# VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY

## (Autonomous)

Thindal, Erode - 638 012

(Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai)
(Accredited by NAAC with 'A+' grade)



## REGULATIONS 2022

## CURRICULUM AND SYLLABUS

## BE - BIOMEDICAL ENGINEERING

## Choice Based Credit System (CBCS)

## SUMMARY OF CREDITS

| S.No | Course Category | Credits per Semester | | | | | | | | Total Credits | Credits in % | Credits as per AICTE Model Curriculum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
| 1 | HS | 4 | 4 | | | | | 4 | | 12 | 7.27% | 12 |
| 2 | BS | 11 | 5 | 4 | 4 | | | | | 24 | 15% | 25 |
| 3 | ES | 4 | 8 | 4 | 4 | | | | | 20 | 12.5% | 24 |
| 4 | PC | - | 6 | 14 | 17 | 12 | 12 | 4 | | 65 | 38.92% | 48 |
| 5 | PE | | | | | 6 | 6 | 6 | | 18 | 11.25% | 18 |
| 6 | OE | | | | | 3 | 3 | 3 | | 9 | 5.62% | 18 |
| 7 | EC | | | | | | 3 | 2 | 12 | 17 | 10.49% | 15 |
| 8 | MC | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | - |
| 9 | VC | | | | | ✓ | | | | | | - |
| 10 | OC, SC, AC | | | | | ✓ | | | | | | - |
| Total Credits / Sem | | 19 | 23 | 22 | 25 | 21 | 24 | 19 | 12 | 165 | | 160 |

HS - Humanities and Social Science
BS - Basic Science
ES - Engineering Science
PC - Professional Core
PE - Professional Elective
OE - Open Elective
EC - Employability Enhancement Course (Project, Seminar, Internship, etc.)
MC - Mandatory Course
VC - Value added course (If three or more credits earned, then one elective course may be exempted)
OC - Online Course (If six or more credits earned, then two elective courses may be exempted)
SC - Self Study course
AC - Audit Course

## ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For Minor Degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes.

| | | VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous) | CURRICULUM |
|---|---|---|---|
| | | | UG |
| | | | R - 2022 |

| Department | Biomedical Engineering |
|---|---|
| Programme | BE- Biomedical Engineering |

### SEMESTER 1

| S. No | Course Code | Course Title | Category | L | T | P | Credits | CA | SE | Tot. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22MCT01 | Induction Programme | - | - | - | - | 0 | - | - | - |
| **Theory** | | | | | | | | | | |
| 2 | 22ENT11 | Communicative English (For Students admitted in the AY 2022-23 only) | HS | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2a | 22ENT11 | Communicative English (For Students admitted from the AY 2023-24 onwards) | HS | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22MAT11 | Matrices And Differential Equations | BS | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 4 | 22PHT11 | Engineering Physics | BS | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22CYT11 | Engineering Chemistry | BS | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22CST11 | Python Programming | ES | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22HST11 | தமிழர்மரபு Tamil Heritage (For Students admitted from the AY 2023-24 onwards) | HS | 1 | 0 | 0 | 1 | 40 | 60 | 100 |
| **Practical** | | | | | | | | | | |
| 8 | 22PHL11 | Physics And Chemistry Laboratory I | BS | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| 9 | 22CSL11 | Python Programming Laboratory (For Students admitted in the AY 2022-23 & 2023-24 only) | ES | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| 9a | 22CSL11 | Python Programming Laboratory (For Students admitted in the AY 2024-25 onwards) | ES | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| **Mandatory** | | | | | | | | | | |
| 10 | 22MCT02 | Universal Human Values | MC | 0 | 0 | 3 | 0 | 100 | 0 | 100 |
| | | | | | | **Total Credits** | 19 | | | |

### SEMESTER 2

| S. No | Course Code | Course Title | Category | L | T | P | Credits | CA | SE | Tot. |
|---|---|---|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | | | | |
| 1 | 22ENT21 | Professional English (For Students admitted in the AY 2022-23 only) | HS | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 1a | 22ENT21 | Professional English (For Students admitted from the AY 2023-24 onwards) | HS | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22MAT21 | Calculus and Complex Analysis | BS | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 3 | 22BMT21 | Medical Physics | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22MET11 | Engineering Graphics | ES | 2 | 0 | 4 | 4 | 40 | 60 | 100 |
| 5 | 22BMT22 | Human Anatomy And Physiology | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22BMT23 | Basic Electrical Engineering | ES | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22HST21 | தமிழரும் தொழில்நுட்பமும் (For Students admitted from the AY 2023-24 onwards) | HS | 1 | 0 | 0 | 1 | 40 | 60 | 100 |
| 8 | 22HST11 | தமிழர் மரபு (For Students admitted in the AY 2022-23 only) | HS | 1 | 0 | 0 | 1 | 40 | 60 | 100 |

