
| | SLO-2 | Myelination challenges | Taste and Smell | Blend with smooth and skeletal muscles | Micturition reflex | Future scope |

**Learning Resources**


1. Laura lee Sherwood, "Human Physiology from cell to system", Brooks Cole , 2012.
2. Laura lee Sherwood, "Fundamental of Physiology of Excitable Cells", 2010
3. Lionel Opie, "Heart Physiology" , Lippincott-Raven, 1998
4. Aidley, "The Physiology of Excitable Cells", Cambridge Press.,2008
5. Francis D Murgatroyd, Andrew D. Krahn, "Handbook of cardia Electrophysiology, A practical guide to invasive EP studies and catheter Ablation",Remedica Publisher, 2002

| Course Designers | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr. Varshini Karthik, SRMIST* |

| Course Code | 18BME364T | Course Name | Biomedical Device Design Fundamentals | Course Category | *E* | *Professional Elective* | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | | Co-requisite Courses | *Nil* | Progressive Courses | *Nil* |
|---|---|---|---|---|---|
| **Course Offering Department** | *Biomedical Engineering* | **Data Book / Codes/Standards** | *Nil* | | |

| **Course Learning Rationale (CLR):** | *The purpose of learning this course is to:* |
|---|---|
| **CLR-1 :** | *Understand the basic concepts of design issues in medical devices* |
| **CLR-2 :** | *Get an idea about the forming applications in the design of medical devices* |
| **CLR-3 :** | *Acquire an idea about the laser processing applications* |
| **CLR-4 :** | *Get an idea about the machining applications and different advanced techniques* |
| **CLR-5 :** | *Acquire an idea about the applications of various technical methods* |
| **CLR-6 :** | *Get an overall idea about the regulation and protection in medical device design* |

| **Course Learning Outcomes (CLO):** | *At the end of this course, learners will be able to:* | **Learning** | | | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *1* | *2* | *3* | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| **CLO-1 :** | *Understand the challenges in the Medical Device Industry* | *1, 2* | *80* | *70* | *H* | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CLO-2 :** | *Have a thorough understanding of typical process parameters* | *1, 2* | *80* | *70* | *M* | - | - | *M* | - | - | - | - | - | - | - | - | *M* | - | - |
| **CLO-3 :** | *Understand the basics of microscale medical device applications* | *2* | *80* | *70* | - | - | - | *M* | - | - | - | - | - | - | - | - | *L* | | - |
| **CLO-4 :** | *Identify the importance of different biomaterials used in device design* | *1* | *80* | *70* | *H* | - | | *M* | - | - | - | - | - | - | - | *M* | - | *L* | - |
| **CLO-5 :** | *Analyze the knowledge on machining based fabrication of medical devices* | *1* | *80* | *70* | - | - | - | *M* | - | - | - | - | - | - | - | *L* | - | - | - |
| **CLO-6 :** | *Extend the basics of safety regulation and protection risk in medical device design* | *1,2* | *80* | *70* | *H* | - | - | - | - | - | - | - | - | - | - | *H* | - | - | - |

| **Duration (hour)** | | Design Issues in Medical Devices | Forming Applications on Implantable Devices | Laser Processing Applications on Medical Devices | Machining Applications and Advanced Techniques on Medical Implants | Regulation and Protection of Medical Devices |
|---|---|---|---|---|---|---|
| | | **9** | **9** | **9** | **9** | **9** |
| S-1 | SLO-1 | *Introduction - Need for Medical Devices* | *Forming Applications - Forming* | Laser Processing procedures | *Machinability of Biocompatible Metal Alloys* | *Minimisation of exposure to radiation* |
| | SLO-2 | *Technology Contribution to Medical Devices* | *Typical Process Parameters* | Microscale Medical Device Applications | *Surfaces Engineering of Metal Implants* | *Medical devices intended to emit radiation* |
| S-2 | SLO-1 | *Subtractive Technologies* | *Typical Process Parameters - Temperature* | Microscale Medical Device Applications | *Surfaces Engineering of Metal Implants* | *Minimisation of exposure to unintended radiation* |
| | SLO-2 | *Net-Shape Technologies* | *Typical Process Parameters - Strain* | Processing Methods for Medical Device Fabrication | *Wear and Failure of Metal Implants* | *Medical devices intended to emit ionising radiation – additional requirements* |
| S-3 | SLO-1 | *Additive Technologies* | *Typical Process Parameters - Strain Rate* | Processing Methods for Medical Device Fabrication | *Wear and Failure of Metal Implants* | *Medical devices intended to emit ionising radiation – additional requirements* |
| | SLO-2 | *Challenges in the Medical Device Industry* | *Tribology and Micro-Tribology* | Processing Methods for Medical Device Fabrication | *Wear and Failure of Metal Implants* | *Medical devices connected to or equipped with an energy source* |
| S-4 | SLO-1 | *Medical Device Development* | *Tribology and Micro-Tribology* | Biomaterials Used in Medical Devices | *Micromilling-Based Fabrication of Metallic Microchannels for Medical Devices* | *Medical devices incorporating electronic programmable systems* |

| | | | | | | |
|---|---|---|---|---|---|---|
| | SLO-2 | *Biomedical Product Life Cycle* | *Manufacturing Process Chain* | Biomaterials Used in Medical Devices | *Micromilling-Based Fabrication of Metallic Microchannels for Medical Devices* | *Safety dependent on internal power supply* |
| S-5 | SLO-1 | *Biomedical Product Life Cycle* | *Manufacture of Alloys and Raw Materials* | Biomaterials Used in Medical Devices | *Machining-Based Fabrication of Polymeric Microneedle Devices* | *Safety dependent on external power supply* |
| | SLO-2 | *Medical Device Development Process* | *Forming* | Microjoining of Similar and Dissimilar Materials | *Machining-Based Fabrication of Polymeric Microneedle Devices* | *Medical devices intended to monitor clinical parameters* |
| S-6 | SLO-1 | *Medical Devices' Design Process* | *Machining and Finishing* | Microjoining of Similar and Dissimilar Materials | *Degenerative Disc Disease* | *Minimisation of risk of electromagnetic fields* |
| | SLO-2 | *Scapholunate Interosseous Ligament* | *Coating* | Microjoining of Similar and Dissimilar Materials | *Degenerative Disc Disease* | *Protection against electrical risks associated with mechanical, vibration, electrical, heat and noise* |
| S-7 | SLO-1 | *Conceptual Design* | *Packaging and Sterilization* | Laser Micromachining for Microfluidics | *Intervertebral Spinal Spacers* | *IEC standards:*<br>*IEC 60601-2-44: Computed tomography* |
| | SLO-2 | *Conceptual Design* | *Implantable Devices* | Laser Micromachining for Microfluidics | *Intervertebral Spinal Spacers* | *IEC 60601-2-43: Interventional procedures* |
| S-8 | SLO-1 | *Embodiment Design* | *Implantable Devices* | Laser Micromachining for Microfluidics | *Inkjet Technology* | *IEC 60601-2-45: Mammographic X-ray equipment* |
| | SLO-2 | *Detailed Design* | *Bone Implants* | Laser Micromachining for Metallic Coronary Stents | *Medical Applications of Inkjet Technology* | *IEC 60601-1-3: Radiation protection in diagnostic X-ray equipment* |
| S-9 | SLO-1 | *Manufacturing a Prototype* | *Bone Implants* | Laser Micromachining for Metallic Coronary Stents | *Material Extrusion Technology* | *IEC 60601-2-54: X-ray equipment for radiography and radioscopy* |
| | SLO-2 | *Manufacturing a Prototype* | *Bone Implants* | Laser Micromachining for Metallic Coronary Stents | *Medical Applications of Extrusion-Based Systems* | *IEC 60601-2-63: Dental extra-oral X-ray equipment; IEC 60601-2-65: Dental intra-oral X-ray equipment* |

**Learning Resources**


1. *Claudio Becchetti,Alessandro Neri , "Medical Instrument Design and Development: From Requirements to Market Placements",Wiley; 1st edition, 2013.*
2. *Andreoni, Giuseppe, Barbieri, Massimo, Colombo, Barbara,"Developing Biomedical Devices Design, Innovation and Protection", Springer, 2014.*
3. *Tugrul Özel, Paolo Jorge Bártolo, Elisabetta Ceretti, Joaquim De Ciurana Gay, Ciro Angel Rodriguez, Jorge Vicente Lopes Da Silva, "Biomedical Devices: Design, Prototyping, and Manufacturing", 1st Edition, 2016.*
4. *Brendan Cooper, "Design Control for Medical Devices: A Short Introduction", Tata McGraw-Hill, New Delhi, 2nd edition, 2016.*
5. *Paul H. King, Richard C. Fries, Arthur T. Johnson, "Design of Biomedical Devices and Systems", CRC Press, 4th edition, 2018.*


**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Mr.P. Muthu, SRMIST* |

| Course Code | 18BME365T | Course Name | Innovation, Translation and Entrepreneurship | Course Category | E | | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Learn a range of creative thinking tool and how to practically apply these to the innovation and entrepreneurial process. |
| CLR-2 : | Explain the business environment and idea generation |
| CLR-3 : | Understand Marketing feasibility and feasibility plan |
| CLR-4 : | Understand about Entrepreneurship |
| CLR-5 : | Familiarizing with the nuances of Intellectual Property Rights |
| CLR-6 : | Apply deep learning in real life medical problems |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Understand the basic of creative thinking learning techniques and correlate to innovation | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Understand the business environment and idea generation | 2 | 80% | 70% | M | | | | | | L | | | | | | | | |
| CLO-3 : | Apply knowledge of Marketing feasibility and feasibility plan | 2 | 80% | 70% | | | M | | M | | | | L | | | | M | | L |
| CLO-4 : | Apply Knowledge about entrepreneurship and new opportunities | 3 | 80% | 70% | | | | | M | | | | L | | | | | | |
| CLO-5 : | Use Knowledge about current scenario on entrepreneurship | 3 | 80% | 70% | M | | L | | | | | | | | | | M | | L |
| CLO-6 : | Apply innovation to come up with new business plan | 3 | 80% | 70% | M | | | L | | | | | M | | | | | | |

| | | Innovation & Creative thinking | Business Plan / Idea | Marketing Feasibility and Planning | Entrepreneurship | Intellectual properties and responsibilities |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Introduction to Creativity | Scanning of Environment | Market survey & Assessment | Understanding the Meaning of "Entrepreneur" | Product Strategies |
| | SLO-2 | Introduction to Innovation | Understanding factors | Market survey & Assessment | Universal definitions | Product Strategies |
| S-2 | SLO-1 | Need for Creativity & Innovation | Sensing Opportunities | Demand and Supply | Characteristics of an Entrepreneur | Distribution Strategies |
| | SLO-2 | Need for Creativity & Innovation | Identify and evaluate factors | Nature of Competition | Characteristics of an Entrepreneur | Distribution Strategies |
| S-3 | SLO-1 | The process of Technological Innovation | harnessing different sources of knowledge and information | Fixing cost and price of product | Classification of Entrepreneurs | Promotional Strategies |
| | SLO-2 | The process of Technological Innovation | harnessing different sources of knowledge and information | Fixing cost and price of product | Classification of Entrepreneurs | Promotional Strategies |
| S-4 | SLO-1 | Sources of Innovative Opportunity : Process Need | Generation of Ideas | Project Innovation and Changes | The Entrepreneurial Scene in India | Concept of Intellectual Property Rights (IPR) |
| | SLO-2 | Sources of Innovative Opportunity: Industry and market structures | Methods for Generating ideas | Identification of applicable Entrepreneurial Opportunities | The Entrepreneurial Scene in India | Patents, Trademarks |
| S-5 | SLO-1 | Sources of Innovative Opportunity : demographics | Product Planning | Data collection for setting up small ventures | Factors Influencing Entrepreneurship | Copyright, Industrial Designs Registrations |
| | SLO-2 | Sources of Innovative Opportunity: changes in perception | Product Planning | Data collection for setting up small ventures | Factors Influencing Entrepreneurship | Geographical Indications, Trade Secrets |
| S-6 | SLO-1 | Organization and personal factors to promote creativity | Writing a Business Plan | Financial, Economic Feasibilities | Entrepreneurial Growth | Territoriality of IPR |
| | SLO-2 | Organization and personal factors to promote creativity | Writing a Business Plan | Technical Feasibilities | Entrepreneurial Growth | Concept and procedures of obtaining rights and ownership for creative works in India |
| S-7 | SLO-1 | Creativity and analytical skill | Using and Implementing the Business Plan | Legal Feasibilities | Problems of Entrepreneurs | Environment protection |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Difference between Creativity and Analytical skill* | *Using and Implementing the Business Plan* | *managerial, Locational and Other Feasibilities* | *Problems of Entrepreneurs* | *Environment protection* |
| **S-8** | **SLO-1** | *Creativity and Problem Solving* | *Difference between 'Basic Ideas' and post scanning ideas* | *Preliminary screening* | *HEIs Strategies & Governance for Promoting Innovation & Entrepreneurship* | *importance of Business Ethics and Values in Business* |
| | **SLO-2** | *Creativity and Problem Solving* | *Difference between 'Basic Ideas' and post scanning ideas* | *Preliminary screening in market* | *National Innovation and Startup Policy (NISP) for Higher Educational Institutions (HEIs)* | *importance of Business Ethics and Values in Business* |
| **S-9** | **SLO-1** | *Different Techniques for Creative Intelligence* | *Self Assessment of idea* | *Preparation of detailed feasibility plan* | *Creating Innovation Pipeline and Pathways for Entrepreneurs* | *Role of entrepreneur in economic growth* |
| | **SLO-2** | *Brain storming technique* | *Reasons for Business Plans Failure* | *Key features of detailed feasibility plan* | *Collaboration Co-creation and Business Relationship and Knowledge Exchange* | *Role of entrepreneur in economic growth* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Peter Drucker, "Innovation and Entrepreneurship", Routledge Classics 2015*<br>2. *Carolina Machado, J. Paulo Davim, "Entrepreneurship and Organizational Innovation", Springer 2020*<br>3. *Norman M. Scarborough , "Essentials of Entrepreneurship and Small Business Management" (6th Edition) by (Paperback - Jan 13, 2010)*<br>4. *Dr.Jayashree suresh –Entrepreneurship Development.-Margham Publication-2012*<br>5. *Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)* | 6. *S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi. 2013*<br>7. *Gupta C.B. & Khanka. S.S, —Entrepreneurship and small business management‖, 5th edition , sultan chand & sons, 2014*<br>8. *Jayshree Suresh, —Entrepreneurial Development‖, Margham Publishers, Chennai, 2011.*<br>9. *Jeff Cornwall, —Entrepreneurship -- From Idea to Launch‖, Udemy online Education, https://www.udemy.com/entrepreneurship-from-idea-to-launch/* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Mrs.P.Bhargavi Haripriya, SRMIST* |

| Course Code | 18BME366T | Course Name | Biomedical Microscopy and Quantitative Imaging | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the basics of optics in microscopy |
| CLR-2 : | Understand the basics of fluorescence microscopy |
| CLR-3 : | Understand the techniques in low light microscopy |
| CLR-4 : | Analyze the various methods for quantitative analysis of microscopic images |
| CLR-5 : | Analyze the various methods for quantitative analysis of fluorescence microscopic images |
| CLR-6 : | Understand the optics of microscopy and the various methods of quantitative analysis |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Describe optics and principle of operation of microscopic image formation | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Describe optics and principle of operation of fluorescence microscopic image formation | 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-3 : | Demonstrate the techniques for low light microscopy | 2 | 80% | 70% | | | M | | M | | | | | | | | M | | L |
| CLO-4 : | Apply the different methods for quantitative analysis of microscopic images | 3 | 80% | 70% | | | | | M | | | | | | | | | | |
| CLO-5 : | Apply the different methods for quantitative analysis of fluorescence microscopic images | 3 | 80% | 70% | M | | | | | | | | | | | | M | | L |
| CLO-6 : | Apply the knowledge in microscopic image formation and its quantitative analysis | 3 | 80% | 70% | M | | | | | | | | | | | | | | |

| | | Optics of microscope image formation | Fluorescence Microscopy | Low-light microscopy | Quantitative Analysis of digital microscope images | Quantitative Fluorescence microscopy |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Finite tube length microscope | Fluorescence Microscopy | Low light imaging | Optical systems as block boxes | Quantitative fluorescence—detectors |
| | SLO-2 | Upright microscope | Beer's Law | Detection of low light | Calibration toolkit | Limits on linearity |
| S-2 | SLO-1 | Infinity optics microscope | Atomic fluorescence | Parameters characterizing imaging devices | Simple calibration curve-relative scale | Illumination variations |
| | SLO-2 | Objective basics | Organic molecular fluorescence | Sensitivity and quantum efficiency | Simple calibration curve-Absolute scale | Detector noise |
| S-3 | SLO-1 | Physical optics: superposition of waves | Excited state lifetime | Spectral response, Units | Precision in a calibration curve | Photon shot noise |
| | SLO-2 | Huygen's Principle | Excited state saturation | Fill factor (CCD format), Camera noise and the signal-to-noise ratio | Standard deviation and errors | Characterizing the performance of an imaging system |
| S-4 | SLO-1 | Young's experiment : two slit interference, Diffraction from single slit | Nonradiative decay mechanisms | Shot noise, Readout noise | Signal to noise ratio | Preprocessing of images for quantitative analysis |
| | SLO-2 | Microscope resolution, Issues in Microscope resolution | Fluorescence Resonance energy | Background and noise, Example calculation | Signal to background ratio | Processing data for quantitative analysis |
| S-5 | SLO-1 | Key components of light microscope | Fluorescence Depolarization | Spatial resolution, Example | Propagation of error in calculated quantities | Methodologies for quantitative imaging |
| | SLO-2 | Illumination Section, Light source | Measuring fluorescence in steady state | Linearity and uniformity, Time response | Error propagation in imaging | Approaches for image deblurring by deconvolution |
| S-6 | SLO-1 | Lamp collector | Construction of monochromator | Dynamic range, Gain | Accuracy and precision | Deblurring or neighbor-based methods |
| | SLO-2 | Internal components of illumination paths | Construction of photomultiplier tube | Frame rate and speed, Resolution, sensitivity, and imaging rate | Flatfield Correction | Restoration methods |
| S-7 | SLO-1 | Field diaphragm, Condenser, Stage and specimen holder | Measuring fluorescence in the time domain | Imaging Detectors and features | Spatial corrections | Image deconvolution: effects and results |
| | SLO-2 | Microscope imaging section, Objective | Boxcar-gated detection method | Video CCD cameras, Slow-scan and fast CCD cameras | Maximizing resolution | Image deconvolution: practical issues |
| S-8 | SLO-1 | Objective Back Focal Plane | Streak Camera method | Intensified Cameras | Converting pixels to microns | Applications for Image Deconvolution |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Revolving nosepiece Turret* | *Photon correlation method, Phase modulation method* | *Digital still cameras, SIT Cameras* | *Imaging warping* | *Quantitative Ratiometric Imaging of FRET-Biosensors in Living Cells* |
| **S-9** | **SLO-1** | *Infinity space, Tube lens, Eyepieces* | *Filters for the selection of wavelength* | *CMOS imagers* | *Two color coincidence* | *Image processing methods* |
| | **SLO-2** | *Koehler Illumination, Conjugate light paths* | *Power of fluorescence of microscopy* | *Image acquisition* | *Two camera and two color imaging* | *Imaging considerations and caveats and pitfalls* |

| | | |
|---|---|---|
| ***Learning Resources*** | 1. Greenfield Sluder, David E. Wolf," Digital Microscopy", 4th Ed, Academic Press, 2013.<br>*3.* Irving J. Bigio, Sergio Fantini "Quantitative Biomedical Optics: Theory, Methods, and Applications" , Cambridge University Press, 2016 | *2. Jennifer Waters, Torsten Wittmann, "Quantitative Imaging in Cell Biology" Academic Press, 2014.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.P.VinuprithaSRMIST* |

| Code | 18BME367T | Course Name | HOSPITAL MANGEMENT SYTEM | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand about quality and performance improve methods |
| CLR-2 : | Analysis of performance management methods and project management |
| CLR-3 : | Gain the knowledge of process redesign and data analytics |
| CLR-4 : | Understand the analytics in healthcare organizations and population health |
| CLR-5 : | Gain knowledge strategically manage hospital system |
| CLR-6 : | Understand the setup of Hospital Information System(HIS) |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Describe performance improve methods | 1, 2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Identify the project management in healthcare | 2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-3 : | Apply the process redesign and data analytics in population health | 2 | 80% | 70% | - | - | M | - | M | - | - | - | - | - | - | - | M | - | L |
| CLO-4 : | Gain the knowledge of health care organizations | 3 | 80% | 70% | - | - | - | - | M | - | - | - | - | - | - | - | - | - | - |
| CLO-5 : | Analyzes the population health management | 3 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | - | L |
| CLO-6 : | Understand hospital management system | 3 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| | | Quality and Performance improve Methods | Performance Management Methods and Project Management | Process Redesign, Data analytics and Population health | Analytics in healthcare organizations and population health management | Strategically Hospital management system |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Introduction to Quality management system | Introduction to Quality Measures | Introduction to process redesign | Introduction to healthcare organizations | Strategic, Tactical, and Operational Information Management |
| | SLO-2 | Quality Management | Process and outcome Measures | Importance of Process Improvement in system implementation | Analytical challenges | Information Management |
| S-2 | SLO-1 | Core components of Quality managements | Plan do check act | Basic process Improvement Approach | The values of analytics in health care | Strategic Information Management |
| | SLO-2 | Planning, Improvement and control | Six sigma and Lean | Lean Six Sigma | Types of data in health care organizations | Operational Information Management |
| S-3 | SLO-1 | Need for health improvement | Theory of constraints and process modeling | Documenting the process | Understanding managing data (Analytical tool and data) | Organizational Structures for Information Management |
| | SLO-2 | Performance improvement | Others Tools and Techniques | Communication Planning | Statistical analysis in health analytics and performance improvement. | Typical Organizational Structures for Strategic Information Management |
| S-4 | SLO-1 | Introduction to performance management | Introduction to developing new quality teams | Solidifying the process Improvement Approach | Introduction to population health management | Typical Organizational Structures for Tactical and Operational Information Management |
| | SLO-2 | Performance management | Building a new Quality | Creating Future State | Measure of population health status | Examples: Organizational Structures for Information Management in a Hospital |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-5** | **SLO-1** | *Health care strategy* | *Managing performance improvement* | *Identify metrics and Information capture points* | *Interaction with community Public health service Provider* | *Information Systems Managers as Architects* |
| | **SLO-2** | *Performance frame work* | *Measure the project status* | *Gap Analysis definition* | *Factors influencing population health status* | *Organizational Structures for Information Management in a Hospital* |
| **S-6** | **SLO-1** | *Change versus improvement* | *Recommendation of Building capacity* | *Introduction to Big data analysis* | *Impact of health disparities and inequities* | *Strategic Planning of Hospital Information Systems* |
| | **SLO-2** | *Performance based planning* | *Recommendation of Building capacity to all* | *Decision Model* | *Healthcare delivery systems* | *Strategic Alignment of Business Plans and Information Management Plans* |
| **S-7** | **SLO-1** | *Benchmarking* | *Introduction to project management in health care* | *Predictive Modeling* | *Continuum of care* | *The Strategic Information Management Plan* |
| | **SLO-2** | *Identifying problem and gap* | *Project initiation and design* | *Define the objects and data collection* | *Care of co-ordination* | *Purpose of Strategic Information Management Plans* |
| **S-8** | **SLO-1** | *Research and Prepare benchmarking visit.* | *Project risk* | *Applying algorithm* | *Network Affiliation Strategies* | *Strategic Monitoring of Hospital Information Systems* |
| | **SLO-2** | *Guideline for performance management* | *Project Execution and Control* | *Apply Prediction to decisions* | *Community needs assessment* | *Certification, Accreditation, and Excellence Programs of HIS* |
| **S-9** | **SLO-1** | *Measure the Historical Performance* | *Change Management* | *Information sharing beyond the Organizational walls* | *Evaluating Community Health status measures* | *Assessment Study of a Telemedicine System to Improve Care* |
| | **SLO-2** | *Forecast the desired Improvement target* | *Project Communication* | *Health information Exchanges* | *Data sources and incentive for health program* | *Strategic Directing of Hospital Information Systems* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *James R. Lang beer II "Performance Improvement in Hospitals and Health Systems Managing Analytics and Quality in Healthcare 2nd Edition", Taylor francs, 2018.*<br>2. *Kathryn J. Hannah Marion J. Ball Series Editors, "Health Informatics", Springer Scienc Business Media, LLC2ndedition, 2009* | 3. *Pradip Kumar Ray, Jhareswar Maiti, "Healthcare Systems Management: Methodologies and Applications: 21st Century Perspectives of Asia", Springer, 2018*<br>4. *Gerald L. Glandon, Donna Jean Slovensky, Detlev Herb Smaltz," Information Systems for Healthcare Management", Health Administration Press, 2014* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr. S. Gnanavel, SRMIST* |