| | | **Practical** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 22PHL21 | Physics And Chemistry Laboratory II | BS | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| 10 | 22MEL11 | Workshop Practices Laboratory | ES | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| | | **Mandatory** | | | | | | | | |
| 11 | 22MCT03 | Environmental Science And Engineering | MC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |
| | | | | **Total Credits** | | | 23 | | | |

| | | **SEMESTER 3** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S. No | Course Code | Course Title | Category | | | | Credits | | | |

| S. No | Course Code | Course Title | Category | Periods / Week | | | Credits | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | CA | SE | Tot. |
| | | **Theory** | | | | | | | | |
| 1 | 22MAT31 | Transform Techniques and their Applications | BS | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 2 | 22BMT31 | Signals and Systems | PC | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 3 | 22BMT32 | Biochemistry | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22BMT33 | Semiconductor Devices | ES | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22BMT34 | Sensors and Measurements | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22BMT35 | Biomaterials and Artificial Organs (For Students admitted in the AY 2022-23 & 2023-24 only) | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6a | 22BMT35 | Biomaterials and Artificial Organs (For Students admitted in the AY 2024-25 onwards) | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22HST21 | தமிழரும் தொழில்நுட்பமும் (For Students admitted in the AY 2022-23 only) | MC | 1 | 0 | 0 | 1 | 40 | 60 | 100 |
| | | **Practical** | | | | | | | | |
| 8 | 22BML31 | Circuits and Devices Laboratory | ES | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| 9 | 22BML32 | Biochemistry and Human Physiology Laboratory | PC | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| | | **Mandatory** | | | | | | | | |
| 10 | 22MCL04 | English for Professionals (For Students admitted in the AY 2022-23 & 2023-24 only) | MC | 0 | 0 | 2 | 0 | 100 | 0 | 100 |
| 10a | 22MCL04 | English for Professionals (For Students admitted in the AY 2024-25 onwards) | MC | 0 | 0 | 2 | 0 | 100 | 0 | 100 |
| | | | | **Total Credits** | | | 22 | | | |

| S. No | Course Code | Course Title | Category | Periods / Week | | | Credits | Max. Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | **SEMESTER 4** | | | | | | | | |
| | | | | L | T | P | | CA | SE | Tot. |
| | | **Theory** | | | | | | | | |
| 1 | 22MAT41 | Probability and Random Processes | BS | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 2 | 22ITT44 | Data Structures using C | ES | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BMT41 | Electronic Circuits | PC | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 4 | 22BMT42 | Analog and Digital Integrated Circuits | PC | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 5 | 22BMC43 | Pathology and Microbiology | PC | 3 | 0 | 2 | 4 | 50 | 50 | 100 |

| 6 | 22BMT44 | Hospital Management | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
|---|---------|---------------------|----|----|----|----|----|----|----|----|
| **Practical** | | | | | | | | | | |
| 7 | 22BML41 | Electronic Circuits Laboratory | PC | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| 8 | 22BML42 | Analog and Digital Integrated Circuits Laboratory | PC | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| 9 | 22ITL43 | Data Structures using C Laboratory | PC | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| **Total Credits** | | | | | | | 25 | | | |

| **SEMESTER 5** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S. No | Course Code | Course Title | Category | Periods / Week | | | Credits | Max. Marks | | |
| | | | | L | T | P | | CA | SE | Tot. |
| **Theory** | | | | | | | | | | |
| 1 | 22ITT31 | Object Oriented Programming using Java | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22BMT51 | Medical Instrumentation – I | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BMT52 | Biosignal Processing | PC | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 4 | | Professional Elective – 1 | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | | Professional Elective – 2 | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | | Open Elective – 1 | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **Practical** | | | | | | | | | | |
| 7 | 22ITL31 | Object Oriented Programming Laboratory | PC | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| 8 | 22BML51 | Biosignal Processing Laboratory | PC | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| **Mandatory** | | | | | | | | | | |
| 9 | 22MCT05 | Aptitude and Logical Reasoning | MC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |
| 10 | 22MCL06 | Communication Skills Laboratory | MC | 0 | 0 | 2 | 0 | 100 | 0 | 100 |
| **Total Credits** | | | | | | | 21 | | | |

| **SEMESTER 6** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S. No | Course Code | Course Title | Category | Periods / Week | | | Credits | Max. Marks | | |
| | | | | L | T | P | | CA | SE | Tot. |
| **Theory** | | | | | | | | | | |
| 1 | 22BMT61 | Bio Control Systems | PC | 3 | 1 | 0 | 4 | 40 | 60 | 100 |
| 2 | 22BMT62 | Medical Instrumentation – II | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BMT63 | Microprocessors and Microcontrollers | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | | Professional Elective – 3 | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | | Professional Elective – 4 | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | | Open Elective – 2 | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **Practical** | | | | | | | | | | |
| 7 | 22BML61 | Medical Instrumentation Laboratory | PC | 0 | 0 | 2 | 1 | 60 | 40 | 100 |

| 8 | 22BML62 | Microprocessors and Microcontrollers Laboratory | PC | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| 9 | 22BML63 | Mini Project | EC | 0 | 0 | 6 | 3 | 40 | 60 | 100 |
| | | | | | | Total Credits | 24 | | | |

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|---|---|---|---|---|---|---|---|---|---|---|
| **SEMESTER 7** | | | | | | | | | | |
| S. No | Course Code | Course Title | Category | Periods / Week | | | Credits | Max. Marks | | |
| | | | | L | T | P | | CA | SE | Tot. |
| **Theory** | | | | | | | | | | |
| 1 | 22ITT71 | Economics and Management for Engineers | HS | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22BMT71 | Medical Image Processing | PC | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | | Professional Elective – 5 | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | | Professional Elective – 6 | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | | Open Elective – 3 | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22HST71 | Human Values and Professional Ethics | HS | 1 | 0 | 0 | 1 | 40 | 60 | 100 |
| **Practical** | | | | | | | | | | |
| 7 | 22BML71 | Medical Image Processing Laboratory | PC | 0 | 0 | 2 | 1 | 60 | 40 | 100 |
| 8 | 22BML72 | Hospital Training | EC | 0 | 0 | 4 | 2 | 60 | 40 | 100 |
| **Mandatory** | | | | | | | | | | |
| 9 | 22MCT07 | Indian Constitution and Traditional Knowledge | MC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |
| | | | | | | Total Credits | 19 | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **SEMESTER 8** | | | | | | | | | | |
| S. No | Course Code | Course Title | Category | Periods / Week | | | Credits | Max. Marks | | |
| | | | | L | T | P | | CA | SE | Tot. |
| **Practical** | | | | | | | | | | |
| 1 | 22BML81 | Internship | EC | - | - | - | 2 | 100 | - | 100 |
| 2 | 22BML82 | Project Work | EC | - | - | 20 | 10 | 40 | 60 | 100 |
| | | | | | | Total Credits | 12 | | | |
| | | | | | | Overall Credits | 165 | | | |

# PROFESSIONAL ELECTIVE COURSES: VERTICALS

| Vertical I<br>Healthcare Devices | Vertical II<br>Signal & Image<br>Processing | Vertical III<br>Communication &<br>Networks | Vertical IV<br>Mechanics & Systems | Vertical V<br>Bio Engineering | Vertical VI<br>Healthcare<br>Management |
|---|---|---|---|---|---|
| Biosensors and Transducers | Speech Processing | Analog and Digital Communication | Biomechanics | BioMEMS & NEMS | Modern Trends in Planning and Design of Hospitals |
| Radiological Equipment | Biometric Systems | Computer Networks | Biofluids & Dynamics | Principles of Tissue Engineering | Electrical Safety & Quality Assurance |
| Wearable Systems | Computer Vision | Embedded Systems and IoT | Rehabilitation Engineering | Principles of Genetic Engineering | Medical Ethics & Standards |
| Human Assist Devices | Virtual Instrumentation | Wireless Sensor Networks | Physiological Modeling | Pharmaceutical Engineering | Foundation Skills in Integrated Product Development |
| Ophthalmology and Dentistry Equipment | Healthcare Analytics | Virtual Reality in Medicine | Robotics in Medicine | Biophotonics | Biomedical Waste Management |
| Surgical Assist Devices | Pattern Recognition & Neural Network | Medical Informatics | Biomimetics | Analytical Instrumentation | Troubleshooting and Maintenance of Medical Equipment |
| Medical Device Design | Brain Computer Interface & Applications | Telehealth Technology | Forensic Science in Healthcare | Biostatistics | Medical Device Regulation & Safety |

**Registration of Professional Elective Courses from Verticals:**

Professional Elective Courses will be registered in Semesters **V and VI**. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted **to choose all the Professional Electives from a particular vertical or from different verticals**. Further, only **one Professional Elective** course shall be chosen in a semester **horizontally (row-wise).** However, **two** courses are permitted from the **same row**, **provided one course is enrolled in Semester V and another in semester VI.**

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2022.