| Course Code | 18BME368T | Course Name | SOFT TISSUE AND BIOFLUID MECHANICS | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-Requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the fundamental of soft tissue mechanics | | | |
| CLR-2 : | Get an idea about the biotransport | | | |
| CLR-3 : | Acquire an idea about the fundamental concepts of biofluid mechanics | | | |
| CLR-4 : | Get an idea about the mechanics of cardiovascular system | | | |
| CLR-5 : | Get an idea about the biofluid mechanics of various human body organ systems | | | |
| CLR-6 : | Understand the soft tissues and biofluid mechanics | | | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | | | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Understanding of the fundamental of the mechanics soft tissue | 1, 2 | 80 | 70 | H | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Analyze the various transport in biological system | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Conceptualization of biofluid mechanics | 2 | 80 | 70 | H | M | - | - | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | Illustrate of the concepts of cardiac system and its biofluid mechanics | 1 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | H | - | M | M |
| CLO-5 : | Illustrate the role of biofluid mechanics in various organ system | 1 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | H | - | - | - |
| CLO-6 : | Outline the importance of understanding soft tissues and biofluid mechanics | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Duration (hour) | | Fundamental of Soft Tissue mechanics | Basic concept of Biofluids | Macrocirculation and microcirculation system | Cardiac mechanics | Biofluid mechanics of organs system |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Introduction: Structural organization of skeletal muscle | Introduction –Body fluids, Dimension and unit | Introduction of macrocirculation and microcirulation | Introduction | Kidney :Structure and function |
| | SLO-2 | Muscle fiber | Basic Concepts and Definitions of Fluid Mechanics | Pulsatile flow properties | Cardiac Geometry and Structure | Fluid flow in an artificial kidney model |
| S-2 | SLO-1 | Motor unit | Fluid Kinematics and Viscosity | Arteries | Cardiac Geometry and Structure | Fluid flow in an artificial kidney model |
| | SLO-2 | Fiber types | Newtonian Fluids | Veins | Ventricular Geometry | Mass transfer in an artificial kidney model |
| S-3 | SLO-1 | Fiber architecture | Non-Newtonian Fluids | Vascular bifurcations and branches | Ventricular Geometry | Mass transfer in an artificial kidney model |
| | SLO-2 | Muscle function | Dimensionless Numbers of Biofluid Mechanics | Blood flow through curved vessels | Myofiber Architecture | Liver: structure and function |
| S-4 | SLO-1 | Muscle function | Steady versus Unsteady Flow and Laminar Versus Turbulent Flow | Mechanical and elasticity properties of vessels | Myofiber Architecture | Hepatic acinus model |
| | SLO-2 | Maximum Muscle Stress | Boundary Conditions and No Slip Boundary Condition | Atherosclerosis characteristics | Extracellular Matrix Organization | Fluid flow in hepatic acinus model |
| S-5 | SLO-1 | Maximum Muscle Contraction Velocity | Compressible and Incompressible Flows, Stress Tensor | Blood flow through stenosis | Cardiac Pump Function: Ventricular Hemodynamics | Mass transfer in hepatic acinus model |
| | SLO-2 | Types of Muscle Models | Viscoelasticity and Viscoplasticity | Arterioles and blood flow aspects | Ventricular Pressure--Volume Relations and Energetics | Lung : Structure and function |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-6** | **SLO-1** | *Huxley biochemical models* | *Basic Equations of Fluid Mechanics-conservation of Mass, Momentum and Energy* | *Capillaries and venules* | *Ventricular Pressure--Volume Relations and Energetics* | *Elasticity of the lung blood vessels and alveoli* |
| | **SLO-2** | *Hill phenomenological models* | *NavierStokes Equations* | *Fahraeus and Fahraeus lindqvist effects* | *Myocardial Material Properties* | *Pressure-volume relationship for air flow in the lungs* |
| **S-7** | **SLO-1** | *Constitutive models* | *Bernoulli Equation* | *Fahraeus and Fahraeus lindqvist effects* | *Myocardial Material Properties: Muscle Contractile Properties* | *Oxygen/carbon dioxide diffusion and transport in the blood* |
| | **SLO-2** | *Tendon-morphology* | *Hagen Poiseuille Equation* | *Mass transport in tissue* | *Muscle Contractile Properties* | *Compressible fluid flow* |
| **S-8** | **SLO-1** | *Tendon-properties* | *Steady Flow Along Tube, Pulsatile Flow in Rigid and Elastic Tubes* | *Porosity, tortuosity and permeability* | *Resting Myocardial Properties* | *Lubrication of joints: function* |
| | **SLO-2** | *Ligament –morphology* | *Resistance, Compliance and Inertance, Two-Phase Flows* | *Governing equations in porous media* | *Resting Myocardial Properties* | *Formation of synovial fluid* |
| **S-9** | **SLO-1** | *Ligament -properties* | *Hematology and blood rheology* | *Governing equations in porous media* | *Regional Ventricular Mechanics: Stress and Strain* | *Synovial fluid flow* |
| | **SLO-2** | *Articular cartilage –morphology and properties* | *Hematology and blood rheology* | *Fluid transport in poroelastic media* | *Regional Ventricular Mechanics: Stress and Strain* | *Mechanical forces within joint* |
| | | | | | | |

| | | |
|---|---|---|
| **Learning Resources** | *1. David A. Rubenstein,Wei Yin&Mary D. Frame "Biofluid mechanics:An introduction to fluid mechanics,macrocirculation and microcirculation(Biomedical Engineering)", Elsevier,2nd edition ,2012*<br>*2. Clement Kleinstreuer "Biofluid Dynamics: Principles and Selected Applications ", CRC Press; 1 edition, 2016*<br>*3. Benjamin Loret, Fernando Manuel & Fernandes Simoes"Biomechanical Aspects of Soft Tissues", CRC Press; 1 edition, 2017*<br>*4.* Yuan-Cheng Fung,"Biomechanics: Mechanical Properties of Living Tissues", Second Edition, 1993 | *5. Susan Hall, "Basic Biomechanics" McGraw-Hill Education,6th edition August 2011*<br>*6.* Ali Ostadfar," Biofluid Mechanics -Principles and Applications," Elsevier,1st edition,2016<br>7.Jagan N. Mazumdar,"Biofluid Mechanics," World Scientific, 2nd edition,1992 |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Ms. Oinam Robita Chanu* |

| Course Code | 18BME369T | Course Name | TROUBLESHOOTING OF MEDICAL DEVICES | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Basic Electronic devices and circuits, Linear Integrated circuits, Biomedical Instrumentation | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| CLR-1 : | Understand the fundamental troubleshooting procedures and testing of basic electronic components | | | |
| CLR-2 : | Learn the methods to ensure electrical safety | | | |
| CLR-3 : | Get an idea about the fault diagnosis in analog and digital ICs. | | | |
| CLR-4 : | Acquire an idea about the basic troubleshooting procedures for biomedical equipment | | | |
| CLR-5 : | Learn the methods of troubleshooting Diagnostic medical Equipments | | | |
| CLR-6 : | Understand the methods of troubleshooting therapeutic medical Equipments | | | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | | | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Apply the common troubleshooting procedures in Electronic Equipment and Outline the testing procedures of active and passive components | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Analyze the faults in analog circuits and digital ICs | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Identify the problems in common biomedical equipment in hospitals when it is not working and provide a suitable solution | 2 | 80 | 70 | - | M | - | - | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | Apply the acquired knowledge in fault diagnosis of medical equipments | 1 | 80 | 70 | - | - | H | - | - | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Explain the methods of troubleshooting Diagnostic medical Equipments | 1 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | M | - | - | - |
| CLO-6 : | Implement the methods of troubleshooting therapeutic medical Equipments | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | L | - | - | - |

| Duration (hour) | | Basic Troubleshooting Techniques & Procedures | Grounding Systems | Troubleshooting Active and Passive components | Troubleshooting of diagnostic Equipments | Troubleshooting of Therapeutic & Surgical Equipments |
|---|---|---|---|---|---|---|
| | | 9 | | | 9 | 9 |
| S-1 | SLO-1 | Making of an electronic equipment | Electrical Hazards | Testing of passive components: Fixed Resistors | Parts of an ECG Machine | Troubleshooting of Defibrillator |
| | SLO-2 | description | Causes | Testing of passive components: variable Resistors | Sources of ECG artifacts | Preventive maintenance of Defibrillator |
| S-2 | SLO-1 | PCB | Types of electrical shock | Testing of passive components: Capacitors | Troubleshooting- ECG Machine | Troubleshooting of Electrosurgical unit |
| | SLO-2 | PCB types | Threshold levels of electrical shock | Testing of passive components: variable Capacitors | Preventive maintenance of ECG system | Preventive maintenance of Electrosurgical unit |
| S-3 | SLO-1 | Causes of Equipment Failure | Electrical grounding | Testing of passive components: Inductors | Parts of an EEG Machine | Troubleshooting of Incubator |
| | SLO-2 | Types of Equipment Failure | Need for grounding | Testing of passive components: variable Inductors | Sources of EEG artifacts | Preventive maintenance of Incubator unit |
| S-4 | SLO-1 | Functional block diagram of a troubleshooting system | Grounding Systems in Electronic Equipment | Testing of PN Diodes | Troubleshooting- EEG Machine | Troubleshooting of Suction apparatus |
| | SLO-2 | Description of a troubleshooting system | Methods | Testing of Zener Diodes | Preventive maintenance of EEG system | Preventive maintenance of Suction apparatus |
| S-5 | SLO-1 | Troubleshooting Process | Temperature Sensitive Intermittent Problems | Testing of NPN transistor | X ray System | Troubleshooting of Anaesthesia Machine |
| | SLO-2 | Description | Methods to rectify | Methods | Sources of errors | Preventive maintenance of Anaesthesia Machine |
| S-6 | SLO-1 | Fault finding Aids | Correction Action to repair the Equipment | Testing of PNP transistor | Troubleshooting- X-ray Machine | Troubleshooting of Nebulizer Machine |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Description* | *Correction Action to repair the Equipment* | *Methods* | *Preventive maintenance of X-ray system* | *Preventive maintenance of Nebulizer Machine* |
| S-7 | SLO-1 | *Troubleshooting techniques: Preliminary Observations* | *Tools & Aids for Servicing & Maintenance* | *Testing of FET* | *Endoscopy: Sources of artifacts* | *Oxygen cylinders* |
| | SLO-2 | *Troubleshooting techniques: Functional block diagram approach* | *Tools & Aids for Servicing & Maintenance* | *Methods* | *Troubleshooting of endoscope & its preventive maintenance* | *Preventive maintenance of Oxygen cylinders* |
| S-8 | SLO-1 | *Troubleshooting techniques: Split half method* | *Situations where repair not to be attempted* | *Typical op-amp based medical circuits* | *Ultrasound: Sources of artifacts* | *Radiation Monitors-trouble shooting* |
| | SLO-2 | *Application of Split half method in circuit troubleshooting* | *Situations where repair not to be attempted* | *Fault diagnosis in op-amp circuits* | *Troubleshooting of Ultrasound system & its preventive maintenance* | *Radiation Monitors-calibration* |
| S-9 | SLO-1 | *Troubleshooting techniques: Systematic Troubleshooting* | *Types of power supply* | *Digital IC Troubleshooter:, Logic clip, Logic probe* | *Troubleshooting of Pulse oximeter* | *Troubleshooting of Autoclaves & sterilizers* |
| | SLO-2 | *Correction action* | *World power supply types* | *Logic pulser, Logic current tracer* | *Troubleshooting of Sphygmomanometers* | *Preventive maintenance of Autoclaves & sterilizers* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Joseph D Bronzino & Donald R Peterson, "Medical Devices and Human Engineering", CRC Press, 4th Edition, 2015*<br>*2. Myer Kutz, "Biomedical Engineering and Design Handbook- Volume 2: Applications", McGraw-Hill, 2nd Edition, 2009*<br>*3. Richard Fries, "Reliable Design of Medical Devices", CRC Press, 2nd Edition, 2006*<br>*4. Basem S EL-Haik & Khalid S Mekki, "Medical Device Design for Six Sigma: A Road Map for Safety and Effectiveness", John Wiley & Sons, 1st Edition, 2008*<br>*5. John J Tobin & Gary Walsh, "Medical Product Regulatory Affairs- Pharmaceutical, Diagnostics, Medical Devices", Wiley-Blackwell, 1st Edition, 2008*<br>*6. Norbert Leitgeb, "Safety of Electromedical Devices Law – Risks – Opportunities", SpringerWienNewYork, 1st Edition, 2010* | *7. "Medical Device Regulations Global overview and guiding principles", World Health Organization Geneva, 2003*<br>*8. Jack Wong and Raymond K Y Tong, "Handbook of Medical device regulatory affairs in Asia", Pan Stanford Publishing Pte. Ltd., 2nd Edition, 2018*<br>*9. Khandpur R S, "Troubleshooting Electronic Equipment- Includes Repair & Maintenance", Tata McGraw-Hill, 2nd Edition, 2009*<br>*10. Nicholas Cram & Selby Holder, "Basic Electronic Troubleshooting for Biomedical Technicians", TSTC Publishing, 2nd edition, 2010*<br>*11. Dan Tomal & Neal Widmer, "Electronic Troubleshooting", McGraw Hill, 3rd edition, 2004*<br>*12. Ministry of Health &Family Welfare, "Medical Equipment Maintenance Manual- A first line maintenance guide for end users", New Delhi, 2010* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
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| Course Code | 18BME370T | Course Name | QUALITY ASSURANCE AND REGULATORY ASPECTS IN MEDICINE | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Basic Electronic devices and circuits, Linear Integrated circuits, Biomedical Instrumentation | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: | Learning |
|---|---|---|

| | | 1 | 2 | 3 |
|---|---|---|---|---|
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the fundamental troubleshooting procedures and testing of basic electronic components | | | |
| CLR-2 : | Get an idea about the fault diagnosis in analog circuits and digital ICs. | | | |
| CLR-3 : | Acquire an idea about the basic troubleshooting procedures for biomedical equipment | | | |
| CLR-4 : | Get an idea about the medical device classification globally and regulatory standards | | | |
| CLR-5 : | Get an idea about the Indian perspective medical device regulatory system | | | |
| CLR-6 : | Get an overall idea about the importance of troubleshooting and medical device classification in India | | | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | 1 | 2 | 3 | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | | | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Apply the common troubleshooting procedures in Electronic Equipment and Outline the testing procedures of active and passive components | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Analyze the faults in analog circuits and digital ICs | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Identify the problems in common biomedical equipment in hospitals when it is not working and provide a suitable solution | 2 | 80 | 70 | - | M | - | - | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | Outline the importance of medical device classification based on the application and ISO standards | 1 | 80 | 70 | - | - | H | - | - | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Describe the Indian medical device regulatory system | 1 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | M | - | - | - |
| CLO-6 : | Outline the job opportunities in regulatory affairs in India | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | L | - | - | - |

| Duration (hour) | | FUNDAMENTALS OF QUALITY MANAGEMENT | QUALITY MANAGEMENT PRINCIPLES | STATISTICAL PROCESS CONTROL TOOLS | QUALITY MANAGEMENT TECHNIQUES | REGULATORY STRATEGY |
|---|---|---|---|---|---|---|
| | | | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Definition of Quality | Customer satisfaction | The seven tools of quality: Flow chart | Benchmarking | Purpose of regulation |
| | SLO-2 | Dimensions of Quality | Customer Perception of Quality | Check list | Benchmarking | Principles of regulation |
| S-2 | SLO-1 | Dimensions of Quality | Customer Complaints | Histograms | Reasons to Benchmark | Legal frame work for regulation: National Legislative process |
| | SLO-2 | Quality Planning | Service Quality | Pareto Diagram | Reasons to Benchmark | Legal frame work for regulation: EU Legislative process |
| S-3 | SLO-1 | Quality costs. | Customer Retention | Cause and Effect diagram | Benchmarking Process | Relationship between national and EU legal instruments |
| | SLO-2 | Analysis Techniques of quality Cost | Employee Involvement- Motivation | Scatter diagram | Benchmarking Process | Basic legialation |
| S-4 | SLO-1 | Analysis Techniques of quality Cost | Empowerment | Control Charts for variables | Quality Function Deployment (QFD) | Scope of legislation |
| | SLO-2 | Basic concepts of Total Quality Management | Teams | Control Charts for attributes | Quality Function Deployment (QFD) | Basic regulatory stratergy |
| S-5 | SLO-1 | Historical Review | Recognition and Reward | New seven Management tools: Affinity diagram | House of Quality | Need for Accreditation of hospitals |
| | SLO-2 | Historical Review | Performance appraisal | Relationship diagram | House of Quality | Need for Accreditation of hospitals |
| S-6 | SLO-1 | Principles of TQM | Continuous process improvement | Tree diagram | QFD Process | FDA Regulations |
| | SLO-2 | Leadership | Juran Trilogy | Matrix Diagram | Taguchi Quality Loss Function | Joint Commission |
| S-7 | SLO-1 | Role of Senior Management - | PDSA Cycle | Matrix diagram | Total Productive Maintenance (TPM | Regulatory Bodies of India-Medical Council of India |

| | | | | | | |
|---|---|---|---|---|---|---|
| | SLO-2 | *Quality Council* | *5S* | *Matrix data analysis diagram* | *Six sigma* | *Importance of regulatory system* |
| S-8 | SLO-1 | *Quality Statements* | *Kaizen* | *Matrix data analysis diagram* | *Six sigma* | *Market Overview* |
| | SLO-2 | *Strategic Planning* | *Performance Measures-Basic concepts* | *Process decision program chart* | *FMEA* | *Overview of Regulatory Environment* |
| S-9 | SLO-1 | *Deming Philosophy* | *Strategy* | *Process decision program chart* | *Types of FMEA* | *Details of Key Regulator* |
| | SLO-2 | *Barriers to TQM Implementation* | *Performance measurement.* | *Arrow diagram* | *Benefits of Fmea* | *Organization Chart — CDSCO* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Rose, J.E., "Total Quality Management", Kogan Page Ltd., 1993*<br>*2. Cesar A. Cacere& Albert Zana, :ThePractise of clinical Engineering". Academic Press, Newyork, 1997*<br>*3. John Bank, "The Essence of Total Quality Management", Prentice Hall of India, 1993*<br>*4. Webster J.G and Albert M.Cook, "Clinical Engineering, Principles & Practices", Prentice Hall Inc., Engle wood cliffs, New Jersey, 1979*<br>*5. John J Tobin & Gary Walsh, "Medical Product Regulatory Affairs- Pharmaceutical, Diagnostics, Medical Devices", Wiley-Blackwell, 1st Edition, 2008*<br>*6. Medical Device Regulations Global overview and guiding principles", World Health Organization Geneva, 2003* | *7. Jack Wong and Raymond K Y Tong, "Handbook of Medical device regulatory affairs in Asia", Pan Stanford Publishing Pte. Ltd., 2ndEdition, 2018*<br>*8. Khandpur R S, "Troubleshooting Electronic Equipment- Includes Repair & Maintenance", Tata McGraw-Hill, 2nd Edition, 2009*<br>*9. Nicholas Cram & Selby Holder, "Basic Electronic Troubleshooting for Biomedical Technicians", TSTC Publishing, 2nd edition, 2010*<br>*10. Dan Tomal& Neal Widmer, "Electronic Troubleshooting", McGraw Hill, 3rd edition, 2004*<br>*11..Ministry of Health &Family Welfare, "Medical Equipment Maintenance Manual- A first line maintenance guide for end users", New Delhi, 2010* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr. Rajalakshmi S, SRMIST* |

| Course Code | 18BME371T | Course Name | Neuro Engineering | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the basic principles of brain anatomy and function |
| CLR-2 : | Learn about the principles of nervous system and neurotransmission |
| CLR-3 : | Learn about the applications of neural engineering in sensory disorders |
| CLR-4 : | Understand the concepts of BCI and neurophysiologic recording and imaging technologies |
| CLR-5 : | Understand the basics of neuro prosthetic devices and neuron modelling |
| CLR-6 : | Learn about the concepts of neural imaging and its modeling techniques for various applications |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning 1 Level of Thinking (Bloom) | Learning 2 Expected Proficiency (%) | Learning 3 Expected Attainment (%) | PLO 1 Engineering Knowledge | PLO 2 Problem Analysis | PLO 3 Design & Development | PLO 4 Analysis, Design, Research | PLO 5 Modern Tool Usage | PLO 6 Society & Culture | PLO 7 Environment & Sustainability | PLO 8 Ethics | PLO 9 Individual & Team Work | PLO 10 Communication | PLO 11 Project Mgt. & Finance | PLO 12 Life Long Learning | PLO 13 PSO - 1 | PLO 14 PSO - 2 | PLO 15 PSO – 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | Understand the anatomy of brain and its functions | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-2 : | Understand the nervous system | 1, 2 | 80 | 70 | M | - | - | | - | - | - | - | - | - | - | | M | - | - |
| CLO-3 : | Identify the applications of neural engineering | 2 | 80 | 70 | M | - | - | | - | - | - | - | - | - | - | | - | - | M |
| CLO-4 : | Understand BCI system and neuro imaging techniques | 1 | 80 | 70 | M | - | | | - | - | - | - | - | - | - | | - | - | M |
| CLO-5 : | Identify the various neuro prosthetic devices and neuron modelling | 1 | 80 | 70 | M | - | - | | - | - | - | - | - | - | - | | - | - | M |
| CLO-6 : | Understand the concepts of neuro prosthetics and its modeling techniques | 1,2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | | - | - | M |