| S. No | Course Code | Course Title | Category | L | T | P | Credits | CA | SE | Tot. |
|---|---|---|---|---|---|---|---|---|---|---|
| all | | **PROFESSIONAL ELECTIVE COURSES: VERTICALS** | | | | | | | | |

| S. No | Course Code | Course Title | Category | L | T | P | Credits | CA | SE | Tot. |
|---|---|---|---|---|---|---|---|---|---|---|
| **VERTICAL 1: HEALTHCARE DEVICES** | | | | | | | | | | |
| 1 | 22BME11 | Biosensors and Transducers | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22BME12 | Radiological Equipment | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BME13 | Wearable Systems | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22BME14 | Human Assist Devices | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22BME15 | Ophthalmology and Dentistry Equipment | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22BME16 | Surgical Assist Devices | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22BME17 | Medical Device Design | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **VERTICAL 2: SIGNAL & IMAGE PROCESSING** | | | | | | | | | | |
| 1 | 22BME21 | Speech Processing | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22BME22 | Biometric Systems | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BME23 | Computer Vision | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22BME24 | Virtual Instrumentation | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22BME25 | Healthcare Analytics | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22BME26 | Pattern Recognition & Neural Network | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22BME27 | Brain Computer Interface & Applications | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **VERTICAL 3: COMMUNICATION & NETWORKS** | | | | | | | | | | |
| 1 | 22BME31 | Analog and Digital Communication | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22BME32 | Computer Networks | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BME33 | Embedded Systems and IoT | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22BME34 | Wireless Sensor Networks | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22BME35 | Virtual Reality in Medicine | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22BME36 | Medical Informatics | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22BME37 | Telehealth Technology | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **VERTICAL 4: MECHANICS & SYSTEMS** | | | | | | | | | | |
| 1 | 22BME41 | Biomechanics | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100. |
| 2 | 22BME42 | Biofluids & Dynamics | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BME43 | Rehabilitation Engineering | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22BME44 | Physiological Modeling | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22BME45 | Robotics in Medicine | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22BME46 | Biomimetics | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22BME47 | Forensic Science in Healthcare | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **VERTICAL 5: BIO ENGINEERING** | | | | | | | | | | |
| 1 | 22BME51 | BioMEMS & NEMS | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22BME52 | Principles of Tissue Engineering | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BME53 | Principles of Genetic Engineering | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22BME54 | Pharmaceutical Engineering | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |

| 5 | 22BME55 | Biophotonics | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
|---|---------|--------------|-----|---|---|---|---|----|----|-----|
| 6 | 22BME56 | Analytical Instrumentation | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22BME57 | Biostatistics | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |

| VERTICAL 6: HEALTHCARE MANAGEMENT | | | | | | | | | | |
|---|---------|--------------|-----|---|---|---|---|----|----|-----|
| 1 | 22BME61 | Modern Trends in Planning and Design of Hospitals | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22BME62 | Electrical Safety  & Quality Assurance | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BME63 | Medical Ethics & Standards | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22BME64 | Productivity Management & Engineering | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22BME65 | Biomedical Waste Management | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22BME66 | Troubleshooting and Maintenance of Medical Equipment | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22BME67 | Medical Device Regulation & Safety | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |

| OPEN ELECTIVES | | | | | | | | | | |
|------|----------------|--------------|----------|---|---|---|---------|-----|-----|------|
| S. No | Course Code | Course Title | Category | Periods / Week L | T | P | Credits | CA | SE | Tot. |
| OFFERED BY DEPARTMENT OF BIO MEDICAL ENGINEERING | | | | | | | | | | |
| 1 | 22BMO01 | Biometric systems and their applications | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22BMO02 | Healthcare Management Systems | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22BMO03 | Basics of Bioinformatics | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22BMO04 | Biology for Engineers | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22BMO05 | Regulatory requirements in Pharmaceutical Industries | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22BMO06 | Rapid Prototyping | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22BMO07 | Radiotheraphy basics and Applications | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 8 | 22BMO08 | Nanotechnology and Applications | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| OFFERED BY DEPARTMENT OF CIVIL ENGINEERING | | | | | | | | | | |
| 1 | 22CEO01 | Civil and Infrastructure Engineering | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22CEO02 | Environmental Pollution and Waste Management | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22CEO03 | Disaster Management and Mitigation | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22CEO04 | Building Services | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| OFFERED BY DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING | | | | | | | | | | |
| 1 | 22CSO01 | Foundation of AR/VR | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22CSO02 | Web Designing | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22CSO03 | Block Chain fundamentals | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22CSO04 | Knowledge Management | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22CSO05 | Cloud Computing Essentials | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |

| | | OFFERED BY DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE ENGINEERING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 22ADO01 | Fundamentals of Database | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22ADO02 | Data Science for Engineers | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22ADO03 | Cyber Security | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22ADO04 | Data Visualization | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22ADO05 | Business Analytics | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| | | OFFERED BY DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING | | | | | | | | |
| 1 | 22ECO01 | Consumer Electronics | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22ECO02 | Advanced Mobile Communication | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22ECO03 | Optoelectronics | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22ECO04 | IOT System Design and Applications | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22ECO05 | 5G Technologies | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| | | OFFERED BY DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING | | | | | | | | |
| 1 | 22EEO01 | Domestic and Industrial Electrical Installations | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22EEO02 | Renewable Energy Sources | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22EEO03 | Electric Vehicles | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22EEO04 | Energy Auditing and Conservation | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| | | OFFERED BY DEPARTMENT OF MECHANICAL ENGINEERING | | | | | | | | |
| 1 | 22MEO01 | Industrial Instrumentation | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22MEO02 | Product Design and Development | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22MEO03 | Sustainable Manufacturing | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22MEO04 | Entrepreneurship Development | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22MEO05 | Fundamentals of Ergonomics | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22MEO06 | Principles of Management and Industrial Psychology | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22MEO07 | Safety Measures for Engineers | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| | | OFFERED BY DEPARTMENT OF MEDICAL ELECTRONICS | | | | | | | | |
| 1 | 22MDO01 | Introduction to Medical Electronics | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22MDO02 | Hospital Waste Management | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22MDO03 | Hospital Information System | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22MDO04 | IoT Applications in Healthcare | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| | | OFFERED BY DEPARTMENT OF INFORMATION TECHNOLOGY | | | | | | | | |
| 1 | 22ITO01 | Basics of Java Programming | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22ITO02 | Ethical Hacking | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22ITO03 | E-Commerce and Applications | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22ITO04 | Basics of Android Application Development | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22ITO05 | Web Essentials | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22ITO06 | Digital Video Editing | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| | | OFFERED BY DEPARTMENT OF SCIENCE AND HUMANITIES | | | | | | | | |
| 1 | 22GEO01 | National Cadet Corps Studies – I | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22GEO02 | National Cadet Corps Studies – II | OE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |

## MANDATORY COURSES

| S. No | Course Code | Course Title | Category | L | T | P | Credits | CA | SE | Tot. |
|-------|-------------|--------------|----------|---|---|---|---------|-----|-----|------|
| 1 | 22MCT01 | Induction Programme | - | - | - | - | 0 | - | - | - |
| 2 | 22MCT02 | Universal Human Values | MC | 0 | 0 | 3 | 0 | 100 | 0 | 100 |
| 3 | 22MCT03 | Environmental Science and Engineering | MC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |
| 4 | 22MCL04 | English for Professionals | MC | 0 | 0 | 2 | 0 | 100 | 0 | 100 |
| 5 | 22MCT05 | Aptitude and Logical Reasoning | MC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |
| 7 | 22MCL06 | Communication Skills Laboratory | MC | 0 | 0 | 2 | 0 | 100 | 0 | 100 |
| 9 | 22MCT07 | Indian Constitution and Traditional Knowledge | MC | 2 | 0 | 0 | 0 | 100 | 0 | 100 |

## OTHER COURSES

| S. No | Course Code | Course Title | Category | L | T | P | Credits | CA | SE | Tot. |
|-------|-------------|--------------|----------|---|---|---|---------|-----|-----|------|
| 1 | 22HST11 | தமிழர்மரபு (Heritage of Tamils) | HS | 1 | 0 | 0 | 1 | 40 | 60 | 100 |
| 2 | 22HST21 | தமிழரும்தொழில்நுட்பமும் (Tamils and Technology) | HS | 1 | 0 | 0 | 1 | 40 | 60 | 100 |
| 3 | 22HST71 | Human Values and Professional Ethics | HS | 3 | 0 | 0 | 3 | 40 | 60 | 100 |

## VALUE ADDED COURSES

| S. No | Course Code | Course Title | Category | L | T | P | Credits | CA | SE | Tot. |
|-------|-------------|--------------|----------|---|---|---|---------|-----|-----|------|
| 1 | 22BMV01 | Industrial Internet of Things | VC | 0 | 0 | 2 | 1 | 100 | 0 | 100 |
| 2 | 22BMV02 | Biomedical Signal and Image Processing using NI Vision and Biomedical Toolkit | VC | 0 | 0 | 2 | 1 | 100 | 0 | 100 |
| 3 | 22BMV03 | Training on Machine Learning | VC | 0 | 0 | 2 | 1 | 100 | 0 | 100 |