| Duration (hour) | | Introduction To Neurons And Nervous Systems | Neuro-Transmission And Neuro-Transmitters | Neural Imaging Techniques | Neural stimulation and Neural modeling | Neuro-Prosthetics |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Brain anatomy | Nervous system | Brain Computer Interface | Sensory prosthetics | Deep brain stimulation |
| | SLO-2 | Structure of neurons | Nervous system | History of BCI | Retinal prosthetics | Deep brain stimulation |
| S-2 | SLO-1 | Function of neurons | Central nervous system | Components of a BCI System | Visual prosthetics | Spinal cord stimulation |
| | SLO-2 | Types of neurons | Peripheral nervous system | Functional Components | Bionic eye | Spinal cord stimulation |
| S-3 | SLO-1 | Neuroglia | Neurotransmission | Feedback | Bionic eye | Cortical stimulation |
| | SLO-2 | Myelinated and unmyelinated nerve fibers | Stages in neurotransmission | Signal Acquisition | Auditory prosthetics | Cortical stimulation |
| S-4 | SLO-1 | Properties of nerve fibres | Synaptic transmission | Invasive Techniques | Cochlear implant | Transcranial direct current stimulation |
| | SLO-2 | Excitability, conductivity, all-or none law, accommodation, adaptation, summation, refractory period, indefatiguability | Synaptic transmission | Noninvasive Techniques | Cochlear implant | Transcranial direct current stimulation |
| S-5 | SLO-1 | Synapse | Chemical synaptic transmission | Feature Extraction and Translation Techniques | Bionic ear | Single neuron model |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Glial cells* | *Chemical synaptic transmission* | *Types of BCI Signals* | *Bionic ear* | *Single neuron model* |
| **S-6** | **SLO-1** | *Myelination* | *Electrical synaptic transmission* | *Training of BCI signals* | *Spinal cord stimulator* | *Hodgkin Huxley neuron model* |
| | **SLO-2** | *Neuronal differentiation* | *Electrical synaptic transmission* | *Signal Processing and Feature Extraction* | *Motor prosthetics* | *Hodgkin Huxley neuron model* |
| **S-7** | **SLO-1** | *Characterization of neuronal cells* | *Neurotransmitters and their release* | *BCI development* | *Bladder control implant* | *Fitzhugh Nagumo models* |
| | **SLO-2** | *Characterization of neuronal cells* | *Neurotransmitters and their release* | *Electroencephalography (EEG)* | *Bladder control implant* | *Fitzhugh Nagumo models* |
| **S-8** | **SLO-1** | *Blood Brain barrier* | *Types of neurotransmitters* | *Principle and working of EEG* | *Sacral anterior root stimulator* | *Morris lecar model* |
| | **SLO-2** | *Blood Brain barrier* | *Types of neurotransmitters* | *Computerized axial tomography (CAT) scans in brain imaging* | *Sacral anterior root stimulator* | *Morris lecar model* |
| **S-9** | **SLO-1** | *Meninges* | *Fast and slow neurotransmission* | *Functional Magnetic Resonance Imaging (fMRI)* | *Prosthetics for conscious control of movements* | *Hind marsh rose model* |
| | **SLO-2** | *Cerebrospinal fluid* | *Fast and slow neurotransmission* | *Functional Magnetic Resonance Imaging (fMRI)* | *Prosthetics for conscious control of movements* | *Hind marsh rose model* |

| | | |
|---|---|---|
| **Learning Resources** | 1. **Bin He, Neural Engineering, Plenum Publishers, 2005.**<br>**2.R.S.Khandpur, Handbook of Biomedical Instrumentation, Mc Graw Hill, 3rd Edition, 2015.** | |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *Dr.A.K.Jayanthy* |

| Course Code | 18BME372T | Course Name | IOT AND TELEHEALTH TECHNOLOGY | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the building blocks of IoT |
| CLR-2 : | Understand the technologies in IoT |
| CLR-3 : | Gain knowledge in system management in wearable devices |
| CLR-4 : | Explore the architecture of smart healthcare systems |
| CLR-5 : | Gain knowledge in basics of tele-health technology and architecture involved |
| CLR-6 : | Gain knowledge in architecture of IoT systems and its applications in healthcare |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 | |
| CLO-1 : | Explain the various models and protocols in IoT | 1, 2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - | |
| CLO-2 : | Demonstrate the various technologies for building IOT | 2 | 80% | 70% | | - | - | L | - | - | - | - | - | - | - | - | M | - | - | |
| CLO-3 : | Explain the IoT system management and its applications | 2 | 80% | 70% | | - | - | L | - | - | - | - | - | - | - | - | M | - | - | |
| CLO-4 : | Apply the techniques in Realtime healthcare applications | 3 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - | |
| CLO-5 : | Explain the architecture in tele health technology | 3 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - | |
| CLO-6 : | Demonstrate the IoT system architecture for healthcare applications | 3 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - | |

| | | Building blocks of IoT | IoT Enabling Technologies | Machine-to-Machine and system management | Smart healthcare applications | Telehealth Technology |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Characteristics of IoT | Wireless sensor network | Smart healthcare | Real time smart healthcare model using IoT | Mobile application for medical diagnosis |
| | SLO-2 | Physical design of IoT | Cloud computing | Distributed Analytics and Edge Intelligence | Sensor modules | Architecture of the program, design of the modules |
| S-2 | SLO-1 | IoT protocols | Big data analytics | Smart Healthcare Use Cases and Applications | Model Architecture | Telecardiology to detect cardiac abnormalities |
| | SLO-2 | IoT devices | Communication protocols | Healthcare Monitoring | Wearable smart health management clothing | Telecommunications, Wearable device for ECG monitoring |
| S-3 | SLO-1 | Network/internet layer | Embedded systems | Wearable Devices | Data acquiring | Virtual clinic – a telemedicine framework |
| | SLO-2 | Transport layer, | Key components | architecture of wearable devices in health care | Training and testing, accuracy prediction | System model |
| S-4 | SLO-1 | Application layer | IoT levels and deployment templates | Pulse Rate Monitoring System | Fog based Real time analytics | Research methodology |
| | SLO-2 | Layer protocols | System components | Smart Glove for Paralyzed Patients | IoT analytics | Proposed clinical decision support systems |
| S-5 | SLO-1 | Logical design of IoT | IoT level - 1 | Automatic Medicine Dispenser | Data gathering and Consumptions | Personalized Telehealth care |
| | SLO-2 | IoT functional blocks | IoT level - 2 | Smart Healthcare Applications and Real-Time Analytics Through Edge Computing q | Protocols used for IoT platform | Categories based tele-based services |
| S-6 | SLO-1 | Communication models | IoT level - 3 | Comparison cloud, fog and edge computing | Real-Time Stream Processing | Telediagnosis |
| | SLO-2 | Request response model | Applications | Edge Computing and Healthcare Systems | Fog Computing | Machine learning approach for telediagnosis |
| S-7 | SLO-1 | Publish subscribe model | IoT Level – 4 | Edge Computing General Framework | Fog computing architecture | Architecture of Mobile Telemedicine System using MMS for telediagnosis |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Push pull model, Exclusive pair model* | *IoT Level – 5* | *Edge Computing Use Cases* | *Characteristics of fog computing* | *Teleconsultation, Telenursing* |
| **S-8** | **SLO-1** | *IoT communication Apls* | *IoT Level – 6* | *Edge Computing for Real-Time Analysis* | *Comparison of fog, cloud, and edge* | *Teletreatment and Telerehabilitation* |
| | **SLO-2** | *Rest based communication APIs* | *Applications* | *Serverless Framework for Real-Time Analysis* | *Role of Fog Computing in Healthcare* | *Tele-Psychiatry* |
| **S-9** | **SLO-1** | *Request response model used by REST* | *Wellness monitoring and diagnosis* | *Real-Time Map-Reduce Framework Using Edge* | *Deployment of Healthcare Applications* | *Ethical Challenges, Telemedicine Authorization* |
| | **SLO-2** | *WebSocket based communication APIs* | *Wearable electronics* | *Challenges for IoT-based Edge computing and deployment* | *Case Study: A Real-Time Fog Healthcare Scenario, Patient monitoring system* | *Challenges to Tele-Based Healthcare* |

| | | |
|---|---|---|
| *Learning Resources* | *1. Arshdeep Bahga, Vijay Madisetti ," Internet of things-Hands on approach"VPT Edition 1, 2014.*<br>*2. Pethuru Raj, Jyotir Moy Chatterjee, Abhishek Kumar, B. Balamurugan. "Internet of Things Use Cases for the Healthcare Industry" Springer, 2020* | *3. Rajkumar Buyya, Amir Vahid Dastjerdi, "Internet of Things: Principles and Paradigms" ,Elsevier, 2016.*<br>*4. Hemanth D. Jude, Valentina Emilia Balas, "Telemedicine Technologies: Big Data, Deep Learning, Robotics, Mobile and Remote Applications for Global Healthcare", Academic Press, 2019* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

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**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr. T.Jayanthi, SRMIST* |

| Course Code | 18BME373T | Course Name | MICRO FLUIDICS | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-Requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the basic concepts o the microfludic and nanofluidic | | | |
| CLR-2 : | Get an idea about the Interfaces in Microfluidic and Nanofluidic Systems | | | |
| CLR-3 : | Acquire an idea about the materials and various fabrication methods and techniques | | | |
| CLR-4 : | Get an idea about the fluidic control methods and detection methods | | | |
| CLR-5 : | Get an idea about the application of various microfludic and nanofluidic in biological system | | | |
| CLR-6 : | Get an overall idea about the microfluidic and nanofluidic system importance in Medical Domain | | | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | | | | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Understanding of the fundamental of the microfluidic and nanofluidic | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Analyze the various interfaces with surface and devices | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Describes about the techniques and methods with materials used for fabrication of micofluidic and nanofluidic structures | 2 | 80 | 70 | - | M | - | - | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | Overview of problem for control and detection 's of fluid interaction and techniques used for solving | 1 | 80 | 70 | - | - | H | - | - | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Outline the importance of microfluidic and nanofluidic in biological application | 1 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | M | - | - | - |
| CLO-6 : | | | | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Duration (hour) | | Basic Microfludic concepts | Materials and fabrication Processes for Microfluidic | Fluidic control methods and Detection methods | Microdevice Technologies | Applications to Biological System |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Introduction to Microfluidics | Materials for Microfluidic Devices | Fluid Control :Basic theory | Actuators for micropumps | Electrophoresis:DNA separation |
| | SLO-2 | Introduction to Microfluidics | Silicon Based Materials | Pressure –Driven Flow | Actuators for micropumps | Case study :DNA separation |
| S-2 | SLO-1 | The microfluidic advantage | Glass Based Materials | Shear driven Flow | Actuators for Microvalves | Shear-driven flow: Biomolecular separation |
| | SLO-2 | Fluidics and Transport Fundamentals: The continuum approximation | Polymers Based Material | Shear driven flow examples | Actuators for Microvalves | Case study : Biomolecular separation |
| S-3 | SLO-1 | Laminar flow | Fabrication of Microfluidics devices | Electrokinetically –driven flow | Flow sensors | Ion Transport with case study |
| | SLO-2 | Laminar flow(contd.) | Photolithography & its techniques | Electrokinetically –driven flow problem and examples | Microarrays | Concentration with case study |
| S-4 | SLO-1 | Diffusion in microfluidic systems | Additive Techniques | Single Molecule Detection Methods | Microarrays | Bioanalysis:Immunoassay |
| | SLO-2 | Diffusion in microfluidic systems(contd.) | Subtractive Techniques | Optical detection methods | Microreactors | DNA analysis |
| S-5 | SLO-1 | Surface forces and droplets | Silicon microfabrication | Optical detection methods examples | Microreactors | On-chip separations and combinations |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Surface forces and droplets(contd.)* | *(Dry Reactive Ion Etching) DRIE* | *Electrochemical method* | *Pipettes and Dispensers* | *Sample injection and separation* |
| **S-6** | **SLO-1** | *Pumps and valves* | *Surface micromachining* | *Electrochemical method examples* | *Pipettes and Dispensers* | *Micro-gas chromatography:* |
| | **SLO-2** | *Pumps and valves(contd.)* | *Glass Microfabrication – wet isotropic etching* | *Measurement of Fluidic Properties: Nonintrusive flow measurement techniques* | *Microanalytical Chips* | *Micro gas sensors for micro GC* |
| **S-7** | **SLO-1** | *Electrokinetics* | *Wafer Bonding – Fusion, Anionic and Adhesive* | *Streaming potential/current measurement in pressure-driven flows* | *Microanalytical Chips* | *Case study for a micro GC* |
| | **SLO-2** | *Electrokinetics(contd.)* | *Polymer microfabrication* | *Current monitoring in electroosmotic flow* | *Electrochemical microfluidics devices* | *Micro-scale impedance measurements* |
| **S-8** | **SLO-1** | *Electro-osmosis* | *Injection molding and Hot embossing* | *Optical flow imaging techniques using a tracer: Properties of flow tracers* | *Electrochemical microfluidics devices(contd.)* | *Biosensor* |
| | **SLO-2** | *Electro-osmosis(contd.)* | *Casting & Lithography* | *Scalar image velocimetry* | *Paper Microfluidics devices* | *Biosensors: Case study 1* |
| **S-9** | **SLO-1** | *Electrophoresis* | *Fabrication of microfluidic channels in SU-8* | *Scalar image velocimetry* | *3D Printed Microfluidic Devices* | *Nano- Biosensors* |
| | **SLO-2** | *Dielectrophoresis* | *Microfluidic networks created in biodegradable materials.* | *Laser-induced fluorescence photo bleaching anemometer with stimulated emission depletion* | *3D Printed Microfluidic Devices(contd.)* | *Nano-Biosensors: Case study 2* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Patric Tabeling "Introduction to Microfluids" Oxford U. Press, New York 2005.*<br>*2. Yujun Song, Daojian Cheng& Liang Zhao," Microfluidics: Fundamentals, Devices, and Applications", Wiley-VCH,First edition ,2018*<br>*3.* Xiujun (James) Li and Yu Zhou," Microfluidic devices for biomedical applications", Woodhead Publishing Limited,16th edition,2013.<br>4.Jeffrey D. Zahn," Methods in Bioengineering -Biomicrofabrication and Biomicrofluidics",Artech House ,1st edition,2010 | *5. Wei-Cheng Tian, Erin Finehout," Microfluidics for Biological Applications"Springer,2008*<br>*6. Nam-Trung Nguyen, Steven T. Wereley,"Fundamentals And Applications of Microfluidics, Artech Print on Demand,Second Edition,2006*<br>*7. Sushanta K. Mitra, Suman Chakraborty "Microfluidics and Nanofluidics Handbook: Fabrication, Implementation, and Applications", CRC Press; 1 edition, 2017.*<br>8. *Jan Korvink, Oliver Haber,"MEMS: A Practical Guide to Design, Analysis, and Applications",Springer,2006*<br>9.Chandra K. Dixit, Ajeet Kaushik," Microfluidics for Biologists: Fundamentals and Applications",Springer,2016 |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Ms. Oinam Robita Chanu* |

| Course Code | 18BME374T | Course Name | MEDICAL ETHICS AND INTELLECTUAL PROPERTY RIGHTS | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the fundamentals of medical ethics | | | |
| CLR-2 : | Get an idea about the codes of medical ethics | | | |
| CLR-3 : | Acquire an idea about intellectual property rights | | | |
| CLR-4 : | Get an idea about patents | | | |
| CLR-5 : | Get an idea about copyrights | | | |
| CLR-6 : | Get an overall idea about trademarks and geographical indicators | | | |

**Course Learning Outcomes (CLO):** *At the end of this course, learners will be able to:*

| | | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Outline the importance of medical ethics | 1, 2 | 80 | 70 | - | - | - | - | - | - | - | H | - | - | - | M | - | - | - |
| CLO-2 : | Analyze the development of IPR | 1, 2 | 80 | 70 | - | - | - | - | - | M | - | - | - | - | - | M | M | - | - |
| CLO-3 : | Understand the principle of various agreements | 2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | M | M | | - |
| CLO-4 : | Outline the importance of patents | 1 | 80 | 70 | - | - | - | - | - | M | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Understand the importance of copyrights | 1 | 80 | 70 | - | - | - | - | - | M | - | - | - | - | - | M | - | - | - |
| CLO-6 : | Understand the concept of trademarks and geographical indicators | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | M | - | - | - |

| Duration (hour) | | Medical Ethics | Introduction to Intellectual Property Rights | Patents | Copyrights | Trademarks and Geographical Indicators |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Definition and historic evolution of bioethics | Origin and development of IPR | Definition of patents | What is copyright | Trademark and purpose of a trademark |
| | SLO-2 | Codes and guidelines, universal principles | History of IPR | Purpose of a patent | Why copyright | Characteristics of trademark |
| S-2 | SLO-1 | Medical ethics:some basic issues | Importance and need for protection of intellectual property | What sort of things can be patented, Patentable and non-patentable inventions, | Literature and artistic works | Functions of trademarks |
| | SLO-2 | Medical ethics:some basic issues | Rights to be given | Conditions for an invention to be patentable | Protection of copyright | Guidelines for the registration of a trademark |
| S-3 | SLO-1 | Teaching and learning medical ethics | Patentable subject matter | Invention vs Innovation | Right of reproduction | Nontraditional trademarks |
| | SLO-2 | Teaching and learning medical ethics | Emerging trends and issues in IPR | Process Patent | Right of public performance | Major types of trademarks |
| S-4 | SLO-1 | Codes of conduct | Creativity and Invention | Product Patent | Right of broadcasting | Protection of a trademark |
| | SLO-2 | Codes of conduct | Theories on concept of property | Types of patent applications | Right of translation | Purpose of a trademark |
| S-5 | SLO-1 | Rights of patients | Public Vs. Private | Precautions while patenting | Right of Adaptation | Madrid system for the International registration of trademarks |
| | SLO-2 | Rights of patients | Tangible Vs. Intangible Industrial Vs. Intellectual | Patent specification | Transfer of copyright | Madrid system for the International registration of trademarks |

| | | | | | | |
|---|---|---|---|---|---|---|
| S-6 | SLO-1 | *Rights of life* | *World Intellectual Property Organization(WIPO)* | *Patent claims* | *Limitations of copyright* | *Industrial design* |
| | SLO-2 | *Rights of life* | *World Trade Organisation (WTO)* | *Disclosures and non-disclosures* | *Enforcement of Rights* | *Purpose of industrial design* |
| S-7 | SLO-1 | *Malpractice* | *General Agreement on Tariffs and Trade(GATT ) agreement* | *Patent rights and infringement* | *International conventions and treaties* | *Protection of industrial design* |
| | SLO-2 | *Negligence* | *Major Conventions on IP* | *Patent rights and infringement* | *International conventions and treaties* | *The Hague agreement* |
| S-8 | SLO-1 | *Care of the terminally ill* | *Berne Convention* | *Rights of a patent owner* | *Benefits from copyright protection* | *Geographical indication* |
| | SLO-2 | *Distributive Justice in Health Care* | *Paris Convention* | *Patent cooperation treaty* | *Benefits from copyright protection* | *Appellation of origin* |
| S-9 | SLO-1 | *Human experimentation* | *TRIPS agreement* | *Paris convention for the protection of industrial property* | *Works that are protected by copyright* | *Protection of geographical indication(GI)* |
| | SLO-2 | *Clinical trials* | *Basic forms of intellectual property rights* | *Importance, advantages and disdvantages of patents* | *Works that are not protected by copyright* | *Difference between a GI and a trademark* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Ramakrishna B and Anil Kumar H S, 'Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers', Notion Press, 2017.*<br>2. *C M Francis, Medical Ethics, Second Edition, Jaypee Brothers, 2004.* | 3. *Chawla H S, Introduction To Intellectual Property Rights, Oxford and IBH Publishing, 2020.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *Dr.A.K.Jayanthy* |

| Course Code | 18BME375T | Course Name | Virtual Instrumentation for Biomedical Engineers | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the fundamental Virtual Instrumentation | | | |
| CLR-2 : | Get an idea about the software used in Virtual Instrumentation and function | | | |
| CLR-3 : | Acquire a concept about the VI programming | | | |
| CLR-4 : | Get an idea about the biomedical application of Virtual Instrument | | | |
| CLR-5 : | Get an idea about the research based development in the area of Virtual Instrument | | | |
| CLR-6 : | Understand the different biological application of LabVIEW | | | |