L - Lecture Period            CA - Continuous Assessment
T - Tutorial Period           SE - Semester Examination
P - Practical Period          Tot - Total Marks

| Category | Credits | Minimum contact periods per week | |
|----------|---------|----------------------------------|---|
| Theory | 3 | 3 | 1 Period = 50 Minutes duration |
| | 4 | 4 | |
| Practical | 1 | 2 | |

## VERTICALS FOR MINOR DEGREE

### (In addition to all the verticals of other programmes)

| Vertical I Fintech and Block Chain | Vertical II Entrepreneurship | Vertical III Public Administration | Vertical IV Business Data Analytics | Vertical V Environmental and Sustainability | Vertical VI Artificial Intelligence |
|---|---|---|---|---|---|
| Financial Management | Foundations of Entrepreneurship | Principles of Public Administration | Statistics for Management | Sustainable infrastructure Development | Introduction to Data Science |
| Fundamentals of Investment | Team Building & Leadership Management for Business | Constitution of India | Data mining for Business Intelligence | Sustainable Agriculture and Environmental Management | Principles of Artificial Intelligence |
| Banking, Financial Services and Insurance | Creativity & Innovation in Entrepreneurship | Public Personnel Administration | Human Resource Analytics | Sustainable Bio Materials | Data Warehousing and Data Mining |
| Introduction to Blockchain and its Applications | Principles of Marketing Management For Business | Administrative Theories | Digital Marketing and Social Network Analytics | Materials for Energy Sustainability | Machine Learning Techniques |
| Fintech Personal Finance and Payments | Human Resource Management for Entrepreneurs | Indian Administrative System | Supply Chain Analytics | Green Technology | Expert Systems |
| Introduction to Fintech | Financing New Business Ventures | Public Policy Administration | Financial Analytics | Environmental Quality Monitoring and Analysis | Cognitive Science |
| - | - | - | - | Integrated Energy Planning for Sustainable Development | Gamification |
| - | - | - | - | Energy Efficiency for Sustainable Development | - |

| S. No | Course Code | Course Title | Category | L | T | P | Credits | CA | SE | Tot. |
|---|---|---|---|---|---|---|---|---|---|---|
| Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals ||||||||||| |
| VERTICAL 1: FINTECH AND BLOCK CHAIN ||||||||||| |
| 1 | 22ITM11 | Financial Management | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22ITM12 | Fundamentals of Investment | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22ITM13 | Banking, Financial Services and Insurance | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22ITM14 | Introduction to Blockchain and its Applications | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22ITM15 | Fintech Personal Finance and Payments | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22ITM16 | Introduction to Fintech | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| VERTICAL 2: ENTREPRENEURSHIP ||||||||||| |
| 1 | 22MEM21 | Foundations of Entrepreneurship | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22MEM22 | Team Building and Leadership Management for Business | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22MEM23 | Creativity and Innovation in Entrepreneurship | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22MEM24 | Principles of Marketing Management for Business | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22MEM25 | Human Resource Management for Entrepreneurs | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22MEM26 | Financing New Business Ventures | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| VERTICAL 3: PUBLIC ADMINISTRATION ||||||||||| |
| 1 | 22ECM31 | Principles of Public Administration | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22ECM32 | Constitution of India | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22ECM33 | Public Personnel Administration | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22ECM34 | Administrative Theories | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22ECM35 | Indian Administrative System | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22ECM36 | Public Policy Administration | PE | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| VERTICAL 4: BUSINESS DATA ANALYTICS ||||||||||| |
| 1 | 22CSM41 | Statistics for Management | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22CSM42 | Data mining for Business Intelligence | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22CSM43 | Human Resource Analytics | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22CSM44 | Digital Marketing and Social Network Analytics | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22CSM45 | Supply Chain Analytics | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22CSM46 | Financial Analytics | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| VERTICAL 5: ENVIRONMENTAL AND SUSTAINABILITY ||||||||||| |
| 1 | 22CEM51 | Sustainable infrastructure Development | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22CEM52 | Sustainable Agriculture and Environmental Management | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22CEM53 | Sustainable Bio Materials | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |

| 4 | 22CEM54 | Materials for Energy Sustainability | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
|---|---------|-------------------------------------|----|---|---|---|---|----|----|-----|
| 5 | 22CEM55 | Green Technology | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22CEM56 | Environmental Quality Monitoring and Analysis | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22CEM57 | Integrated Energy Planning for Sustainable Development | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 8 | 22CEM58 | Energy Efficiency for Sustainable Development | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| **VERTICAL 6: ARTIFICIAL INTELLIGENCE** | | | | | | | | | | |
| 1 | 22ADM61 | Introduction to Data Science | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 2 | 22ADM62 | Principles of Artificial Intelligence | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 3 | 22ADM63 | Data Warehousing and Data Mining | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 4 | 22ADM64 | Machine Learning Techniques | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 5 | 22ADM65 | Expert  Systems | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 6 | 22ADM 66 | Cognitive Science | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |
| 7 | 22ADM67 | Gamification | MD | 3 | 0 | 0 | 3 | 40 | 60 | 100 |