**Program Learning Outcomes (PLO)**

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | 1 Engineering Knowledge | 2 Problem Analysis | 3 Design & Development | 4 Analysis, Design, Research | 5 Modern Tool Usage | 6 Society & Culture | 7 Environment & Sustainability | 8 Ethics | 9 Individual & Team Work | 10 Communication | 11 Project Mgt. & Finance | 12 Life Long Learning | 13 PSO - 1 | 14 PSO - 2 | 15 PSO – 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | Analyze the Virtual Instrument in healthcare domain | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Explain the Virtual Instrument processes and software | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Differentiate the various Programming techniques | 2 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | Illustrate the concepts of LabVIEW in Real time experimental | 1 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | - | - | M | - |
| CLO-5 : | Illustrate the concepts of LabVIEW with suitable examples | 1 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-6 : | Outline the research application in Biological | 1,2 | 80 | 70 | - | - | L | - | - | - | - | - | - | - | - | - | - | - | - |

| Duration (hour) | | Virtual Instrumentation | PROGRAMMING MODE& TECHNIQUES | HARDWARE INSTRUMENT | COMMON INSTRUMENT INTERFACE | LABVIEWS TOOLS & ITS APPLICATIONS |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Virtual Instrumentation - *Introduction* | Data Flow Programming | Digital I/O Techniques | General Purpose Interface Bus(GPIB) | *Signal Process:* Fourier transform |
| | SLO-2 | Conventional Instrumentation | G' Programming Concepts | Digital I/O Techniques | GPIB :IEEE 488.2 STANDARD | Fourier transform problem |
| S-2 | SLO-1 | Architecture of VI | Creating and Saving VIs, SubVIs | Data Acquisition in LabVIEW | RS232 | Power spectrum |
| | SLO-2 | Architecture of VI | Wiring, Editing, and Debugging VI | Data Acquisition in LabVIEW | RS485 | Correlation |
| S-3 | SLO-1 | Conventional Virtual Instrumentation | Control Structures such as the For Loop and the While Loop | Hardware Installation and Configuration | Virtual Instrument Software Architecture(VISA) | Windowing |
| | SLO-2 | Distributed Virtual Instrumentation | Shift Registers and Their function | Components of DAQ | VXI | Filters |
| S-4 | SLO-1 | Virtual Instruments Versus Traditional Instruments | Selection Structures: Case and sequence structures | Components of DAQ | VXI | Oscilloscope |
| | SLO-2 | Advantages of VI | Selection Structures: Formulae nodes, feedback nodes | DAQ Signal Accessory | USB | Waveform generator |
| S-5 | SLO-1 | Evolution of LabVIEW | Arrays | DAQ Signal Accessory | USB | Multi-channel data acquisition |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | Creating Virtual Instruments Using LabVIEW | Arrays | DAQ Assistant: Create a MAX-Based Task | PCI | *Vision and Motion tools* |
| **S-6** | **SLO-1** | Creating Virtual Instruments Using LabVIEW | Cluster :Creating Cluster Controls and Indicator | DAQ Assistant: Create a Project-Based Task | PCI Express | *Vision and Motion tools- problems* |
| | **SLO-2** | Advantages of LabVIEW | Cluster functions | DAQ Hardware | PXI | *Vision and Motion tools -problems* |
| **S-7** | **SLO-1** | Front Panel of Virtual Instruments | Waveform Chart and graph | DAQ Hardware | PCMCIA | Bio Bench |
| | **SLO-2** | Block Diagram of Virtual Instruments | XY Graph | DAQ Software | PCMCIA | Biomedical work bench |
| **S-8** | **SLO-1** | LabVIEW Environment and its Menus | Strings, Creating String Controls and Indicators | 4–20mA Current Loop | SCXI | *Biomedical real time application- ECG* |
| | **SLO-2** | LabVIEW Environment and its Menus | String Functions | 4–20mA Current Loop | SCXI | *Biomedical real time application-EMG* |
| **S-9** | **SLO-1** | Palletes of LabVIEW | Tables and List Boxes | 60 mA Current Loop | LXI | *Biomedical real time application-EEG* |
| | **SLO-2** | Palletes of LabVIEW | File Input/Output Functions | 60 mA Current Loop | LXI | *Biomedical real time application-EOG* |

| | | |
|---|---|---|
| **Learning Resources** | *1. S. Sumathi and P. Surekha, "Labview based Advanced Instrumentation Systems ", Springer, First edition, 2007*<br>*2. Gary Jonson, "Labview Graphical Programming", Second Edition, McGraw Hill, New York, Fourth edition 2006.*<br>*3. Lisa K. wells and Jeffrey Travis, "Labview for everyone", Prentice Hall Inc., New Jersey;First edition 1997.*<br>*4. Gupta S and Gupta J P, "PC interfacing for Data Acquisition & Process Control", Instrument Society of America, Second Edition, 1994* | *5. Jon B. Olansen and Eric Rosow, "Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in LabVIEW ",Prentice Hall,First edition, 2001*<br>*6.* Ronald W. Larsen ,"LabVIEW for Engineers", Pearson ,First edition, 2010<br>*7. Robert H. Bishop," Learning with LabVIEW" , Pearson, First edition, 2014*<br>*8. John Essick ," Hands-On Introduction to LabVIEW for Scientists and Engineers ",Oxford University Press, Fourth edition ,2018* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Ms Oinam Robita Chanu, SRMIST* |

| Course Code | 18BME461T | Course Name | BIOMEDICAL INFORMATICS | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Electronics and Communication Engineering with specialization in Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand what is medical informatics, The types of medical databases and carious theft issues |
| CLR-2 : | Gain knowledge about the structure of Hospital information system, clinical Information system |
| CLR-3 : | Understand the telemedicine technology, and types of data transfer |
| CLR-4 : | Gain knowledge in an automation of clinical laboratories |
| CLR-5 : | Learn different decision making algorithms and computerized imaging techniques |
| CLR-6 : | The learn different types of computer aids for handicapped and computers in the care of critically ill patients |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Understand applications of computers in health care and different types of medical databases | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Implement Hospital Information system and Clinical Information system | 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-3 : | Gain knowledge on telemedicine technology | 2 | 80% | 70% | | | M | | M | | | | | | | | M | | L |
| CLO-4 : | Implement automation of clinical laboratories | 3 | 80% | 70% | | | | | M | | | | | | | | | | |
| CLO-5 : | Apply different decision making algorithm for imaging and diagnosis | 3 | 80% | 70% | M | | | | | | | | | | | | M | | L |
| CLO-6 : | Gain knowledge on various computer aids for handicapped and computers role in care of critically ill patients | 3 | 80% | 70% | M | | | | | | | | | | | | | | |

| | | Medical informatics and Computer based patient record | Hospital Information system and Clinical information system, Telemedicine | Computers in a Clinical Laboratory | Computer assisted medical Decision making | Computer aids for the handicapped & Computers in the care of critically ill patients |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | What is Medical Informatics? | Functional capabilities of computerized Hospital information system | Microprocessor for automation | General model of CMD | Mobility, EMG controlled limbs |
| | SLO-2 | Prospects of medical informatics | Need for computerization oh hospitals in India | Database approach to laboratory computerization | Various approaches in decision making | Aids for Blind and visually handicapped |
| S-2 | SLO-1 | Historical review of the development of computers and informatics | Security of computer records | Automation of clinical laboratories | Computer assisted decision support systems | Braille system, bat cane |
| | SLO-2 | Foundation ontology | Cost effectiveness of information processing by computer | Automated methods in hematology | Algorithmic methods | Portable reading aids |
| S-3 | SLO-1 | What is computer based patient record | Benefits of clinical information system | Chromosome analysis by computer | Elements of a protocol | Artificial vision for the blind |
| | SLO-2 | History taking by computer and Dialogue with the computer | Sources of data for decision making | Computerized cytology and histology | Probabilistic approaches to decision making | Concept of artificial retina |
| S-4 | SLO-1 | Development tools Intranet | Modes of decision output to Physician | Automated scanning for cervical scanner | Sequential Bayes, Linear discriminant function | Computer aids for the deaf |
| | SLO-2 | CPR in radiology | Registry of Computerized Medical record system | Computer assisted semen analysis | Multivariate analysis | Computer speech generation and recognition |
| S-5 | SLO-1 | Types of databases: Bibliographic databases | CIS in obstetrics – Gynecology | Radio Immunoassays | Database comparisons and case based reasoning | Robotics to assist the elderly infirm |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Non Bibliographic databases* | *Fetal Monitoring* | *Intelligent laboratory information system* | *Production rule systems* | *Cognitive system engineering* |
| S-6 | **SLO-1** | *Medical information retrieval* | *What is telemedicine* | *Computer aided analysis of Echocardiograms* | *Cognitive models* | *Automated computer assisted Fluid and metabolic balance* |
| | **SLO-2** | *Medical information retrieval techniques* | *Need for telemedicine* | *Computerized ECG, analysis of signals* | *Semantic networks* | *Pulmonary function Evaluation* |
| S-7 | **SLO-1** | *Legal, Security and privacy issues in computers and internet* | *Telemedicine technology* | *Assessment of performance of ECG computer programs* | *Decision analysis in clinical medicine* | *Computerized decision support for mechanical ventilation* |
| | **SLO-2** | *Types of threats* | *Types of data transfer* | *Computerized EEG* | *Computers in nuclear medicine* | *Cardiovascular physiological evaluation* |
| S-8 | **SLO-1** | *Cryptography* | *Mode of transmission* | *Long term monitoring of EEG* | *Data acquisition, manipulation and processing* | *Computer assisted surgery* |
| | **SLO-2** | *Digital Signature* | *Internet and telemedicine* | *Computerized EMG* | *Computer assisted medical imaging-CT* | *Robotics in surgery* |
| S-9 | **SLO-1** | *User Authentication* | *Telemedicine websites* | *Single fibre EMG* | *CT-Radiation therapy planning* | *Sensing system* |
| | **SLO-2** | *Attacks from inside and outside the system* | *Applications of telemedicine* | *Computerized EEG* | *Computer for MRI* | *Interactive modes* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Ramchandra Lele., "Computers in Medicine Progress in Medical Informatics", Tata McGraw-Hill Publishing Company Limited, New Delhi First Edition, 2005*<br>2. *Mohan Bansal, M S., "Medical Informatics A Primer", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2nd edition 2003.* | 3. *Edward H.Shortliffe, James J. Climino., "Biomedical informatics Computer Applications in Health Care and Biomedicine", Springer, Third Edition, 2006.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1., Dr. S. P. Angeline Kirubha, SRMIST* |

| Course Code | 18BME462T | Course Name | PHYSIOLOGICAL MODELING | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | 18BMC305T Biocontrol Systems | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the process of modeling to various physiological systems |
| CLR-2 : | Understand the mathematical tools for static analysis of models |
| CLR-3 : | Perform time domain analysis of the physiological models |
| CLR-4 : | Perform frequency domain analysis of the physiological models |
| CLR-5 : | Understand techniques in system identification and parameter estimation |
| CLR-6 : | Understand the techniques in designing physiological system models and to perform analysis |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Explain the different techniques in designing physiological model | 1,2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-2 : | Detail about the tools for static analysis of physiological system | 1,2 | 80% | 70% | - | M | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Describe the techniques for time domain analysis of physiological model | 1,2 | 80% | 70% | - | M | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-4 : | Describe the techniques for frequency domain analysis of the physiological models | 1,2 | 80% | 70% | - | M | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-5 : | Outline the various methods for system identification and parameter estimation | 1,2 | 80% | 70% | - | M | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-6 : | Interpret the various physiological system models | 1,2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |

| Duration (hour) | | Linear Model | Static Analysis | Time Domain Analysis | Frequency Domain Analysis | System Identification |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Introduction to modeling methodology, need for models, approaches to modeling | Static analysis: Open loop versus closed loop | Introduction to time domain analysis | Frequency response: Open loop frequency response | Identification of physiological control system |
| | SLO-2 | Model identification, model validation and Simulation | Loop gain calculation: Room temperature control | Linearized respiratory mechanics transient response | Closed loop frequency response | Basic problems in Physiological system analysis |
| S-2 | SLO-1 | System analysis, fundamental concepts | Steady state characteristics | Linearized respiratory mechanics first order model – impulse response for open loop | Relation between transient and frequency response | Nonparametric and parametric identification methods |
| | SLO-2 | Physiological control system an example | Determination of steady state operating point for simple model of muscle stretch reflex | Linearized respiratory mechanics first order model – impulse response for closed loop | Frequency domain specifications | Numerical Deconvolution, Least square estimation |
| S-3 | SLO-1 | Engineering control system versus physiological control system | Human body Glucose – Insulin regulatory system | Transient response descriptors : Impulse response | Graphical representation of frequency response: Bode plot | Estimation using correlation functions |
| | SLO-2 | Science of modeling | Steady state analysis of glucose –insulin model | Transient response descriptors : Step response | Bode plot :Linearized lung mechanics | Estimation in frequency domain, optimization techniques |
| S-4 | SLO-1 | Generalized system properties | Human body chemical regulation of ventilatory system | Concept of sliding theory | Graphical representation of frequency response: Nicholas chart | Problems in parameter estimation |
| | SLO-2 | Models with combinations of system elements | Mechanism of respiration | Neuromuscular reflex action | Nicholas chart : Linearized lung mechanics | Input design |
| S-5 | SLO-1 | Linear model of respiratory mechanics | Gas exchanger mathematical modeling | Mathematical model of neuromuscular reflex motion | Graphical representation of frequency response : Nyquist plot | Identification of closed loop systems – "opening the loop" |
| | SLO-2 | Linear model of respiratory mechanics: Derivation of transfer function | Respiratory controller mathematical modeling | Calculation of transfer function | Nyquist plot: Linearized lung mechanics | Starling heart- lung preparation |
| S-6 | SLO-1 | Linear model of muscle mechanics | Closed loop analysis : lung and controller | Stability and transient response | Introduction : Circulatory system | Kao's cross – circulation experiment |
| | SLO-2 | Linear model of muscle mechanics: Derivation of transfer function | Calculation of transfer function | Root locus and Routh-Hurwitz stability criterion | Mathematical model of circulatory system | Opening the Pupillary reflex loop |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-7** | **SLO-1** | *Distributed versus lumped parameter model* | *Heart and systemic circulation* | *Stability analysis: root locus method* | *Frequency response of circulatory system* | *Read rebreathing technique* |
| | **SLO-2** | *Distributed versus lumped parameter model: Derivation of transfer function* | *Mathematical modeling of cardiac output* | *Introduction to Nyquist plot* | *Graphical representation for frequency response of circulatory system* | *Adaptive control of Physiological variables* |
| **S-8** | **SLO-1** | *Linear system and superposition principle* | *Calculation of transfer function for simplified model of cardiac output regulation* | *Nyquist criterion for stability* | *Frequency response of glucose – insulin model* | *General adaptive control system* |
| | **SLO-2** | *Laplace transform and transfer function* | *Cardiac characteristics curve analysis* | *Relative stability theory* | *Mathematical model and simulation of glucose – insulin model* | *Multiple model adaptive control* |
| **S-9** | **SLO-1** | *Impulse function analysis* | *Venous return curve* | *Physiology: Pupillary reflex control* | *Frequency response approach to pupil control* | *Model reference adaptive control* |
| | **SLO-2** | *Basics of Linear convolution* | *Closed loop analysis of heart and systemic circulation* | *Stability analysis of pupillary reflex control* | *Frequency response characteristics curve for pupillary control* | *Optimization in systems with negative feedback* |

| | | |
|---|---|---|
| **Learning Resources** | 1. Michael C.K. Khoo, "*Physiological Control Systems - Analysis, Simulation and Estimation*", Prentice Hall of India Private Ltd., 2nd edition, New Delhi, 2001. | 2. V.Z. Marmarelis, *"Advanced Methods of Physiological System Modeling"*, Vol.3, Springer Science and Business Media, 2013. |
| | 3. Claudio Cobelli Ewart Carson, , "*Introduction to Modeling in Physiology and Medicine*", Academic press series, 1st edition, 2008. | 4. Johnny T. Ottesen, Mette S. Olufsen, Jesper K. Larsen, "*Applied Mathematical Models in Human Physiology",* Vol.9,SIAM, 2004. |
| | 5. Dorf, "*Modern Control Systems*", Pearson Education India, 1st edition, 2008. | |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *30 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr. T.Jayanthi, SRMIST* |

| Course Code | 18BME463T | Course Name | BIOMIMETICS | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the fundamentals of biomimetics and its applications | | | |
| CLR-2 : | Study the concepts of biomimetic materials and process | | | |
| CLR-3 : | Acquire an idea about the mechanism of cognition and open ended design automation | | | |
| CLR-4 : | Utilize the basic concepts of bio-inspired sensors and actuators | | | |
| CLR-5 : | Employ the skills about the biomimetics of human motion | | | |
| CLR-6 : | Get an overall idea about the application of biomimetic technologies | | | |

**Course Learning Outcomes (CLO):** *At the end of this course, learners will be able to:*

| | | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Apply the basic mechanism in biomimetic design in various applications | 1, 2 | 80 | 70 | L | L | - | - | - | - | - | - | - | - | - | - | L | M | - |
| CLO-2 : | Identify the basic biologically inspired mechanism, materials and process | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | L | - | - |
| CLO-3 : | Identify the mechanism of cognition and open ended design automation | 2 | 75 | 65 | - | L | L | - | - | - | - | - | - | - | - | - | L | | - |
| CLO-4 : | Analyze the importance bio-inspired sensors and biomimetic actuators | 1,2 | 75 | 65 | - | - | M | - | | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Analyze the biomechanics and rhythmics of motion | 2,3 | 75 | 65 | L | M | L | - | - | - | - | - | - | - | - | M | - | L | M |
| CLO-6 : | Outline the application of biomimetic technologies | 1,2 | 75 | 65 | - | L | - | L | - | - | - | - | - | - | - | M | - | -M | - |

| Duration (hour) | | Introduction to Biomimetics | *Mechanism of cognition and open ended design automation* | Bio-Inspired Sensors and Biomimetic Actuators | Biomimetics of motion | Application of Biomimetic Technologies |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | *Introduction : Biologically Inspired Mechanisms* | ***Mechanized Cognition*** | *Biomimetic tactile sensing:Human sense of touch* | *Biomechanics of motion: Control center* | *Artificial intelligence through symbolic connectionism* |
| | SLO-2 | *Biologically Inspired Mechanisms* | *Training and Education* | *Biomimetic tactile sensing:Human sense of touch* | *Biomechanics of motion: Control center* | *Localist symbolic connectionism* |
| S-2 | SLO-1 | *Biologically Inspired Structures and Parts* | *Language Cognition* | *Biomimetic artificial touch* | *Passive external and internal actuation* | *Distributed symbolic connectionism* |
| | SLO-2 | *Defense and Attack Mechanisms in Biology* | *Language Cognition* | *Examples of bio-inspired tactile sensing* | *Active external and internal actuation* | *Symbolic connectionism in biological models* |
| S-3 | SLO-1 | *Materials and Processes in Biology* | *Sound Cognition* | *Bio-Inspired hair based interial sensors: Hair structures for inertial sensing* | *Agonist Mechanism: Hygroscopic mechanism* | *Neurofuzzy systems* |
| | SLO-2 | *Materials and Processes in Biology* | *Sound Cognition* | *Cricket-inspired accelerometer* | *Muscular actuation* | *Neurofuzzy systems* |
| S-4 | SLO-1 | *Bio-Sensors* | *Visual Cognition* | *Fly-inspired gyroscope* | *Antagonist mechanism: Spring Antagonism* | *Bio-Inspired adhesion technologies* |
| | SLO-2 | *Bio-Sensors* | *Visual Cognition* | *Fly-inspired gyroscope* | *Muscular Antagonism* | *Bio-Inspired adhesion technologies* |
| S-5 | SLO-1 | *Robotics Emulating Biology* | *Machine Bodies and Brains: Evolving Controllers and Some Aspects of the Morphology* | *Olfactory sensor system for the e-nose* | *Power amplification: Elastic amplification* | *Bio-Inspired locomotion mechanisms* |
| | SLO-2 | *Interfacing Biology and Machines* | *Evolving Bodies and Brains* | *Olfactory classification-data processing* | *Deformation of a constant volume* | *Size and current technologyconstrains* |
| S-6 | SLO-1 | *Muscle function* | *Morphology Representations: Tree representations* | *Polymer network actuators* | *Mechanics of hydrostatic systems: Single compartment systems* | *Quadruped robot system: Mechanical components* |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Muscle function* | *Developmental representations* | *Biomimetic vision systems* | *Multiple compartment systems* | *Quadruped robot system: Mechanical components* |
| **S-7** | **SLO-1** | *Muscle design* | *Regulatory network representations* | *Novel biomimetic materials :Introduction* | *Rhythmics of motion: Gait* | *Electrical components of quadruped robot* |
| | **SLO-2** | *Muscle design* | *Evolving Machines in Physical Reality* | *Design of self-oscillating polymer gel* | *Rhythmics of motion: Gait* | *Electrical components of quadruped robot* |
| **S-8** | **SLO-1** | *Muscle adaptation* | *Evolving Machines in Physical Reality* | *Control of self-Oscillating chemomechanical behaviors* | *Passive Locomotion* | *Biologically inspired antenna array design* |
| | **SLO-2** | *Biomimetics of muscle design* | *Economy of Design Automation* | *Design of biomimetic soft actuators* | *Passive locomotion* | *Biologically inspired antenna array design* |
| **S-9** | **SLO-1** | *Bio-inspired fiber composites* | *Principles of Design* | *Design of autonomous mass transport systems* | *Limbless locomotion* | *Biologically inspired antenna beam pattern design* |
| | **SLO-2** | *Bio-inspired fiber composites* | *Research Methodology* | *Self-oscillating fluids* | *Multiple limb locomotion* | *Biologically inspired antenna beam pattern design* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Yoseph Bar-Cohen, "BIOMIMETICS Biologically Inspired Technologies", CRC Press, 1 st Edition, 2006.*<br>*2. Trung Dung Ngo, "Biomimetic Technologies: Principles and Applications", Wood head Publishing Ltd, 1 st Edition, 2015.* | *3. Sandra Persiani, "Biomimetics of Motion: Nature-Inspired Parameters and Schemes for Kinetic Design", Springer, 1 st Edition, 2019.*<br>*4. P Gruber, D Bruckner, C Hellmich, · H B. Schmiedmayer, H. Stachelberger, I C. Gebeshuber, "Biomimetics – Materials,Structuresand ProcessesExamples, Ideas and Case Studies", Springer, 1 st Edition, 2011* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.D.Ashok kumar, SRMIST* |

| Course Code | 18BME464T | Course Name | NEURAL NETWORK AND GENETIC ALGORITHM | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Electronics and Communication Engineering with specialization in BioElectronics | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the fundamental of Artificial Neural Network | | | |
| CLR-2 : | Get an insight about various ANN model | | | |
| CLR-3 : | Familiarize about the principle of self-organizing map | | | |
| CLR-4 : | Study the basic concepts of Genetic algorithm | | | |
| CLR-5 : | Get an idea about genetic algorithm operators | | | |
| CLR-6 : | Explore on the concepts of ANN for Biomedical Application | | | |

**Course Learning Outcomes (CLO):** *At the end of this course, learners will be able to:*

| | | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Apply the concepts of Artificial neural network | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Implement the algorithm of various ANN | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Apply the concepts of Neural network based on competition | 2 | 80 | 70 | - | M | - | - | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | Outline the concepts of genetic algorithm | 1 | 80 | 70 | - | - | H | - | - | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Describe the genetic algorithm operators | 1 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | M | - | - | - |
| CLO-6 : | Implement the concepts of ANN for Biomedical applications | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | L | - | - | - |

| Duration (hour) | | Artificial neural network: An Overview | Artificial Neural network model | Neural network based on competition | Introduction to Genetic Algorithm | GA Operators and Biomedical Applications |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Basics of Artificial Neural network | Feed forward networks | Kohonen SOM : Architecture | Biological Background | Genetic operators: |
| | SLO-2 | Basics of Artificial Neural network | Feed forward networks | Algorithm | Genetic algorithm world | Reproduction, Crossover |
| S-2 | SLO-1 | Biological neuron, Properties | Back propagation network- structure | Learning vector Quantization(LVQ) : Architecture | Evolution and optimization | Mutation, Replacement |
| | SLO-2 | Artificial model | Algorithm, Applications | Algorithm | Evolution and Genetic algorithm | Fitness form |
| S-3 | SLO-1 | Network parameters: Weight, activation, threshold | Tutorial: BPN | Max net: Architecture | Gradient based local optimization method | Scaling |
| | SLO-2 | Typical architecture: Single layer net, Multilayer net, competitive layer | Tutorial: BPN | Application procedure | Gradient based local optimization method | Population |
| S-4 | SLO-1 | Common activation function | Associative memory: Heteroassociative memory : Architecture | Mexican Hat: Architecture | Random search | Data structure |
| | SLO-2 | Common activation function | Applications | Training algorithm | Stochastic Hill climbing | Encoding: Binary , Octal, |
| S-5 | SLO-1 | McCULLOCH-PITTS net: Architecture | Associative memory:Autoassociative Net: Architecture | Hamming net : Architecture | Simulated anneling | Encoding: Hexadecimal |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Algorithm* | *Algorithm, Applications* | *Application procedure* | *Simple genetic algorithm* | *Encoding: Permutation* |
| **S-6** | **SLO-1** | *HEBB net: Architecture* | *Hopfield network:Architecture, Algorithm* | *ART Fundamentals* | *Simple genetic algorithm* | *Encoding: Value and Tree* |
| | **SLO-2** | *HEBB net: Algorithm* | *Tutorials* | *ART: Basic architecture* | *Comparison of Genetic algorithm with other optimization techniques* | *ECG signal classification using neural network* |
| **S-7** | **SLO-1** | *Perceptron: Architecture* | *Hopfield -travelling salesmanproblem* | *Learning in ART* | *Genetic algorithm at work simulation by hands* | *ECG signal classification using neural network* |
| | **SLO-2** | *Perceptron: Algorithm* | *Boltzman machine* | *Visualization in U matrix* | *Genetic algorithm at work simulation by hands* | *ECG signal classification using neural network* |
| **S-8** | **SLO-1** | *Delta rule* | *Issue in network design* | *Basics of SVM* | *Data structures* | *EMG pattern recognition* |
| | **SLO-2** | *Tutorial* | *Radial Basis function* | *Basics of SVM* | *Data structures* | *EMG pattern recognition* |
| **S-9** | **SLO-1** | *Tutorial* | *Matlab programing* | *Tutorial* | *Application of Genetic algorithm* | *Breast cancer detection* |
| | **SLO-2** | *Tutorial* | *Matlab programing* | *Tutorial* | *Advantages and limitation of Genetic algorithm* | *Breast cancer detection* |

| | | |
|---|---|---|
| **Learning Resources** | *1. LaureneFausett, "Fundamentals of Neural Networks: Architectures, Algorithms, and Applications", Pearson Education India, 3rd edition, 2008.*<br>*2. Mohamad H. Hassoun, "Fundamentals of Artificial Neural Network", Cambridge, The MIT Press, 1stedition,1995*<br>*3. B.Yegnanarayana, "Artificial Neural Networks", Prentice Hall of India, 3rd edition,2006.*<br>*4 S. N. Sivanandam, S. N Deepa, "Introduction to Neural Networks Using Matlab 6.0", Tata McGrawHill, 2006.* | *5.James A Freeman and David M.Skapra, "Neural Network", Addison – Wesley, India,Third edition, 2008*<br>*6.Robert J Schalkoff, "Artificial Neural Networks", McGraw Hill, Third edition, 2011.*<br>*7.David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education, Fourth edition, 2009.*<br>*8. Melanie Mitchell, An Introduction to Genetic Algorithms" Prentice Hall of India, New Delhi, First edition, 1998* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr. Rajalakshmi S, SRMIST* |

| Course Code | 18BME465T | Course Name | WEARABLE SYSTEMS AND MOBILE HEALTH CARE | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Principles of Communication | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

| Course Learning Rationale (CLR): | The purpose of the learning this course is to provide an overview of the technical background of wearable system and its application in health care using mobile technology |
|---|---|
| CLR-1 : | Comprehend technical information and challenges in WBAN. |
| CLR-2 : | Describe the hardware requirements of BAN |
| CLR-3 : | Review the wearable sensors and standards for BAN |
| CLR-4 : | Describe the mobile devices that is available for health care |
| CLR-5 : | Summarize the possible and latest applications of mobile healthcare |
| CLR-6 : | Learn about context-aware health care applications |

| Course Learning Outcomes (CLO): | At the end of this course, learns will be able to : | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | List out the BAN challenges | 1 | 80% | 75% | | L | | | | | | | | | | | | | |
| CLO-2 : | Identify the hardware necessary for BAN | 1 | 80% | 75% | L | | | | | | | | | | | | | | |
| CLO-3 : | List and describe the various wearable sensors | 1,2 | 80% | 75% | | L | | | | | | | | | | | L | | |
| CLO-4 : | Appreciate the mobile devices available for healthcare | 1.2 | 80% | 75% | L | | | | | | | | | | | | | | |
| CLO-5 : | List the latest applications and research opportunities with mobile healthcare. | 2 | 80% | 75% | | | | | | | | | | | | | | L | |
| CLO-6 : | Think about context-aware health care solutions | 3 | 80% | 75% | | | | | | | | | | | | | | | M |

| Duration (hour) | | Basics of BAN | Hardware requirement for BAN | Wireless communication | Application of WBAN | WBAN application in healthcare |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | BAN-Definition | Processor in BAN | RF communication | Sensors for wearable system | Mobile health technologies |
| | SLO-2 | Terminologies used with BAN | Low Power MCUs | RF communication in and around the body | Wearable system design for specific applications | Mobile nutrition tracking |
| S-2 | SLO-1 | Technical Challenges | Mobile Computing MCU | Antennal Design | Wearable system for ECG monitoring, | Accessing existing virtual electronic patient record |
| | SLO-2 | Sensor design concepts | Integrated processor | Antenna testing | Wearable system for EEG monitoring, | Mobile personal health records, |
| S-3 | SLO-1 | Types of sensors | Radio transceiver along with the processor | Propagation issues | Wearable system for Gait analysis | Monitoring hospital patients, |
| | SLO-2 | Biocompatibility issues | Integrated processor with Memory | Base Station considerations | Evaluation of general performance | Sensing vital signs |
| S-4 | SLO-1 | Energy Requirements | Antenna for BAN | Network topology | Evaluation of night time performance | Transmission using wireless networks |
| | SLO-2 | Energy supply | Antenna Requirements | Stand – Alone BAN | Evaluation parameters | Continuous monitoring |
| S-5 | SLO-1 | Nodes, number of node | Antenna Considerations | Wireless personal Area Network | Latest health monitoring methods | Patient Monitoring and wearable devices |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Optimal node placement in BAN* | *Types of antenna* | *Wireless personal Area Network Technologies* | *Smart phone based health care monitoring system* | *Patient Monitoring in Diverse Environments* |
| **S-6** | **SLO-1** | *System security* | *Wire antenna* | *IEEE 802.15.1* | *Phone based fall risk prediction* | *A framework for Capturing Patient Consent in Pervasive Healthcare Applications* |
| | **SLO-2** | *System Reliability* | *Ceramic antenna* | *IEEE P802.15.13* | *Emergency alerts* | *M-health application* |
| **S-7** | **SLO-1** | *BAN Standards* | *External antenna* | *IEEE 702.15.14* | *RFID based personal mobile medical assistance* | *Context aware sensing* |
| | **SLO-2** | *BAN with other standards* | *Sensor Interface* | *Zigbee* | *Other similar technologies* | *Technology Enablers for context-Aware healthcare Applications* |
| **S-8** | **SLO-1** | *BAN Architecture* | *Considerations on the interface* | *BAN and WBAN technologies* | *Infusing image processing capabilities* | *8 channel ECG using Ultra wide band WBAN* |
| | **SLO-2** | *BAN and other technologies* | *Power sources- Batteries* | *Limitations in use* | *Secure medical sensor network with HIP* | *Pulse generator using Ultra wide band WBAN* |
| **S-9** | **SLO-1** | *BAN and Healthcare* | *Fuel cells for sensor nodes.* | *Coexistence issues with BAN* | *Diagnostic applications* | *Multichannel neural recording system* |
| | **SLO-2** | *Medical Applications of BAN* | *Other novel power sources* | *Other practical considerations* | *Therapeutic applications* | *Electronic pills* |

**Learning Resources**


1. *Annalisa Bonfiglio, Danilo De Rossi, " Wearable Monitoring Systems", Springer, 2011.*
2. *Philip Olla, Josep Tan, " Mobile Health solutions for Biomedical applications", Medical Information science reference, Hershey New York, **IGI Global 2009.***
3. *Zhang, Yuan-Ting, Wearable Medical Sensors and systems, Sringers, 2013.*
4. *Guang-Zhogn Yang(ED), " Body Sensor Networks", Springers, 2013*
5. *Mehmet R. Yuce Jamil Y.Khan, " Wireless Body Area Networks Technology, Implementation and applications", Pan Standford Pte. Ltd., Singapore, 2012*
6. *Konstantina, James C. Lin, Dimitrios, Maria Teresa, " Wireless mobile communication and healthcare", Secon International ICST conference, Mobihealth 2011, Springers 2011.*
7. *Ullah, Sana, Et at, " A review of wireless body area networks for medical applications", arXiv: 1001.083, 2010*
8. *Patel, Shyamal, Et al, " A review of wearable sensors and systems with application in rehabilitation", Neuroeng Rehabil 9.12, 2012, 1-17.*


**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *30 %* | - | *30 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

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| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.Varshinin Karthik SRMIST* |
| | | *2.Mrs. Laskhmi Prabha* |

| Course Code | 18BME466T | Course Name | ARTIFICIAL INTELLIGENCE IN HEALTH CARE | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the basics of Artificial Intelligence and its principles |
| CLR-2 : | Learn the algorithm of various search techniques |
| CLR-3 : | Become familiar with knowledge representation |
| CLR-4 : | Explore the techniques of machine learning applicable for healthcare |
| CLR-5 : | Understand the use of machine learning in healthcare applications |
| CLR-6 : | Understand the role of artificial intelligence in healthcare |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Demonstrate the basic principles of AI towards problem solving | 1, 2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Explain the various search techniques in problem solving | 2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-3 : | Describe the techniques in knowledge representation | 2 | 80% | 70% | - | - | M | | M | - | - | - | - | - | - | - | M | | L |
| CLO-4 : | Explain the role of machine learning in healthcare applications | 3 | 80% | 70% | - | - | | | M | - | - | - | - | - | - | - | - | - | - |
| CLO-5 : | Demonstrate the use of machine learning in healthcare applications | 3 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | | L |
| CLO-6 : | Use the AI algorithms for various healthcare applications to solve problems | 3 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| | | Principles of Artificial Intelligence | Search Techniques | Knowledge Representation | Machine learning in Healthcare | Machine learning – applications in healthcare |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | AI-introduction and definition | Informed search methods | First order logic-syntax and semantics | Data Preparation, Feature Cleaning | Healthcare Survey Dataset with Unsupervised Learning |
| | SLO-2 | Turing Test approach | Best first search-Greedy search | Symbols, terms, sentences | Feature Engineering, Feature Transformation | Feature selection using the Particle swam optimization |
| S-2 | SLO-1 | Intelligent agents | A* search-behavior | Quantifiers, equality | Feature Extraction, Feature Selection | Disease Detection System (DDS) Using Machine Learning Technique |
| | SLO-2 | Structure of intelligent agents, Agent programs, example | Complexity of A* search | Extensions | Machine learning models | System Implementation and Disease Detection Methodology |
| S-3 | SLO-1 | Simple reflex agents | Heuristic functions | notational variations | Machine learning categories | Architecture of DDS |
| | SLO-2 | Goal based agents | Heuristics for constraint satisfaction problem | Higher order logic, A-expression | Machine Learning Challenges | Use Case Diagram of DDS |
| S-4 | SLO-1 | Utility based agents | Iterative deepening A* search (IDA*) | Using first order logic-kinship domain | Machine Learning Tools | Accuracy Comparison of DDS with Previous Works |
| | SLO-2 | Environment programs | Simplified Memory Bounded A* search | Axioms, definitions and theorems | Patient centric Machine learning model | Simulation for Result |
| S-5 | SLO-1 | Problem solving-problem solving agents | Hill-climbing search | Domain of sets | Pre-processing of data, Results and discussions | Deep learning solutions for skin cancer detection |
| | SLO-2 | Formulating problems, | Simulated annealing | special notations for sets, lists and arithmetic | Machine Learning Models to Classify Healthcare Data | Convolution neural network, methods, dataset |
| S-6 | SLO-1 | Well defined problems and solutions | Applications in constraint satisfaction problems | Logical agents for Wumpus world | Exploratory Data Analysis | Data augmentation, |
| | SLO-2 | Example-Toy problems, travelling salesman problem | Knowledge and reasoning | Simple reflex agent-limitations | Machine learning techniques-supervised and unsupervised approaches | Network architecture, performance metrics |
| S-7 | SLO-1 | Searching solutions | Knowledge based agent | Representing change in the world-situation calculus | Natural language Processing | Security of Healthcare Systems with Smart Health Records Using Cloud Technology |
| | SLO-2 | Data structures for search trees | Representation reasoning and logic | Frame problem and its relatives | Types of Unsupervised Learning | Cloud Computing in Healthcare |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-8** | **SLO-1** | *Search Strategies-breadth first, Uniform cost search* | *Semantics, Inference* | *Deducing hidden properties if the world* | *Clustering* | *Cloud Service Models* |
| | **SLO-2** | *Depth first search* | *Propositional logic* | *Preferences among actions, toward a global agent* | *Clustering Algorithms* | *Deployment Models in Cloud Computing* |
| **S-9** | **SLO-1** | *Iterative search* | *Syntax, semantics* | *Knowledge engineering - introduction* | *K-Means Algorithm* | *Cloud Computing Security* |
| | **SLO-2** | *Bidirectional search* | *Validity and inference* | *Knowledge engineering and programing* | *Density Based Clustering* | *Healthcare Data Security in the Cloud, sample algorithm* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Eugene Charniak*, "Introduction to Artificial Intelligence", Pearson Education India, 1985<br>2. *Stuart Jonathan Russell, Peter Norvig, Ernest Davis, "Artificial Intelligence: A Modern Approach,* Prentice Hall series in artificial intelligence, *Prentice Hall, 2010* | *3. Bernard Nordlinger, Cédric Villani, Daniela Rus, "Healthcare and Artificial Intelligence", Springer Nature, 2020*<br>4. *Vishal Jain, Jyotir Moy Chatterjee "Machine Learning with Health Care Perspective: Machine Learning and Healthcare* Volume 13 of Learning and Analytics in Intelligent Systems*", Springer Nature, 2020* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

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| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Mrs.Bhargavi Haripriya, SRMIST* |

| Course Code | 18BME467T | Course Name | BIO INSPIRED ROBOTICS | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | |
|---|---|
| **CLR-1 :** | *Understand the basic about bio inspired robots* |
| **CLR-2 :** | *Get an idea about the musculoskeletal movements* |
| **CLR-3 :** | *Acquire an idea about the basic of postural balances* |
| **CLR-4 :** | *Get an idea about assistive and rehabilitation robotics* |
| **CLR-5 :** | *Get an idea about the stability analysis* |
| **CLR-6 :** | *Get an overall idea about the importance of* Develop skills related to the design, construction and testing of advanced robotic systems |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning 1 Level of Thinking (Bloom) | Learning 2 Expected Proficiency (%) | Learning 3 Expected Attainment (%) | PLO 1 Engineering Knowledge | PLO 2 Problem Analysis | PLO 3 Design & Development | PLO 4 Analysis, Design, Research | PLO 5 Modern Tool Usage | PLO 6 Society & Culture | PLO 7 Environment & Sustainability | PLO 8 Ethics | PLO 9 Individual & Team Work | PLO 10 Communication | PLO 11 Project Mgt. & Finance | PLO 12 Life Long Learning | PLO 13 PSO - 1 | PLO 14 PSO - 2 | PLO 15 PSO – 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CLO-1 :** | *Apply the common troubleshooting procedures in Electronic Equipment and Outline the testing procedures of active and passive components* | *1, 2* | *80* | *70* | *M* | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CLO-2 :** | *Analyze the faults in analog circuits and digital ICs* | *1, 2* | *80* | *70* | *M* | - | - | - | - | - | - | - | - | - | - | - | *M* | - | - |
| **CLO-3 :** | *Identify the problems in common biomedical equipment in hospitals when it is not working and provide a suitable solution* | *2* | *80* | *70* | - | *M* | - | - | - | - | - | - | - | - | - | - | *M* | | - |
| **CLO-4 :** | *Outline the importance of medical device classification based on the application and ISO standards* | *1* | *80* | *70* | - | - | *H* | - | - | - | - | - | - | - | - | *M* | - | *M* | - |
| **CLO-5 :** | *Describe the Indian medical device regulatory system* | *1* | *80* | *70* | - | - | - | - | - | - | - | - | - | - | - | *M* | - | - | - |
| **CLO-6 :** | *Outline the job opportunities in regulatory affairs in India* | *1,2* | *80* | *70* | - | - | - | - | - | - | - | - | - | - | - | *L* | - | - | - |

| Duration (hour) | | *Introduction to Bio Inspired Robots* | *A review of computational Musculoskeletal Analysis of Human Lower Extremities* | *Personalized Modeling for Home –Based Postural Balance Rehabilitation* | *Non Invasive brain machine interfaces for assistive and rehabilitation robotics* | *Psychological modeling of humans by assistive robots* |
|---|---|---|---|---|---|---|
| | | ***9*** | | ***9*** | ***9*** | ***9*** |
| **S-1** | **SLO-1** | *Introduction to Bio-inspired Robotics* | *Introduction to Musculoskeletal Analysis* | *Introduction* | *Introduction to brain machine interfaces* | *Introduction* |
| | **SLO-2** | *Introduction to Bio-inspired Robotics* | *Introduction to Musculoskeletal Analysis* | *Introduction* | *Introduction to brain machine interfaces* | *Introduction* |
| **S-2** | **SLO-1** | *Principles of Biomechanics* | *Human walking Gait cycle* | *Home – Based postural balance rehabilitation* | *BMI for assistive robotics* | *Dimensions of Human characterization* |
| | **SLO-2** | *Basic Features* | *Human walking Gait cycle* | *Home – Based postural balance rehabilitation* | *BMI for assistive robotics* | *Dimensions of Human characterization* |
| **S-3** | **SLO-1** | *What is a biologically Inspired Robotic System, and its advantages and disadvantages* | *Biomechanics of Normal human walking* | *Body segment parameters* | *BMI for rehabilitation robotics* | *Constructing behavioral models for HRI* |
| | **SLO-2** | *its advantages and disadvantages* | *Biomechanics of Normal human walking* | *Body segment parameters* | *BMI for rehabilitation robotics* | *Constructing behavioral models for HRI* |
| **S-4** | **SLO-1** | *Mobility systems Requirements* | *Quantitative Human Walking Models* | *Estimating center of mass position for human subjects* | *Kalman Filter Implementation* | *Economic decision-making models* |
| | **SLO-2** | *Mobility systems Requirements* | *Quantitative Human Walking Models* | *Estimating center of mass position for human subjects* | *Kalman Filter Implementation* | *Economic decision-making models* |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-5** | **SLO-1** | *legs* | *Computational Musculoskeletal Analysis Interaction with articulated systems* | *Various Methods for balance rehabilitation* | *Challenges in exoskeleton design* | *Interfering psychological models* |
| | **SLO-2** | *swimming* | *Computational Musculoskeletal Analysis Interaction with articulated systems* | *Various Methods for balance rehabilitation* | *Challenges in exoskeleton design* | *Interfering psychological models* |
| **S-6** | **SLO-1** | *flying system* | *EMG motion classification* | *Dynamic Model* | *Biomechanical modeling* | *Haptic stability* |
| | **SLO-2** | *Sensors* | *EMG motion classification* | *Dynamic Model* | *Biomechanical modeling* | *Haptic stability* |
| **S-7** | **SLO-1** | *Characteristics of Sensors* | *Task modeling for human interfaces* | *Dynamic Optimization* | *Development of HRI model* | *Human operator Modeling* |
| | **SLO-2** | *tactile,* | *Task modeling for human interfaces* | *Dynamic Optimization* | *Development of HRI model* | *Human operator Modeling* |
| **S-8** | **SLO-1** | *vision* | *An EMG –controlled Human Robot Interface using Task modelling* | *Body motion sensing* | *Design examples* | *Haptic assist control* |
| | **SLO-2** | *electronic nose* | *An EMG –controlled Human Robot Interface using Task modelling* | *Body motion sensing* | *Design examples* | *Haptic assist control* |
| **S-9** | **SLO-1** | *Evolution of Bio Inspired Robot* | *Modeling of joint stiffness* | *Strain-Sensitive conductive polymers* | *Stability analysis* | *System validation and experimental evaluation* |
| | **SLO-2** | *Evolution of Bio Inspired Robot* | *Modeling of joint stiffness* | *Strain-Sensitive conductive polymers* | *Stability analysis* | *System validation and experimental evaluation* |

| | | |
|---|---|---|
| **Learning Resources** | *1.* Biologically Inspired Robotics 1st Edition by Yunhui Liu (Editor), Dong Sun (Editor)<br>*2* Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies (Intelligent Robotics and Autonomous Agents series) by Dario Floreano | |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

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| Course Code | 18BME468T | Course Name | COMPUTATIONAL TOOLS IN BIOENGINEERING AND BIOMEDICINE | Course Category | | *Professional Elective* | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | | Co-requisite Courses | *Nil* | Progressive Courses | *Nil* |
|---|---|---|---|---|---|
| **Course Offering Department** | *Biomedical Engineering* | **Data Book / Codes/Standards** | *Nil* | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | *1* | *2* | *3* |
| **CLR-1 :** | *Understand the basic concepts of computational tools in bioengineering and biomedicinie* | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| **CLR-2 :** | *Get an idea about the Concept of aortic dissection* | | | |
| **CLR-3 :** | *Acquire an idea about the Mechanistic approach to analysis antioxidant action* | | | |
| **CLR-4 :** | *Get an idea about the Radical adduct formation ( RAF) mechanism* | | | |
| **CLR-5 :** | *Acquire an idea about the coupling algorithms on cochlear mechanics* | | | |
| **CLR-6 :** | *Get an overall idea about the advanced computational approach* | | | |

| **Course Learning Outcomes (CLO):** | *At the end of this course, learners will be able to:* | | | |
|---|---|---|---|---|
| **CLO-1 :** | *Understand the need for computational tools in the field of bioengineering and biomedicine* | *1, 2* | *80* | *70* |
| **CLO-2 :** | *Have a thorough understanding of basic equations of fluid flow and solid motion* | *1, 2* | *80* | *70* |
| **CLO-3 :** | *Understand the basics of antiradical mechanisms in the presence of different free radicals* | *2* | *80* | *70* |
| **CLO-4 :** | *Identify the importance of radical adduct formation mechanism* | *1* | *80* | *70* |
| **CLO-5 :** | *Analyze the knowledge on the model of cochlea including feedforward and feedbackward forces* | *1* | *80* | *70* |
| **CLO-6 :** | *Extend the basics of functional Spaces and functional inequalities* | *1,2* | *80* | *70* |