**22MCT01**                    **INDUCTION PROGRAMME**                    **L    T    P    C**
                               *(*Common to all Branches)                 **-    -    -    0**

**Pre-requisites : Nil**

**Preamble**
This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. " Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

**The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program:**
  (i)  **Physical Activity**
       This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.
  (ii) **Creative Arts**
       Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it every day for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.
  (iii) **Universal Human Values**
       This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

**(iv) Literary Activity**

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

**(v) Proficiency Modules**

This would address some lacunas that students might have, for example, English, computer familiarity etc.

**(vi) Lectures by Eminent People**

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

**(vii) Visits to Local Area**

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

**(viii) Familiarization to Dept./Branch & Innovations**

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

**(ix) Department Specific Activities**

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering /Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

**Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.**

**REFERENCES:**

- Guide to Induction program from AICTE

**22ENT11**              **COMMUNICATIVE ENGLISH**              **L   T   P   C**

(Common to all B.E/B. Tech Programmes)              **3   0   0   3**

(For Students admitted in the AY 2022-23 only)

**Pre-requisites : Nil**

**Preamble**

Communicative English is a life skill necessary for all students of Engineering and Technology. The course Communicative English aims at developing Communication Skills in English which is essential for the learner to handle English language for a variety of everyday purposes through acquisition of basic grammar and vocabulary along with LSRW skills.

**UNIT 1   INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION              9**

**Listening:** Listening for General Information - Specific Details – Conversations - Telephone Conversation - Listening to Voicemail and Messages - Listening and Filling a form **Speaking**: Self Introduction - Introducing a Friend - Politeness Strategies - Telephone Conversation - Leave a Message with Another Person - Asking for Information to Fill Details in a form  **Reading:** Reading Brochures - Telephone Messages - Social Media Messages relevant to Technical Contexts **Writing:** Writing Reviews - Book/Movie – Writing about Oneself  **Grammar & Vocabulary:** Tenses - Types of Questions - Parts of Speech - Contextual Meaning of Words - Abbreviations and Acronyms.

**UNIT 2   EXPRESSING CASUAL CONVERSATIONS              9**

**Listening:** Information about Hotels and Accommodation - Recipes and Food Items - Listening to Conversations Asking for and Giving Directions – Making an Enquiry **Speaking:** Life Style Changes and Making Comparisons - Talking about Food - Making Conversation using Asking for Directions - Making an Enquiry - Role Plays - Dialogues  **Reading**: Habit Formation and Changing Habits - International Cuisine - Reading a Print Interview and Answering Comprehension Questions  **Writing**: E-Mail to Friend –  E-Mails about Food and Recipes, Inviting Dignitaries, Accepting and Declining Invitations **Grammar & Vocabulary**: Evaluations and Comparisons with Adjectives – Prepositions - Modifiers.

**UNIT 3   CLARIFICATION AND RECOMMENDATIONS              9**

**Listening:** Listening to Short Talks and Fill a table – Gap Filling Exercises - Note Taking **Speaking:** Group Discussion - Agreeing and Disagreeing - Tips and Strategies for GD  **Reading:** Reading Problems and Solutions – Articles - Essays drawn from various sources **Writing:** Making Recommendations - Giving Instructions - Note Making - Itinerary- Process Description **Grammar & Vocabulary**: Word Formation - Compound Nouns - Phrasal Verbs.

**UNIT 4   PUBLIC SPEAKING AND BUSINESS COMMUNICATION              9**

**Listening:** Listening to Speeches by Famous People and Identifying the Central Message of the Speech - Answering Multiple Choice Questions **Speaking**: Welcome Address - Vote of Thanks - Special Address on Specific Topic **Reading**: Life and Achievements of a Famous Personality - Reading Motivational Essays on Famous Engineers and Technologists **Writing:** Checklists - Business Communication - Quotations, Placing Orders, Complaints **Grammar & Vocabulary**: Modal Verbs and Probability - Collocations – Fixed Expressions - Semi-Fixed Expressions.