**Program Learning Outcomes (PLO)**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO -1 | PSO -2 | PSO –3 |
| *H* | - | - | - | - | - | - | - | - | - | - | *M* | - | - | - |
| *H* | - | - | - | - | *H* | - | - | - | - | - | - | *L* | - | - |
| - | *L* | - | - | - | *H* | - | - | - | - | - | - | *L* | | *L* |
| *H* | - | | - | - | *H* | - | - | - | - | - | - | - | *M* | - |
| - | - | - | - | - | *H* | - | - | - | - | - | - | - | - | - |
| *H* | - | - | - | - | - | - | - | - | - | - | *M* | - | - | - |

| Duration (hour) | | ***Need for computational tools*** | ***Computational approach in aortic dissection*** | ***Computational approach in antioxidative mechanisms*** | ***Computational approach in cochlear mechanics*** | ***Advanced computational approach*** |
|---|---|---|---|---|---|---|
| | | ***9*** | ***9*** | ***9*** | ***9*** | ***9*** |
| S-1 | SLO-1 | *Elements of computational tools* | *Diagnostic techniques of acute aortic dissection* | *Prevention of oxidative stress* | *Cochlear mechanics* | *Functional Spaces and Functional Inequalities* |
| | SLO-2 | *Elements of computational tools* | *Diagnostic techniques of acute aortic dissection* | *Prevention of oxidative stress* | *Concepts of modeling* | *Metric Spaces* |
| S-2 | SLO-1 | *Elements of mathematical modeling* | *Treatment of acute aortic dissection* | *Characteristics of good antioxidants* | *Concepts of modeling* | *Complete Metric Spaces* |
| | SLO-2 | *Elements of mathematical modeling* | *Treatment of acute aortic dissection* | *Characteristics of good antioxidants* | *Solid model* | *Normed Spaces* |
| S-3 | SLO-1 | *Elements of physics* | *Basic equations of fluid flow* | *The proposed reaction mechanisms* | *Solid model* | *Banach Spaces* |
| | SLO-2 | *The rational continuum mechanics approach to matter in motion* | *Basic equations of fluid flow* | *The proposed reaction mechanisms* | *Fluid model* | *Banach Spaces* |
| S-4 | SLO-1 | *Balance laws in integral form* | *Basic equations of solid motion* | *The proposed reaction mechanisms* | *Fluid model* | *Hilbert Spaces* |
| | SLO-2 | *Balance laws in integral form* | *Basic equations of solid motion* | *Mechanistic approach* | *Loose coupling algorithm* | *Hilbert Spaces* |
| S-5 | SLO-1 | *Balance laws in local form* | *Basic equations of solid motion* | *Mechanistic approach* | *Loose coupling algorithm* | *The Nonlinear Differential Model System* |
| | SLO-2 | *Balance laws in local form* | *Solid fluid interaction* | *Thermodynamical parameters for quercetin and gallic acid* | *Strong coupling algorithm* | *Time Semidiscretization* |

| | | | | | | |
|---|---|---|---|---|---|---|
| S-6 | SLO-1 | *Continuum approach for multicomponent mixtures* | *Solid fluid interaction* | *Thermodynamical parameters for quercetin and gallic acid* | *Strong coupling algorithm* | *Time Semidiscretization* |
| | SLO-2 | *Continuum approach for multicomponent mixtures* | *Concept of aortic dissection* | *Thermodynamical parameters for quercetin and gallic acid* | *Need for finite element modeling of cochlea* | *Time Semidiscretization* |
| S-7 | SLO-1 | *Continuum approach for multicomponent mixtures* | *Concept of aortic dissection* | *Antiradical mechanisms in the presence of different free radicals* | *Basic criteria for finite element modeling of cochlea* | *Block Nonlinear Jacobi and Gauss–Seidel Iterations* |
| | SLO-2 | *Constitutive relations for fluids* | *Need for 3D reconstruction* | *Antiradical mechanisms in the presence of different free radicals* | *Concept of finite element modeling of cochlea* | *Block Nonlinear Jacobi and Gauss–Seidel Iterations* |
| S-8 | SLO-1 | *Constitutive relations for solids* | *Need for 3D reconstruction* | *Mechanistic approach to analyze antioxidant action* | *Finite element models of cochlea* | *Block Nonlinear Jacobi and Gauss–Seidel Iterations* |
| | SLO-2 | *Constitutive relations for solids* | *Need for 3D reconstruction* | *Mechanistic approach to analyze antioxidant action* | *Finite element models of cochlea* | *Application of Functional Iterations to Biological Models* |
| S-9 | SLO-1 | *Constitutive relations for multicomponent mixtures* | *Need for geometric 3D modeling* | *Radical adduct formation (RAF) mechanism* | *Model of cochlea including feedforward and feedbackward forces* | *Application of Functional Iterations to Biological Models* |
| | SLO-2 | *Constitutive relations for electromagnetism and electrodynamics* | *Need for geometric 3D modeling* | *Radical adduct formation (RAF) mechanism* | *Model of cochlea including feedforward and feedbackward forces* | *Application of Functional Iterations to Biological Models* |

| | | |
|---|---|---|
| **Learning Resources** | *1.Nenad Filipovic,"Computational Modeling in Bioengineering and Bioinformatics", Academic Press,1st Edition, 2019.*<br>*2.Z.C.Yang,"Finite Element Analysis for Biomedical Engineering Applications", CRC Press,1st Edition,2019*<br>*3.Butta Singh," Computational Tools and Techniques for Biomedical Signal Processing", IGI Global, 1st edition, 2016.* | *4.Andreas Öchsner, Holm Altenbach, "Applications of Computational Tools in Biosciences and Medical Engineering", Springer, 1st edition, 2015.*<br>*5.Geris, Liesbet,"Computational Modeling in Tissue Engineering", Springer, 1st edition,2013.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Mr.P. Muthu, SRMIST* |

| Course Code | 18BME469T | Course Name | NEURO REHABILITATION AND HUMAN MACHINE INTERFACE | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Basic Electronic devices and circuits | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning |
|---|---|---|
| CLR-1 : | Explain the basic growth responses of neurons with cellular and molecular mechanism | |
| CLR-2 : | Analyze the plasticity of cerebral motor function | |
| CLR-3 : | Summarize the role of inflammatory response in central nervous system | |
| CLR-4 : | Illustrate the future perspective of human machine interface (HMI) | |
| CLR-5 : | Explain the motor recovery and compensation in neurorehabilitation | |
| CLR-6 : | Understanding the usage of Human machine Interface in translational research | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | 1 Level of Thinking (Bloom) | 2 Expected Proficiency (%) | 3 Expected Attainment (%) |
|---|---|---|---|---|
| CLO-1 : | Understanding cellular and molecular mechanisms of neural plasticity | 1, 2 | 80 | 70 |
| CLO-2 : | Get an idea of Functional Plasticity in the Central Nervous System | 1, 2 | 80 | 70 |
| CLO-3 : | Identify the Regeneration in the Injured Nervous System | 2 | 80 | 70 |
| CLO-4 : | Illustrate the future perspective of human machine interface (HMI) | 1 | 80 | 70 |
| CLO-5 : | Application of Human machine interface in translational research | 1 | 80 | 70 |
| CLO-6 : | Understanding the usage and design development of HMI for research | 1,2 | 80 | 70 |

**Program Learning Outcomes (PLO)**

| | 1 Engineering Knowledge | 2 Problem Analysis | 3 Design & Development | 4 Analysis, Design, Research | 5 Modern Tool Usage | 6 Society & Culture | 7 Environment & Sustainability | 8 Ethics | 9 Individual & Team Work | 10 Communication | 11 Project Mgt. & Finance | 12 Life Long Learning | 13 PSO - 1 | 14 PSO - 2 | 15 PSO – 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | M | M | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | M | M | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | H | - | - | | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | H | - | - | - | - | - | - | - | - | - | - | H | - | M | - |
| CLO-5 : | H | - | - | - | - | - | - | - | - | - | - | M | M | - | - |
| CLO-6 : | H | - | M | M | - | - | - | - | - | - | - | H | H | - | - |

| Duration (hour) | | Neural Plasticity: Cellular and Molecular Mechanisms | Functional Plasticity in the Central Nervous System | Determination of Regeneration in the Injured Nervous System | Ambient Intelligence and Ubiquitous Computing Scenario | Translational Research: Application in Human Machine Interface |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Learning and memory: basic principles and model systems | Plasticity of mature and developing somatosensory systems | Non-mammalian models of nerve regeneration | The advanced human machine interface (HMI) framework | Application uses in robotics |
| | SLO-2 | Learning and memory: basic principles and model systems | Plasticity of mature and developing somatosensory systems | Non-mammalian models of nerve regeneration | The advanced human machine interface (HMI) framework | Application uses in robotics |
| S-2 | SLO-1 | Cellular and molecular mechanisms of associative and nonassociative learning | Activity-dependent plasticity in the intact spinal cord | Myelin-associated axon growth inhibitors, Inhibitors of axonal regeneration | The advanced human machine interface (HMI) framework | Robotics and wearable technology for measurement |
| | SLO-2 | Cellular and molecular mechanisms of associative and nonassociative learning | Activity-dependent plasticity in the intact spinal cord | Myelin-associated axon growth inhibitors, Inhibitors of axonal regeneration | The advanced human machine interface (HMI) framework | Robotics and wearable technology for measurement |
| S-3 | SLO-1 | Degenerative changes and reactive growth responses of neurons following denervation and axotomy | Plasticity of cerebral motor functions: Implications for repair and rehabilitation | Role of the inflammatory response in central nervous system injury and regeneration | Human machine interface systems – structure, protocols, | Clinical application of robotics and technology in restoration of walking |
| | SLO-2 | Degenerative changes and reactive growth responses of neurons following denervation and axotomy | Plasticity of cerebral motor functions: Implications for repair and rehabilitation | Role of the inflammatory response in central nervous system injury and regeneration | Human machine interface systems – structure, protocols | Clinical application of robotics and technology in restoration of walking |

| | | | | | | |
|---|---|---|---|---|---|---|
| S-4 | **SLO-1** | *Contemporary issue and theories of motor control learning.* | *Plasticity of cerebral motor functions: Implications for repair and rehabilitation* | *Role of the inflammatory response in central nervous system injury and regeneration* | *Human machine interface systems – applications* | *Clinical application of robotics and technology in children undergoing neurorehablitation* |
| | **SLO-2** | *Contemporary issue and theories of motor control learning.* | *Plasticity of cerebral motor functions: Implications for repair and rehabilitation* | *Role of the inflammatory response in central nervous system injury and regeneration* | *Human machine interface systems – applications* | *Clinical application of robotics and technology in children undergoing neurorehablitation* |
| S-5 | **SLO-1** | *Limbic system influence over motor control and learning* | *Plasticity in visual connection retinal ganglion cell axonal development and regeneration* | *Sensor-motor interaction and error augumentation* | *Human machine interface systems – applications* | *Clinical application of robotics and technology in children undergoing neurorehablitation* |
| | **SLO-2** | *Limbic system influence over motor control and learning* | *Plasticity in visual connection retinal ganglion cell axonal development and regeneration* | *Sensor-motor interaction and error augumentation* | *. The next-generation advanced HMI 2* | *Biomimetic design of neural prosthesis Brain responses to neural prosthesis* |
| S-6 | **SLO-1** | *Learning of damaged brain/spinal cord neuroplasticity* | *Plasticity in auditory function cross model plasticity in visual system* | *Limbic system influence on motor control and learning* | *The next-generation advanced HMI 2* | *Biomimetic design of neural prosthesis Brain responses to neural prosthesis* |
| | **SLO-2** | *Learning of damaged brain/spinal cord neuroplasticity* | *Plasticity in auditory function cross model plasticity in visual system* | *Limbic system influence on motor control and learning* | *The next-generation advanced HMI 2* | *Biomimetic design of neural prosthesis Brain responses to neural prosthesis* |
| S-7 | SLO-1 | *Movement neuroscience foundation of neurorehabilitation* | *Plasticity in auditory function cross model plasticity in visual system* | *Normal and impaired cooperative hand movement role of neural coupling* | *A future perspective for next-generation HMI: fNIRS-EEG* | *Intracranial human machine interfaces for communication and control* |
| | SLO-2 | *Movement neuroscience foundation of neurorehabilitation* | *Plasticity in auditory function cross model plasticity in visual system* | *Normal and impaired cooperative hand movement role of neural coupling* | *A future perspective for next-generation HMI: fNIRS-EEG* | *Intracranial human machine interfaces for communication and control* |
| S-8 | SLO-1 | *Sensor-motor interaction and error Augumentation* | *Plasticity in auditory function* | *Physiological aspect of adaptation and adjustment during various phase of neurological Disablity* | *A future perspective for next-generation HMI: fNIRS-EEG* | *Intracranial human machine interfaces for communication and control* |
| | SLO-2 | *Sensor-motor interaction and error Augumentation* | *Plasticity in auditory function* | *Physiological aspect of adaptation and adjustment during various phase of neurological Disablity* | *A future perspective for next-generation HMI: fNIRS-EEG* | *Understanding motor recovery and compensation in neurorehabilitation* |
| S-9 | SLO-1 | *Physiological aspect of adaptation and adjustment during various phase of neurological Disablity* | *Plasticity in auditory function* | *Multisystem neurorehablitation in rodents w ith spinal cord injury* | *Multi-Modal HMI.* | *Understanding motor recovery and compensation in neurorehabilitation* |
| | SLO-2 | *Physiological aspect of adaptation and adjustment during various phase of neurological Disablity* | *Plasticity in auditory function* | *Multisystem neurorehablitation in rodents w ith spinal cord injury* | *Multi-Modal HMI.* | *Understanding motor recovery and compensation in neurorehabilitation* |

| | | |
|---|---|---|
| *Learning Resources* | *1. Michael E. Seizer, Stephanie Clarke, Lenardo G. Cohen. GertKwakkel, Robert H. Miller., "Textbook of Neural repair and rehabilitation", Volume 1-Neural repair and Plasticity", Cambridge university press, 2nd edition, 2014.*<br>*2. Jose L Pons, Diego Torricelli,"Textbook of Neural repair and rehabilitation", Springer, 1stedition,2014.*<br>*3.Darcy Ann Umphred, Rolando T. Lazaro, Margaret Roller, Gordon Burton ,Neurological Rehabilitation - E-Book,Elsvier mosby 2013.*<br>*4. Panagiotis Artemiadi , Neuro-Robotics: From Brain Machine Interfaces to Rehabilitation Robotics springer publishing 2014.*<br>*5. David J. Reinkensmeyer, Volker Diet , Neurorehabilitation Technology ,springer publishing 2016.* | *3. Surjo R. Soekadar, NielsBirbaumer, Marc W. Slutzky, Leonardo G. Cohen., "Brain- machine interfaces in neurorehabilitation of stroke', Neurobiology of disease, 2015.*<br>*4. F. Nijboer, "Technology transfer of brain-computer interfaces as assistive techno logy: Barriers and opportunities", Annals of physical and Rehabilitation Medicine, 2015.*<br>*5. U.Chaudhary, N. Birbaumer, M.R.Curado., "Brain-machine interface (BMI) in paralysis", Annals of physical and rehabilitation medicine, 2015.*<br>*6. D.D. Franks and J.H. Turner., "Handbook of Neurosociology", Springer, 1stedition, 2013.*<br>*7. Jose L Pons, Diego Torricelli, Marta Pajaro., "Converging clinical and engineering research on neurorehabilitation", Springer, 1stedition, 2013.* |

| **Learning Assessment** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *Mrs.P.Laskhmi Prabha* |

| Course Code | 18BME470T | Course Name | Assistive and Augmentative Technologies | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the fundamentals of assistive technology tools in various disabilities | | | |
| CLR-2 : | Use the universal principles and human factors for Augmentative and alternative communication and assistive technology | | | |
| CLR-3 : | Utilize the idea about the low and high technology tools for various disabilities | | | |
| CLR-4 : | Study the assistive technology tools for deafness and hearing impairments | | | |
| CLR-5 : | Study the assistive technology tools for visual and dual sensory impairments | | | |
| CLR-6 : | Get an overall idea about the various assistive technology tools for mobility, seating and daily living | | | |

**Course Learning Outcomes (CLO):** *At the end of this course, learners will be able to:*

| | | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Apply the universal principles of assistive technology tools for various disabilities | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | L- | L | M |
| CLO-2 : | Identify the basic principles and human factors for person with disabilities | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | L | | - |
| CLO-3 : | Identify the utilization of low and high technology tools in various disability conditions | 1,2 | 80 | 70 | - | M | - | - | - | - | - | - | - | - | - | - | L | L | - |
| CLO-4 : | Analyze the assistive technology tools and its usage in hearing impairments persons | 2,3 | 80 | 70 | M | L | L | - | - | - | - | - | - | - | - | M | - | L | M |
| CLO-5 : | Analyze the assistive technology tools and its usage in visual and sensory impairments persons | 2,3 | 80 | 70 | M | L | L | - | - | - | - | - | - | - | - | M | - | L | M |
| CLO-6 : | Identify the basic assistive technology tools for activities of daily living | 2,3 | 80 | 70 | - | M | M | L | - | - | - | - | - | - | - | L | - | L | M |

| Duration (hour) | | Universal Principles and Human factors | Assistive Technology for Communication, Deafness and hearing impairments | Assistive Technology for Visual and Dual sensory impairments and daily living | Augmentative Technology for Prosthetic and Orthopedics | Technology for mobility, seating and |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Augmentative and alternative communication (AAC) and Assitive technology (AT) software | Hearing functional assessment | Anatomy of eye, Image formations in eye | Anatomy of upper & lower extremities | Basic assessment and evaluation for mobility |
| | SLO-2 | Evaluation of AAC and AT software | Surgical and non surgical hearing aids | Categories of visual impairment | Classification of amputation types | Mobility devices |
| S-2 | SLO-1 | Technical and user considerations | Devices to improve hearing | Artificial vision implants | Prosthesis prescription | Wheel chair :seating assessment |
| | SLO-2 | Quality resources on AAC and AT | Implants: Cochlear implant | Cortical and retinal implants | Hand and arm replacement | Interventions in seating system |
| S-3 | SLO-1 | Evaluation of quality resources | Bone anchored hearing aids | External visual devices | Different types of models | Biological aspects of tissue health |
| | SLO-2 | Universal principles in AAC and AT | Assistive listening devices | Low and High technology to improve mobility | externally powered limb prosthesis | Support surface classification |
| S-4 | SLO-1 | Evidence based practice in AT | Electronic communication aids | Electronic Travel Aids(ETA) | Foot orthosis | Optimum seated posture |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **SLO-2** | *Human factors in evaluation of AT* | *Analog and digital recorders* | *Low and High technology for reading and writing* | *Pediatric orthoses* | *Types of wheelchairs : Manual wheel chairs* |
| **S-5** | **SLO-1** | *Environmental and social factors* | *Assistive listening devices* | *Auditory information display* | *Wrist-hand orthosis* | *Power wheelchairs* |
| | **SLO-2** | *Psychological factors influencing the use of technology* | *Devices to improve communication* | *AT for dual sensory impairments* | *feedback in orthotic system* | *Power assisted wheelchairs* |
| **S-6** | **SLO-1** | *Various Physiological influencing factors* | *Design constraints in designing Adapted mouse* | *AT for leisure and recreation* | *Components of upper limb prosthesis* | *Control systems, navigation in virtual space by wheelchairs* |
| | **SLO-2** | *Sensory and Motor factors* | *Smart pen- technology* | *Activities of daily living (ADL)* | *Components of lower limb prosthesis* | *Control systems, navigation in virtual space by wheelchairs* |
| **S-7** | **SLO-1** | *Low technology :Communication displays* | *Keyboard variations for differently abled* | *Daily living aids* | *Lower extremity- and upper extremity-orthoses* | *EOG based voice controlled wheelchair* |
| | **SLO-2** | *Object communication displays, Communication Boards* | *Modifying existing technology* | *AT in Home* | *Intelligent prosthesis* | *BCI based wheelchair* |
| **S-8** | **SLO-1** | *Principles of high technology assistive devices* | *Voice recognition and word prediction software* | *Technology for writing* | *functional electrical stimulation* | *Wheel chair standards & tests* |
| | **SLO-2** | *Difference in high and medium technology* | *Communication devices* | *Alternative devices for safety* | *Electric Electronic Stimulation* | *Wheel chair standards & tests* |
| **S-9** | **SLO-1** | *Picture exchange communication system* | *Smart phones, Cell phones and videophones* | *Orientation & navigation Aids* | *Fuzzy logic expert system for automatic tuning of myoelectric prostheses* | *Wheel chair transportation* |
| | **SLO-2** | *Issues and considerations for low and high tech tools* | *Visual devices using sign* | *Alert systems* | *Fuzzy logic expert system for automatic tuning of myoelectric prostheses* | *Mobility device Accessories* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Oliver Wendt, Raymond W Quist, Lyle L Lloyd, "Assistive Technology: Principles and Applications for Communication Disorders and Special Education", Emerald group publishing Ltd, 1st Edition, 2011 .*<br>*2. Albert Cook, Janice Polgar, "Assistive Technologies -Principles and Practice", Mosby, 4th Edition, 2015.*<br>*3. Rory A, Cooper, Hisaichi Ohnabe, Douglas A, Hodson, "An Introduction to Rehabilitation Engineering", CRC press, Ist Edition, 2006.*<br>*4. Marion A Hersh, Michael A, Johnson, "Assistive Technology for Visually impaired and blind people", Springer , 1stEdition, 2008* | *5. Brownsell, Simon, et al,. A systematic review of lifestyle monitoring technologies, Journal of telemedicine and telecare 17.4 (2011): 185-189*<br>*6. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, 1st ed., Springer Science & Business Media, 2010*<br>*7. Kenneth J. Turner, Advances in Home Care Technologies: Results of the match Project, 1st ed., Springer, 2011*<br>*8. Pascal Verdonck, Advances in Biomedical Engineering, 1st ed., Elsevier, 2009* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Mrs. A Bhargavi Haripriya, SRMIST* |

| Course Code | 18BME471T | Course Name | MACHINE LEARNING AND DEEP LEARNING TECHNIQUES IN MEDICINE | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Neural Networks | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Understand the applications of machine learning and types of learning algorithms | | | |
| CLR-2 : | Learn about the parametric model of classification | | | |
| CLR-3 : | Gain knowledge in multivariate data handling and analysis | | | |
| CLR-4 : | Learn about the clustering methods | | | |
| CLR-5 : | Know the techniques to compare and assess the learning algorithms | | | |
| CLR-6 : | Apply deep learning techniques in biomedical field | | | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Explain what are the different types of learning algorithm | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Familiarize with different parametric models | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | M | - | - |
| CLO-3 : | Describe the multivariate data analysis and the different techniques | 2 | 80 | 70 | - | M | - | - | - | - | - | - | - | - | - | - | M | | - |
| CLO-4 : | Give a detailed account on clustering techniques | 1 | 80 | 70 | - | - | H | - | - | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Compare the performance of different algorithms | 1 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | M | - | - | - |
| CLO-6 : | Apply the machine and deep learning algorithms for concept related to image analysis | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | L | - | - | - |

| Duration (hour) | | Machine Learning - Introduction | Parametric models and Multivariate Methods | Unsupervised learning | Machine learning Experiments | Deep learning Application |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Bayesian decision theory , Classification | Parametric Methods | Clustering | Design and Analysis of Machine Learning Experiments | Regularization, Normalizing inputs |
| | SLO-2 | Bias and Variance | Maximum Likelihood Estimation | Mixture Densities | cost-sensitive learning | Weight Initialization for Deep Networks |
| S-2 | SLO-1 | Bayes' Estimator | Bernoulli Density | k-Means Clustering | Experiment | Numerical approximation of gradients |
| | SLO-2 | Losses and risks | Multinomial Density | vector quantization | strategies of experimentation | Gradient checking, Gradient Checking Implementation |
| S-3 | SLO-1 | Discriminant Functions | Parametric Classification-Regression | leader cluster algorithm | factorial design | Mini-batch gradient descent |
| | SLO-2 | Utility Theory | Bias/Variance | leader cluster algorithm | Response Surface Design | Exponentially weighted averages |
| S-4 | SLO-1 | Value of information | Model Selection Procedures | Expectation-Maximization Algorithm | Randomization, replication, blocking, pairing | Classical Supervised Tasks with Deep Learning |
| | SLO-2 | Bayesian networks | Validation techniques , Minimum length description, Bayesian model selection | Mixtures of Latent Variable Models | Guidelines for Machine Learning Experiments | Brain MRI Age Classification |
| S-5 | SLO-1 | Influence Diagrams | Multivariate Data | Supervised Learning after Clustering | Choice of Factors and Levels | Image Denoising |
| | SLO-2 | Association Rules | Parameter Estimation | Hierarchical Clustering | Choice of Experimental Design, Performing the Experiment | Image Denoising |

| | | | | | | |
|---|---|---|---|---|---|---|
| S-6 | **SLO-1** | *Machine learning applications-learning associations,* | *Estimation of Missing Values* | *Choosing the Number of Clusters* | *Statistical Analysis of the Data* | *Analysis of medical images* |
| | **SLO-2** | *classification, regression,* | *Multivariate Normal Distribution* | *Nonparametric Methods* | *Cross-Validation and Resampling Methods* | *Analysis of medical images* |
| S-7 | SLO-1 | *unsupervised learning, reinforcement learning* | *Multivariate Methods- Multivariate Data* | *Instance-based memory-based learning* | *K-Fold Cross-Validation* | *Automatic Interpretation of Carotid Thickness* |
| | SLO-2 | *Supervised learning-examples* | *Parameter Estimation* | *Nonparametric Density Estimation* | *5×2 Cross-Validation* | *Automatic Interpretation of Carotid Thickness* |
| S-8 | SLO-1 | *Regression, Noise, learning multiple classes* | *Principal Components Analysis* | *Kernel Estimator* | *Bootstrapping* | *3-D Brain Tumor Segmentation* |
| | SLO-2 | *Probably Approximately Correct (PAC) learning* | *Eigen faces and Eigen digits* | *k-Nearest Neighbor Estimator* | *Measuring Classifier Performance* | *3-D Brain Tumor Segmentation* |
| S-9 | SLO-1 | *Vapnik–Chervonenkis (VC) dimension* | *reconstruction error, Karhunen-Lève expansion* | *Generalization to Multivariate Data* | *Interval Estimation* | *Convolutional NN for Real time 2D/3D Registration* |
| | SLO-2 | *Exercises* | *Multidimensional scaling, Linear discriminant Analysis* | *Nonparametric Classification* | *Comparing Multiple Algorithms* | *Convolutional NN for Real time 2D/3D Registration* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Tony J. Cleophas and Aeilko H. Zwinderman, "Machine Learning in Medicine - a Complete Overview", Springer,2015*<br>*2. Sunila Gollapudi, S. , "Practical Machine Learning", Packt Publishing Ltd.2016*<br>*3. Applied Deep Learning: A Case-Based Approach to Understanding Deep Neural Networks, By Umberto Michelucci, Delaware corporation, 2018* | *4. Deep Learning for Medical Image Analysis, edited by S. Kevin Zhou, Hayit Greenspan, Dinggang Shen , Academia Press, 2017*<br>*5. Deep Learning, An MIT Press book, Ian Goodfellow and Yoshua Bengio and Aaron Courville http://www.deeplearningbook.org*<br>*6. Introduction to Deep Learning: From Logical Calculus to Artificial Intelligence, By Sandro Skansi, Springer, 2018* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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| Course Code | 18BME472T | Course Name | Virtual Reality in Health care | Course Category | E | Professional Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 2 | 4 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the sensors in virtual reality systems |
| CLR-2 : | Understand the techniques in image creation |
| CLR-3 : | Understand the techniques in image manipulation and viewing |
| CLR-4 : | Gain knowledge in techniques involved in haptics |
| CLR-5 : | Gain knowledge in auditory aspects in VR |
| CLR-6 : | Understand the various input sensors, visual and auditory aspects of virtual reality systems |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| CLO-1 : | Explain the terms and the various input sensors used in VR | 1,2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | | |
| CLO-2 : | Analyze the visual aspects of VR systems | 2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | | |
| CLO-3 : | Demonstrate the various techniques for image creation and manipulation | 2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | | L | |
| CLO-4 : | Explain the various haptic sensors and techniques used in VR | 2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | | |
| CLO-5 : | Explore the various auditory aspects related to VR | 2 | 80% | 70% | M | - | - | - | - | - | - | - | - | - | - | - | M | | |
| CLO-6 : | Describe and explain the various components of Virtuality reality systems | 2 | 80% | 70% | | L | - | - | - | - | - | - | - | - | - | - | M | | |

| | | Input Periphery | Visual Aspects- I | Visual Aspects - II | Haptic Aspects | Auditory Aspects and applications |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Definition of Virtual Reality (VR) | Computer graphics, building blocks | Light Sources and Reflection | Haptic sense and perception | Auditory Sense and Perception |
| | SLO-2 | Presence and Immersion, Need for training in medicine | Visual sense and perception | Point light, directional light, spot light | Tactile receptors, | interaural level differences |
| S-2 | SLO-1 | Principles of VR, Main components | Human eye, photoreceptors, color vision | Ambient light, diffuse reflection, specular reflection, | Kinesthetic receptors, | Design of Auditory Displays |
| | SLO-2 | Problems in VR | RGB color space, liquid crystal display | Viewing projections | Psychophysics | Headphones |
| S-3 | SLO-1 | Human Actuators , Input Modalities | color spaces, subtractive model | Image projection in the thin lens camera model | Haptic Display Technology | Mono, Stereo, and Surround Loudspeaker Systems |
| | SLO-2 | Position and movement recording | HSV color space | Depth of field in thin lens camera model | Kinematic principles, serial and parallel | Auditory Rendering |
| S-4 | SLO-1 | Resistive sensors, Capacitive sensors | Depth Perception, monocular cues | Projection in pinhole camera | Actuation principles | Olfactory and Gustatory Aspects |
| | SLO-2 | Inductive sensors, Ultrasound and optical methods | Oculomotor cues, | Early depiction of a Camera Obscura | Shape memory alloys | wearable olfactory display devices |
| S-5 | SLO-1 | Position and movement measuring systems | binocular cues | Perspective projection | Electroactive Polymers | Gustatory Sense and Perception |
| | SLO-2 | Desktop systems, body mounted systems | Visual Display technology | 2D mapping in the yz-plane | Piezoelectric Actuators | Virtual Reality for Rehabilitation |
| S-6 | SLO-1 | Contact free and remote systems | Stereoscopic rendering | Orthographic projection | Control Principles of Haptic Displays | Virtual Reality Supported Physiotherapy |
| | SLO-2 | Eye tracking systems | Display hardware | Orthographic projection onto image plane | Terminology | Gait Rehabilitation, |
| S-7 | SLO-1 | Force and torque recording | Virtual reality displays | Surface Shading | Admittance and Impedance Control Architectures | Robot-Assisted Gait Training |
| | SLO-2 | Sound and speech recording | Cave Automatic Virtual Environment | Flat Shading | Stability, Passivity and safety of Haptic Displays | Motivation for Robot Aided Arm Therapy |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-8** | **SLO-1** | *Physiological data recording* | *Head mounted displays* | *Gouraud Shading* | *Ground- and Wall-Mounted Systems* | *Virtual Reality Applications with ARMin* |
| | **SLO-2** | *Bioelectrical signal* | *Rendering in computer graphics* | *Phong Shading* | *Tactile and Portable systems* | *Wheelchair Mobility and Functional ADL Training* |
| **S-9** | **SLO-1** | *Blood pressure measurements, pulse oximetry, skin conductance* | *Object representations* | *Advanced Rendering Techniques, Ray Tracing* | *Haptic Rendering* | *VR Based surgical simulator and its components* |
| | **SLO-2** | *Respiratory measurements* | *Geometry transformations (basics)* | *Radiosity, Visual Displays in Medical VR* | *Penalty method, Haptic Displays in Medical VR* | *VR for Surgical planning* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Robert Riener, Matthias Harders, "Virutal Reality in Healthcare"Springer, 2012.*<br>2. *Wadee Alhalabi "Virtual Reality Implementation in Healthcare Settings", Medical Information Science Reference, 2017* | 3. *Lynne Edgar, "Virtual Reality: Future of Health Care" ,iUniverse, 2003.*<br>4. *James Roland, "Virtual Reality and Medicine", ReferencePoint Press, Incorporated, 2018.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldive* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.T.Jayanthi, SRMIST* |

| Course Code | 18BMO121T | Course Name | Fundamentals of Biomedical Engineering | Course Category | O | Open Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Have an idea about the basics of physiology | | | |
| CLR-2 : | Know the basic aspects of biomedical recorders | | | |
| CLR-3 : | Learn the various patient monitoring systems used in health care | | | |
| CLR-4 : | Perceive the physics behind x-ray imaging and computed tomography (CT) | | | |
| CLR-5 : | Understand the physics behind magnetic resonance and the techniques in resonance imaging | | | |
| CLR-6 : | Describe the properties and techniques involved in Therapeutic Equipment's | | | |

**Course Learning Outcomes (CLO):** *At the end of **this** course, learners will be able to:*

| | | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | Explain the basics of physiology | 1, 2 | 80 | 70 | M | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | Describe the basic concepts of biomedical recorders | 1, 2 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | M | M | - | - |
| CLO-3 : | Implement the various uses of patient monitoring system | 2 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | M | M | | - |
| CLO-4 : | Understand the physics behind X- ray and CT | 1 | 80 | 70 | - | - | | M | - | - | - | - | - | - | - | M | - | M | - |
| CLO-5 : | Explain the concepts of MRI | 1 | 80 | 70 | - | - | - | M | - | - | - | - | - | - | - | M | - | - | - |
| CLO-6 : | Apply the recent advancements in Therapeutic Equipment's | 1,2 | 80 | 70 | - | - | - | - | - | - | - | - | - | - | - | H | - | - | - |

| Duration (hour) | | FUNDAMENTALS OF BIOMEDICAL INSTRUMENTATION | BIOMEDICAL RECORDERS | PATIENT MONITORING SYSTEMS | DIAGNOSTIC IMAGING SYSTEMS | THEREPEUTIC EQUIPMENTS |
|---|---|---|---|---|---|---|
| | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Anatomy and Physiology | Electrocardiograph | Introduction to cardiac monitor | Basics of diagnostic radiology | Need for cardiac pacemaker |
| | SLO-2 | Physiological system of the body | Block diagram of an ECG machine | Basic Block diagram of Bedside patient monitoring systems | Nature of X-rays | External and Implantable pacemaker |
| S-2 | SLO-1 | Sources of Biomedical signals | Block diagram of an ECG machine | Basic block diagram of Central monitors | Production of X-rays | Need for Defibrillators |
| | SLO-2 | Sources of Biomedical signals | The ECG leads | Measurement of heart rate | Stationary anode tube | DC defibrillator |
| S-3 | SLO-1 | Basic Block diagram of medical instrumentation system | The ECG leads | Average heart rate meters | Rotating anode tube | Implantable defibrillator |
| | SLO-2 | Basic Block diagram of medical instrumentation system | Effects of Artifacts on ECG recording | Instantaneous heart rate meters | Block diagram of an X-ray machine | Principle of surgical diathermy |
| S-4 | SLO-1 | General constraints in design of medical instrumentation system | Block diagram of Microprocessor based ECG machine | Measurement of pulse rate | Block diagram of an X-ray machine | Surgical diathermy machine |
| | SLO-2 | General constraints in design of medical instrumentation system | Phonocardiograph (PCG) | Blood pressure measurement | Introduction to computed tomography | Short wave diathermy |
| S-5 | SLO-1 | Origin of bioelectrical signals | Origin of heart sound | Blood pressure measurement | Introduction to computed tomography | Microwave diathermy and Ultrasonic unit |
| | SLO-2 | Electrocardiogram | Origin of heart sound | Direct methods of monitoring blood pressure | Basic principles of CT | Working of hemodialysis machine |
| S-6 | SLO-1 | Electroencephalogram | Electroencephalograph | Direct methods of monitoring blood pressure | Basic principles of CT | Principle of peritoneal dialysis |
| | SLO-2 | Electromyogram | Electroencephalograph | Indirect methods of monitoring blood pressure | Introduction to Nuclear imaging | Need for anesthesia |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-7** | **SLO-1** | *Recording electrodes* | *Block diagram description of Electroencephalogram* | *Indirect methods of monitoring blood pressure* | *Single photon emission computed tomography* | *Working principle of anesthesia machine* |
| | **SLO-2** | *Silver-silver chloride electrodes* | *Block diagram description of Electroencephalogram* | *Automatic blood pressure measuring apparatus using korotkoffs method* | *Positron emission tomography* | *Mechanics of respiration* |
| **S-8** | **SLO-1** | *Electrodes for ECG* | *Electromyography* | *Ultrasonic method* | *Principle of NMR imaging, spin polarization* | *Ventilators and types of ventilators* |
| | **SLO-2** | *Electrodes for EEG* | *Block diagram description of Electroencephalograph* | *Measurement of Respiration rate* | *Resonance, relaxation, spin echoes, gradient echoes* | *Automated Drug delivery system* |
| **S-9** | **SLO-1** | *Electrodes for EMG* | *Block diagram description of Electroencephalograph* | *Displacement method* | *Introduction to ultrasound* | *Infusion pumps* |
| | **SLO-2** | *Microelectrodes* | *Biofeedback Instrumentation* | *Apnoea detectors* | *Modes of ultrasound* | *Implantable Infusion system* |

| | | |
|---|---|---|
| **Learning Resources** | *1. Jerrold T. Bushberg, John M. Boone, "The essential physics of medical imaging", Lippincott Williams & Wilkins, 3rd edition, 2011.*<br>*2. Rongguang Liang, "Biomedical optical imaging technologies: Design and applications", Springer Science & Business Media, 1st edition, 2012* | *.Nadine Barrie Smith, Andrew Webb, "Introduction to medical imaging: Physics, Engineering and clinical applications", Cambridge University Press, 1st edition, 2010.*<br>*4. M. A. Flower (Editor), "Webb's Physics of medical imaging, Second Edition", CRC Press, Taylor & Francis Group, ISBN: 978-0-7503-0573-0, 2nd edition, 2016.* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

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|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1.Dr.P.Vinupritha, SRMIST* |

| Course Code | 18BMO122T | Course Name | Health information systems | Course Category | O | Open Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the basic of health information |
| CLR-2 : | Appreciate the use new methods in health information acquisition and medical records |
| CLR-3 : | Identifying different architecture of HIS |
| CLR-4 : | Understand strategies in HIS data management regulations |
| CLR-5 : | Use Health information system for the hospital benefit |
| CLR-6 : | Apply HIS usage in Indian context |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning: Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | PLO 1: Engineering Knowledge | PLO 2: Problem Analysis | PLO 3: Design & Development | PLO 4: Analysis, Design, Research | PLO 5: Modern Tool Usage | PLO 6: Society & Culture | PLO 7: Environment & Sustainability | PLO 8: Ethics | PLO 9: Individual & Team Work | PLO 10: Communication | PLO 11: Project Mgt. & Finance | PLO 12: Life Long Learning | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | Appreciate the role of information technologies in potentially revolutionizing healthcare delivery, administration, education, and research | 1, 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-2 : | Integration of existing & emerging technology in Healthcare | 2 | 80% | 70% | M | | | | | | | | | | | | | | |
| CLO-3 : | Know about architecture standards in HIS | 2 | 80% | 70% | | | M | | M | | | | | | | | M | | L |
| CLO-4 : | Identify acceptance testing & issues on standards in HIS | 3 | 80% | 70% | | | L | | M | | | | | | | | | | |
| CLO-5 : | Use health information for computer aided diagnostic purposes | 3 | 80% | 70% | M | | L | | | | | | | | | | M | | L |
| CLO-6 : | Apply Health Information in hospital context | 3 | 80% | 70% | M | | | | | | | M | L | | | | | | |

| | | Foundations of Health Information Management | Medical Records and other documents | Architecture and Interfacing for Healthcare Technology | Regulations and Computer Aided detection | Future of HIS and Technology |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | ***Health Care Systems*** | ***A Brief Introduction to Medical record history*** | ***Complexity of systems in healthcare*** | ***Computer-Aided Diagnostics*** | *eHealth, mHealth* |
| | SLO-2 | ***Evolution Health Care*** | ***Physical Record - Data expected in record*** | ***Wireless networks*** | ***Computer-Aided detection*** | *Equipment used in eHealth, mHealth data* |
| S-2 | SLO-1 | ***Health Informatics*** | ***Health Insurance Portability and Accountability Act (HIPAA)*** | *LAN security* | *Electronic Health Record Data* | *Social Media, and Telemedicine* |
| | SLO-2 | ***Types of data to expect in Life Science*** | ***Problems-advantages of Physical Records*** | *overcoming LAN security vulnerabilities* | *Database Presentation and Statistics* | ***Improved use of Telemedicine*** |
| S-3 | SLO-1 | ***Information Management Profession in Hospitals*** | ***Modules in Hospital Information System(HIS)*** | *Middleware* | *Health Record Data* | *Parts of telemedicine* |
| | SLO-2 | ***Confidentiality Issue, Ethics*** | ***Admission/Discharge/Transfer (ADT) system*** | *Different products in Middleware* | *Representing data* | *Connecting rural India through telemedicine* |
| S-4 | SLO-1 | ***Medical Data , Importance of confidentiality*** | ***Scheduling & Registration*** | ***Network Interoperability*** | ***Public Health Informatics*** | ***Voice enabled recordings in health*** |
| | SLO-2 | ***Personal and Impersonal data*** | ***Pharmacy System*** | ***Platform interoperability*** | ***Patient EHR Databases in public health*** | ***disease progression modeling*** |
| S-5 | SLO-1 | ***Health Information Infrastructure*** | Embedded CDSS | *Database Interoperability* | ***Clinical decision support systems*** | ***Handheld Technologies in Healthcare at home*** |
| | SLO-2 | ***Health Information Systems*** | ***Connecting Teleradiology*** | *GUI/MUI Interoperability* | ***Clinical decision support systems*** | ***Handheld Technologies in Healthcare at hospital*** |
| S-6 | SLO-1 | ***Standalone Information System*** | ***Laboratory Information System(LIS)*** | ***Multi-Location Enterprise*** | ***Privacy and patient protection concerns*** | ***Integrating Handheld Technologies at hospital*** |
| | SLO-2 | ***Clinical Decision Support System(CDSS)*** | ***Laboratory Information System(LIS)*** | ***Inter-enterprise health care solution*** | ***Privacy and patient protection concerns*** | ***Technology for personalized medicine*** |
| S-7 | SLO-1 | ***Hospital Information System(HIS)*** | *Electronic Health Record Data* | ***Timely Admissions, Discharges, and Transfers*** | ***Implementing Computerized Physician Order Entry*** | ***Automated Patient Identification*** |
| | SLO-2 | ***Related Parties in HIS*** | ***Dangers of Large Databases*** | ***Connectivity to Another Health Plan*** | ***Issues and Ethics in HIS*** | ***Automated Patient Identification in medicine*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-8** | **SLO-1** | ***Profit & Nonprofit healthcare stakeholders ; Provider (Hospital)*** | ***Internal Data – Clinical, Administrative*** | ***Information Systems Life Cycle*** | ***Privacy and health Law*** | ***Bar Coding, and Smart Cards*** |
| | **SLO-2** | ***Payers(Insurance Companies) ; Employers ; Practitioners ;*** | ***Use of internal data*** | ***Information Systems Life Cycle*** | ***Predicting Uncertainty*** | ***Applying Bar Coding, and Smart Cards in research in Hospital*** |
| **S-9** | **SLO-1** | ***Public Health Officials; Educator ; Consumers*** | ***External Data – Comparative, Expert Data,*** | ***Health Care Informatics*** | ***Risk management in HIS*** | ***Impact of HIS on Research*** |
| | **SLO-2** | ***Expectations and roles of above parties involved*** | ***External Data- Knowledge Base*** | ***Project management in health Informatics*** | ***Risk management in HIS*** | ***Impact of Technology on Policy, and Public Health*** |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Winter, A., Haux, R., Ammenwerth, E., Brigl, B., Hellrung, N., Jahn, F., "Health Information Systems-Architectures and Strategies", 2nd Edition Number , Springer-Verlag London, 2011*<br>2. *Mervat Abdelhak Mary Alice Hanken, "Health Information: Management of a Strategic Resource" , 5th Edition, Saunders, 2015* | 3. *Karen A. Wager, Frances W. Lee, John P. Glaser, "Health Care Information Systems: A Practical Approach for Health Care Management", John Wiley & Sons, 4th edition, 2017*<br>4. *Jean A Balgrosky, "Essentials of Health Information Systems and Technology" , Jones & Bartlett Publishers, 2014* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1.Mrs.Bhargavi Haripriya, SRMIST* |

| Course Code | 18BMO123T | Course Name | Basics of medical imaging | Course Category | O | Open Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/ Standards | | | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Gain knowledge about the working principle of X-ray imaging | | | |
| CLR-2 : | Understand the working principle of Computed tomography | | | |
| CLR-3 : | Gain knowledge in physics behind nuclear radiation and the imaging modalities in nuclear medicine | | | |
| CLR-4 : | Understand the working principle of ultrasound and its different imaging modalities | | | |
| CLR-5 : | Interpret the working principle of magnetic resonance and its application in imaging | | | |
| CLR-6 : | Understand the physics behind the working of medical imaging modalities | | | |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO – 1: Professional Achievement | PSO – 2: Project Management Techniques | PSO – 3: Analyze & Reseach |
| CLO-1 : | Describe the principle behind the working of X-ray imaging | 1 | 80 | 70 | M | | | | | | | | | | | | M | | |
| CLO-2 : | Explain the understanding of principle behind working of tomographic imaging and reconstruction procedures. | 1, 2 | 80 | 70 | M | | | | | | | | | | | | M | | |
| CLO-3 : | Gain knowledge in working principle of nuclear medicine imaging modalities | 1,2 | 80 | 70 | | | | | | M | | | | | | | | | M |
| CLO-4 : | Understand the physics of ultrasound and the modes of ultrasound imaging | 1 | 80 | 70 | | | | | | M | | | | | | | | | M |
| CLO-5 : | Explain the physical principle of magnetic resonance imaging and the instrumental components involved in MR imaging | 1 | 80 | 70 | M | | | | | | | | | | | | | | M |
| CLO-6 : | Explain the principle, working and clinical application of imaging modality | 1,2 | 80 | 70 | M | | | | | | | | | | | | | | |

| | | X-Ray imaging | Computed Tomography | Nuclear Medicine | Ultrasound | Magnetic Resonance Imaging |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | Principles of Imaging with X-rays | Computed Tomography | General principles of Nuclear Medicine | General Principles -Wave Propagation | Nuclear Magnetism |
| | SLO-2 | Production of X- ray | Historical development | Radioactivity basics | Ultrasound Characteristics | Quantum mechanical description |
| S-2 | SLO-1 | Interaction of X-ray with Tissue-Coherent, Compton and photoelectric effect | Instrumentation | Production of radionuclides | Wave reflection and refraction | Radiofrequency pulse and rotating frame |
| | SLO-2 | Attenuation coefficients of X-rays in tissue | Hounsfield unit | Types of radioactivity | Absorption, Scattering, Attenuation | Spin-Spin and Spin-Lattice relaxation |
| S-3 | SLO-1 | Instrumentation of Planar X-ray imaging-collimators | Detectors and Detector arrays | Instrumentation-Gamma camera | Instrumentation-Transducers | Measurement of T1 and T2 |
| | SLO-2 | Anti-scatter grids | Tomographic reconstruction | Collimators, scintillation crystal | Transducer arrays | Inversion recovery |
| S-4 | SLO-1 | Intensifying screen | Back projection algorithm<br>Digital image display | Photomultiplier tubes | Scanning modes-A-Mode | Spin echo sequences |
| | SLO-2 | Electronic Intensifier | Radiation dose | Pulse height analyzer | B-Mode scan | Slice Selection |
| S-5 | SLO-1 | X-ray Film | Image quality | Single photon emission computed tomography | M-Mode | Phase and frequency encoding |
| | SLO-2 | Image characteristics | Artifacts | Instrumentation | Duplex scanner | |
| S-6 | SLO-1 | Digital radiography | Helical CT | Image reconstruction | Image characteristics- signal to noise ratio | MRI Instrumentation- Block Diagram |
| | SLO-2 | Flat panel detectors | Multislice spiral CT | Clinical Application | Spatial resolution, Contrast -to-noise ratio | Magnets |
| S-7 | SLO-1 | Mammography – Basics | Multislice CT - Detector configurations | Photon Emission Tomography-General Principles | Doppler effect, Continuous wave Doppler | Magnetic field gradient coil |
| | SLO-2 | Mammography – Basic block diagram | | Radionuclides used for PET | | Radiofrequency coil |
| S-8 | SLO-1 | X-ray tube design | Phase selective imaging Introduction | Instrumentation for PET | Color Doppler imaging | Image characteristics |
| | SLO-2 | Digital Mammography | Phase selective imaging Applications | Image reconstruction | Safety in ultrasound imaging | MRI contrast agents |
| S-9 | SLO-1 | Fluoroscopy - Introduction | CT Applications-cerebral scans | Image characteristics | Clinical applications-obstetrics and gynecology | Clinical application-Brain |
| | SLO-2 | Fluoroscopy Imaging system | CT Applications - Pulmonary diseases | Clinical applications of PET | Clinical Applications - Cardiac disease | Clinical application -Cardiac system |

| | | |
|---|---|---|
| **Learning Resources** | 1. R.S.Khandpur., 'Handbook of Biomedical instrumentation', Tata McGraw Hill Publishing Co Ltd., 3rd edition, 2014.<br>2. Jerrold T. Bushberg, John M. Boone., "The essential physics of medical imaging", Lippincott Williams & Wilkins, 3rd edition, 2011. | 3. M. A. Flower (Editor)., "Webb's Physics of medical imaging, Second Edition", CRC Press, Taylor & Francis Group, ISBN: 978-0-7503-0573-0, 2nd edition, 2016. Nadine Barrie Smith, Andrew Webb, "Introduction to medical imaging: Physics, Engineering and clinical applications", Cambridge University Press, 1st edition, 2010.<br>4. K. Kirk Shung, Michael Smith, Benjamin M.W. Tsui., "Principles of medical imaging", Academic Press, 1st edition, 2012. |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

**Course Designers**

| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
|---|---|---|
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1.Dr.S.P.Angeline kirubha SRMIST* |

| Course Code | 20BM0124T | Course Name | REHABILITATION ENGINEERING | Course Category | O | Open elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | Nil | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | | Nil | |

| Course Learning Rationale (CLR): | The purpose of learning this course is to: |
|---|---|
| CLR-1 : | Understand the biomechanics of mobility and universal design |
| CLR-2 : | Learn about personal transportation, manual and powered wheelchairs |
| CLR-3 : | Follow the working of prosthetics, orthotics |
| CLR-4 : | Understand sensorial prostheses |
| CLR-5 : | Perceive the idea of rehabilitation medicine and advocacy |
| CLR-6 : | Explore the advanced technologies in rehabilitation engineering |

| Course Learning Outcomes (CLO): | At the end of this course, learners will be able to: | Learning 1: Level of Thinking (Bloom) | Learning 2: Expected Proficiency (%) | Learning 3: Expected Attainment (%) | PLO 1: Engineering Knowledge | PLO 2: Problem Analysis | PLO 3: Design & Development | PLO 4: Analysis, Design, Research | PLO 5: Modern Tool Usage | PLO 6: Society & Culture | PLO 7: Environment & Sustainability | PLO 8: Ethics | PLO 9: Individual & Team Work | PLO 10: Communication | PLO 11: Project Mgt. & Finance | PLO 12: Life Long Learning | PLO 13: PSO - 1 | PLO 14: PSO - 2 | PLO 15: PSO - 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO-1 : | Explain gait cycle and basic rehabilitation terminologies | 1, 2 | 80% | 70% | | L | L | | | | | | | | | | | | |
| CLO-2 : | Describe the types and technologies with wheelchairs | 2 | 80% | 70% | | M | | M | | | | L | | | | | | | |
| CLO-3 : | Design basic orthotics and prosthetics | 2 | 80% | 70% | | | | M | | | | | | | | | | | |
| CLO-4 : | Describe the possibilities of sensorial prosthetics | 3 | 80% | 70% | | | M | | | | | | | | | | | | L |
| CLO-5 : | Tell about the rehabilitation robotics field | 3 | 80% | 70% | | M | | | | L | | | | | | | | | M |
| CLO-6 : | Explain the various advanced topics and challenges in rehabilitation engineering | 3 | 80% | 70% | L | L | | | | | | | | | | | | L | |

| | | Rehabilitation Engineering Introduction | Wheelchair technologies | Orthotics and Prosthetics | Sensorial Prosthetics | Rehabilitation applications |
|---|---|---|---|---|---|---|
| Duration (hour) | | 9 | 9 | 9 | 9 | 9 |
| S-1 | SLO-1 | ***Introduction to rehabilitation Engineering*** | ***Personal transportation*** | ***Upper extremity-anatomy overview*** | *Sensorial Prosthetics- Introduction* | *Functional electrical stimulation* |
| | SLO-2 | ***Scope*** | ***Associated disabilities*** | ***Lower extremity-anatomy overview*** | *Types of sensorial prosthetics* | *FES application* |
| S-2 | SLO-1 | ***Assistive technology*** | ***Lift mechanisms*** | *Amputation classification* | *Categories of visual impairment* | *Robots in rehabilitation* |
| | SLO-2 | ***Terminologies involved*** | ***Application areas*** | *Prosthesis prescription* | *Cortical implants* | ***Therapeutic robots*** |
| S-3 | SLO-1 | ***Design considerations*** | *Wheelchairs* | *Components of upper limb prosthetics* | *Retinal implants* | *Rehabilitation in sports* |
| | SLO-2 | ***Scope of this field*** | *Types* | *Fabrication techniques* | *Mobility aids for blind* | *Areas of sports application* |
| S-4 | SLO-1 | ***Rehabilitation approaches*** | ***Wheelchair standards*** | *Components of lower limb prosthetics* | ***Aids for reading and writing*** | ***Daily living aids*** |
| | SLO-2 | *Concepts in rehabilitation engineering* | *Safety testing* | *Fabrication techniques* | *Graphic access* | *Daily living aids ctd.* |
| S-5 | SLO-1 | *Universal design* | *Manual wheelchair* | *Latest technologies* | *Orientation and navigation aids* | *Assistive technology for dyslexia* |
| | SLO-2 | *Concept of universal design* | *Components* | *Latest trends in prosthetics* | *Intelligent mobility aids* | *Assistive technology for speech disorders* |
| S-6 | SLO-1 | ***Barrier free design*** | ***Powered wheelchair*** | ***Orthotics*** | ***Hearing functional assessments*** | *Assistive technology for dysphagia* |
| | SLO-2 | ***Disability assessment*** | ***Design considerations*** | ***Needs and types*** | ***Surgical hearing aids*** | *Available types* |
| S-7 | SLO-1 | ***Legal aspects*** | ***Wheels and casters*** | *Lower extremity orthotics* | ***Non surgical hearing aids*** | ***Neurological rehabilitation*** |
| | SLO-2 | ***Provision available*** | ***Motor selection*** | *Types and consideration* | ***Latest technologies*** | ***Cognitive rehabilitation*** |
| S-8 | SLO-1 | ***Mobility*** | ***Batteries and microprocessors used*** | *Upper extremity orthotics* | ***Tactile prosthetics*** | ***Neuromotor rehabilitation*** |
| | SLO-2 | ***Biomechanics of mobility*** | *Smart wheelchair* | *Types and consideration* | ***Tongue prosthetics*** | ***Examples*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-9** | **SLO-1** | *Introduction to Gait cycle* | *Other wheelchair technologies* | *Latest technologies* | ***Olfactory prosthetics*** | *Latest technologies* |
| | **SLO-2** | *Its applications* | ***Human factor*** *,Fault tolerance* | *Latest trends in Orthotics* | *Future of sensorial rehabilitation* | *Future trends* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Rory.A.Cooper, "Rehabilitation Engineering Applied to Mobility and Manipulation", First Edition, CRC Press, 2010*<br>2. *Horia-Nicolai.L.Teodorescu, Lakhmi C. Jain, "Intelligent Systems and Technologies in Rehabilitation Engineering", First Edition, CRC press, 2010.* | 3. *Glenn Hedman, "Rehabilitation Technology", First Edition, Haworth Press Inc, 1990.*<br>4. *Michael P. Barnes, Anthony B. Ward, "Oxford Handbook of Rehabilitation Medicine", First Edition, Oxford University Press, 2005* |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.Varshini Karthik, SRMIST* |

| **Course Code** | 18BMO125T | **Course Name** | Quality control for biomedical devices | **Course Category** | *O* | *Open Elective* | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| | | | | | |
|---|---|---|---|---|---|
| **Pre-requisite Courses** | | **Co-requisite Courses** | *Nil* | **Progressive Courses** | *Nil* |
| **Course Offering Department** | *Biomedical Engineering* | **Data Book / Codes/Standards** | | *Nil* | |

| **Course Learning Rationale (CLR):** | *The purpose of learning this course is to:* | **Learning** | | | **Program Learning Outcomes (PLO)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO - 3 |
| **CLR-1 :** | *Utilize Quality, Quality control measures essential for an organization* | | | | | | | | | | | | | | | | | | |
| **CLR-2 :** | *Utilize the quality management principles and good management practices* | | | | | | | | | | | | | | | | | | |
| **CLR-3 :** | *Utilize the various quality control tools* | | | | | | | | | | | | | | | | | | |
| **CLR-4 :** | *Utilize the various quality management tools* | | | | | | | | | | | | | | | | | | |
| **CLR-5 :** | *Analyze the various standards applicable to healthcare globally and nationally* | | | | | | | | | | | | | | | | | | |
| **CLR-6 :** | *Implement the global standards in healthcare* | | | | | | | | | | | | | | | | | | |
| **Course Learning Outcomes (CLO):** | *At the end of this course, learners will be able to:* | | | | | | | | | | | | | | | | | | |
| **CLO-1 :** | *Analyze the underlying concepts of quality and quality control concepts of an organization* | *1, 2* | *80%* | *70%* | | | | | | | | | | | | | | | |
| **CLO-2 :** | *Evaluate the various quality management principles and good management practices* | *2* | *80%* | *70%* | | | | | | | | | | | | | | | |
| **CLO-3 :** | *Evaluate various tools of quality control* | *2* | *80%* | *70%* | | | | | | | | | | | | | | | |
| **CLO-4 :** | *Analyze the various quality management tools* | *3* | *80%* | *70%* | | | | | | | | | | | | | | | |
| **CLO-5 :** | *Analyze the various standards applicable to healthcare globally and nationally* | *3* | *80%* | *70%* | | *L* | | | | | | | | | | | | | |
| **CLO-6 :** | *Analyze the outcomes of implementing global standards* | *3* | *80%* | *70%* | | | *M* | *L* | *L* | | | | | | | | | *L* | |

| | | Introduction to quality | TQM principles | Statistical process control | TQM tools | Standards for medical devices |
|---|---|---|---|---|---|---|
| **Duration (hour)** | | 9 | 9 | 9 | 9 | 9 |
| **S-1** | **SLO-1** | *Quality: Terminologies* | *Customer satisfaction – Customer Perception of Quality* | *The seven tools of quality* | *Benchmarking* | Standards |
| | **SLO-2** | *Dimensions of Quality* | *Customer Complaints* | *Cause-and-effect diagram* | *Reasons to Benchmark* | *Standards* |
| **S-2** | **SLO-1** | *Quality Planning* | *Service Quality* | *Check sheet* | *Benchmarking Process* | Need for standards |
| | **SLO-2** | *Quality Planning* | *Customer Retention* | *Check sheet* | *Benchmarking Process* | Need for standards |
| **S-3** | **SLO-1** | *Basic concepts of Total Quality Management* | *Employee Involvement* | *Control chart* | *Quality Function Deployment (QFD)* | Types |
| | **SLO-2** | *Basic concepts of Total Quality Management* | *Employee Involvement* | *Control chart* | *Quality Function Deployment (QFD)* | Types |
| **S-4** | **SLO-1** | *Principles of TQM* | *Motivation* | *Histogram* | *House of Quality* | *Medical device safety* |
| | **SLO-2** | *Principles of TQM* | *Motivation* | *Histogram* | *House of Quality* | *medical device quality management systems requirements* |
| **S-5** | **SLO-1** | *Leadership – Concepts* | *Empowerment* | *Pareto chart* | *QFD Process - Benefits* | ISO 9000:2000 Quality System |
| | **SLO-2** | *Role of Senior Management* | *Empowerment* | *Pareto chart* | *QFD Process - Benefits* | Clauses |
| **S-6** | **SLO-1** | *Quality Council* | *Teams* | *Scatter diagram* | *Total Productive Maintenance (TPM) – Concept* | FDA |
| | **SLO-2** | *Quality Statements* | *Teams* | *Scatter diagram* | *Total Productive Maintenance* | *Functions* |
| **S-7** | **SLO-1** | *Strategic Planning* | *Team Work* | *Stratification* | *Improvement Needs* | ASTM International |
| | **SLO-2** | *Strategic Planning* | *Team Work* | *Stratification* | *Improvement Needs* | *Description* |
| **S-8** | **SLO-1** | *Strategic Planning* | *Recognition and Reward* | *Six sigma* | *FMEA* | CE |
| | **SLO-2** | *Strategic Planning* | *Recognition and Reward* | *Six sigma* | *FMEA* | *CE marking* |
| **S-9** | **SLO-1** | *Barriers to TQM Implementation* | *Performance Appraisal* | *Six sigma* | *Stages of FMEA* | IEC |
| | **SLO-2** | *Barriers to TQM Implementation* | *Performance Appraisal* | *Six sigma* | *Stages of FMEA* | *Specifications* |

| | | |
|---|---|---|
| **Learning Resources** | 1. *Rose J.E, Total Quality Management, Kogan Page Ltd., 1993*<br>2. *Cesar A. Cacere, Albert Zana,The Practise of clinical Engineering, Academic Press,1997*<br>3. *Greg Bounds, Beyond Total Quality Management-Toward the emerging paradigm, McGraw Hill, 2013* | 4. *Joseph J.Carr, Elements of Electronics Instrumentation and Measurement, 2nd ed., Pearson Education, 2003*<br>*Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011* |
| | | |

**Learning Assessment**

| | Bloom's Level of Thinking | Continuous Learning Assessment (50% weightage) | | | | | | | | Final Examination (50% weightage) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember<br>Understand | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| Level 2 | Apply<br>Analyze | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| Level 3 | Evaluate<br>Create | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

# CLA – 4 can be from any combination of these: Assignments, Seminars, Tech Talks, Mini-Projects, Case-Studies, Self-Study, MOOCs, Certifications, Conf. Paper etc.,

| **Course Designers** | | |
|---|---|---|
| Experts from Industry | Experts from Higher Technical Institutions | Internal Experts |
| *Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives* | *Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University* | *1. Dr.D.Kathirvelu SRMIST* |

| Course Code | 18BMO126T | Course Name | Biomechanics of Human Movements | Course Category | O | Open Elective | L | T | P | C |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 3 | 0 | 0 | 3 |

| Pre-requisite Courses | | Co-requisite Courses | Nil | Progressive Courses | Nil |
|---|---|---|---|---|---|
| Course Offering Department | Biomedical Engineering | Data Book / Codes/Standards | Nil | | |

**Course Learning Rationale (CLR):** *The purpose of learning this course is to:*

| | | Learning | | |
|---|---|---|---|---|
| | | 1 | 2 | 3 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) |
| CLR-1 : | Identify essential anatomical components of the musculoskeletal system. | | | |
| CLR-2 : | Get an idea about movements using standard anatomical terminology.. | | | |
| CLR-3 : | Identify key contributors to the various events in a gait cycle. | | | |
| CLR-4 : | Describe measurements used in analysis of human movement. | | | |
| CLR-5 : | Identify causes and compensation mechanisms for pathological gait | | | |
| CLR-6 : | Perform inverse dynamic analysis to determine internal forces and internal moments | | | |

**Course Learning Outcomes (CLO):** *At the end of this course, learners will be able to:*

| | | Learning | | | Program Learning Outcomes (PLO) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| | | Level of Thinking (Bloom) | Expected Proficiency (%) | Expected Attainment (%) | Engineering Knowledge | Problem Analysis | Design & Development | Analysis, Design, Research | Modern Tool Usage | Society & Culture | Environment & Sustainability | Ethics | Individual & Team Work | Communication | Project Mgt. & Finance | Life Long Learning | PSO - 1 | PSO - 2 | PSO – 3 |
| CLO-1 : | *Apply the common troubleshooting procedures in Electronic Equipment and Outline the testing procedures of active and passive components* | *1, 2* | *80* | *70* | *M* | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CLO-2 : | *Analyze the faults in analog circuits and digital ICs* | *1, 2* | *80* | *70* | *M* | - | - | - | - | - | - | - | - | - | - | - | *M* | - | - |
| CLO-3 : | *Identify the problems in common biomedical equipment in hospitals when it is not working and provide a suitable solution* | *2* | *80* | *70* | - | *M* | - | - | - | - | - | - | - | - | - | - | *M* | | - |
| CLO-4 : | *Outline the importance of medical device classification based on the application and ISO standards* | *1* | *80* | *70* | - | - | *H* | - | - | - | - | - | - | - | - | *M* | - | *M* | - |
| CLO-5 : | *Describe the Indian medical device regulatory system* | *1* | *80* | *70* | - | - | - | - | - | - | - | - | - | - | - | *M* | - | - | - |
| CLO-6 : | *Outline the job opportunities in regulatory affairs in India* | *1,2* | *80* | *70* | - | - | - | - | - | - | - | - | - | - | - | *L* | - | - | - |

| Duration (hour) | | Introduction to Biomechanics | Biomechanics of Human Movements | Joint Mobility | Measurement of Human Movement | Restoring and optimizing human movements |
|---|---|---|---|---|---|---|
| | | 9 | | 9 | 9 | 9 |
| S-1 | SLO-1 | *Under standing movement for réhabilitation* | *Structure of Protein filaments* | *Introduction to joint mobility* | *Linear Kinematics* | *Basic Principles of motor learning* |
| | SLO-2 | *Under standing movement for réhabilitation* | *The sarcomere anatomical details* | *Introduction to joint mobility* | *Angular Kinematics* | *Theories of skill learning* |
| S-2 | SLO-1 | *Force measurement* | *The difference between muscle force and muscle strength* | *Factors involved in assisting and restricting range of movements* | *Forces and movements* | *The balance theory model* |
| | SLO-2 | *Vector,scalar general introduction* | *Muscle work* | *Factors involved in assisting and restricting range of movements* | *Newton's First law of motion* | *The task environment* |
| S-3 | SLO-1 | *Drawing vectors ,point of application* | *Muscle strength* | *Normal range definition* | *Newton's second law of motion* | *The task design* |
| | SLO-2 | *Drawing vectors ,point of application.* | *Muscle fiber types* | *Normal range* | *Newton's third law of motion* | *The task design* |
| S-4 | SLO-1 | *The force of muscles working principle* | *Gradation of muscle force* | *Abnormal limitations* | *Full three dimensional motion capture* | *Gait of the child with cerebral palsy before and after surgery* |
| | SLO-2 | *Magnitude and direction of moments* | *Length-Tension relationship* | *Abnormal limitations* | *Full three dimensional motion capture* | *Gait of the child with cerebral palsy before and after surgery* |
| S-5 | SLO-1 | *Measuring force basic model* | *Active and passive tension measurement technique* | *Effects of decreased range of movements* | *Movement assessment systems* | *The sit to stand movement* |
| | SLO-2 | *Gravity* | *Force –Velocity relationship* | *Effects of decreased range of movements* | *Movement assessment systems* | *The sit to stand movement* |
| S-6 | SLO-1 | *Moments and posture* | *Angle of pull* | *Types of therapeutic movement of joints* | *Visual movement evaluation* | *Upper limb impairment after stroke* |
| | SLO-2 | *Moments and posture* | *Stability and sequencing* | *Types of therapeutic movement of joints* | *Linear Displacement* | *Upper limb impairment after stroke* |

| | | | | | | |
|---|---|---|---|---|---|---|
| **S-7** | **SLO-1** | *Standing balance* | *Stability and sequencing* | *Passive movements* | *Angular Displament* | *Medical history and evaluation* |
| | **SLO-2** | *Standing balance* | *Measuring muscle strength ,endurance* | *Passive movements* | *Body functions and structures* | *Medical history and evaluation* |
| **S-8** | **SLO-1** | *Force magnitude and change in motion* | *Measuring muscle strength ,endurance* | *Active movements* | *Case study 1:treadmill training* | *Motor impairment* |
| | **SLO-2** | *Force magnitude and change in motion* | *Increased vascularization* | *Active movements* | *Case study 1:treadmill training* | *Motor impairment* |
| **S-9** | **SLO-1** | *Local and general stability* | *Increased strength* | *Normal joint constraint in an intact systems* | *Promoting physical activity to improve health* | *Functional limitations* |
| | **SLO-2** | *Local and general stability* | *Increased endurance* | *Normal joint constraint in an intact systems* | *Promoting physical activity to improve health* | *Functional limitations* |

| | |
|---|---|
| **Learning Resources** | 1. **B**asic Biomechanics of the Musculoskeletal System, Margareta Nordin and Victor Frankel Lippincott Williams & Wilkins, 2001<br>2. Biomechanical Analysis of Fundamental Human Movements, Arthur Chapman First Edition 2013<br>3. Biomechanics and Motor Control of Human Movement, David Winter 17 September 2009, 2009 John Wiley & Sons, Inc. |

**Learning Assessment**

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|---|---|---|---|---|---|---|---|---|---|---|---|
| | | CLA – 1 (10%) | | CLA – 2 (15%) | | CLA – 3 (15%) | | CLA – 4 (10%)# | | | |
| | | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice | Theory | Practice |
| Level 1 | Remember | *40 %* | - | *40 %* | - | *40 %* | - | *30 %* | - | *30%* | - |
| | Understand | | | | | | | | | | |
| Level 2 | Apply | *40 %* | - | *40 %* | - | *40 %* | - | *40 %* | - | *40%* | - |
| | Analyze | | | | | | | | | | |
| Level 3 | Evaluate | *20 %* | - | *20 %* | - | *20 %* | - | *30 %* | - | *30%* | - |
| | Create | | | | | | | | | | |
| | Total | 100 % | | 100 % | | 100 % | | 100 % | | 100 % | |

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