**UNIT 5   WRITING DEFINITIONS AND PRODUCT DESCRIPTION              9**

**Listening**: Listening to Product Description - Labeling and Gap Filling Exercises - Seeking help with Office Equipment - Job Details **Speaking:** Describe a Product - Compare and Contrast with other Products - Buying a Product - Selling a Product - Cancelling and Fixing Appointments - Hotel Accommodation - Training Facilities - Conference Facilities **Reading:** Reading Graphical Material for Comparison (advertisements) -  Clarifying an Error in the Bill **Writing:** Writing Definitions – Single Line Definition and Extended Definition - Compare and Contrast Paragraphs - Designing a Website **Grammar & Vocabulary**: Use of Discourse Markers – One Word Substitution.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Richards, Jack. C with Jonathan Hull and Susan Proctor New Interchange: English for International Communication. (Level1, Student's Book) Cambridge University Press, New Delhi: 2017.
2. Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook, Oxford University Press, 2020.

**REFERENCES:**
1. M Ashraf Rizvi, "Effective Technical Communication", McGraw-Hill, 2nd Edition, New Delhi, 2018.
2. J K Gangal, "A Practical course in Spoken English", PHI Learning Pvt. Ltd., 1st Edition, Delhi, 2014.

**e-Resources:**
1. https://learnenglish.britishcouncil.org/intermediate-vocabulary
2. http://www.usingenglish.com
3. https://learnenglish.britishcouncil.org/intermediate-grammar
4. https://learnenglish.britishcouncil.org/speaking

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1   Converse and read fluently using basic grammar components.
CO2   Communicate through writing without any grammatical errors.
CO3   Write clear, coherent and organized passages adhering to instructions.
CO4   Speak effectively in real-time and business situations.
CO5   Enhance vocabulary through listening and reading.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | - | - | - | - | 1 | 3 | - | - | 2 | 3 | - | 1 | - | - |
| CO 2 | - | - | - | - | 1 | 3 | - | - | 2 | 3 | - | 1 | - | - |
| CO 3 | - | - | - | - | 1 | 3 | - | - | 2 | 3 | - | 1 | - | - |
| CO 4 | - | - | - | - | 1 | 3 | - | - | 2 | 3 | - | 1 | - | - |
| CO 5 | - | - | - | - | 1 | 1 | - | - | 2 | 3 | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22MAT11**          **MATRICES AND DIFFERENTIAL EQUATIONS**     **L**    **T**    **P**    **C**
          (Common to B.E. BM, EC, EE and MD Programmes in First Semester)    **3**    **1**    **0**    **4**

**Pre-requisites : Nil**

**Preamble**
The course aims at achieving conceptual understanding of topics in Differential Calculus, Differential equations and computation of Matrix. The syllabus is designed to provide the skills for modeling engineering problems and understand the role of single variable and multi variables in the discipline of engineering.

**UNIT 1   MATRICES**                                                 **9+3**
Characteristic equation – Statement and application of Cayley Hamilton Theorem – Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors (without proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of Quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation.

**UNIT 2   DIFFERENTIAL CALCULUS**                              **9+3**
Curvature – Radius, Centre and Circle of curvature in Cartesian and Parametric form - Evolute – Envelope of family of curves with one and two parameters.

**UNIT 3   FUNCTIONS OF SEVERAL VARIABLES**                   **9+3**
Partial derivatives – Differentiation of implicit functions – Jacobian- Properties – Taylor's series expansion for functions of two variables – constrained Maxima and Minima – Lagrange's multipliers with single constraint.

**UNIT 4   ORDINARY DIFFERENTIAL EQUATIONS**                 **9+3**
Linear higher order differential equations with constant coefficients – Particular Integrals for the types: $e^{ax}, \cos ax \text{ or } \sin ax, x^n, e^{ax}V(X)$ – Method of variation of parameters –Applications of differential equations: Simple harmonic motion – Electric circuits (Differential equations and associated conditions need to be given).

**UNIT 5   PARTIAL DIFFERENTIAL EQUATIONS**                   **9+3**
Formation of partial differential equations – Solving partial differential equations of first order: Clairaut's form, Lagrange's linear equation – Solving Linear partial differential equations of second and higher order with constant coefficients of homogeneous type - Particular Integrals for the types:
$e^{ax+by}, x^m y^n, \sin(ax+by) \text{ or } \cos(ax+by), e^{ax+by}V(x,y)$.

**Lecture : 45, Tutorial : 15, Total : 60**

**TEXT BOOKS:**
1. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. George B, Thomas, Joel Hass, Christopher Heil and Maurice D. Weir "Thomas' Calculus". Pearson 14 th Edition, 2018

**REFERENCES:**
1. N.P.Bali,Manish Goyal, "Engineering Mathematics",Lakshmi Publications(Pvt) Ltd,4th edition,2014.
2. Grewal B.S., "Higher Engineering Mathematics" 43rd Edition,Khanna Publishers, New Delhi, 2014.

**e-Resources:**
1. https://nptel.ac.in/courses/122104018, Mathematics II, Prof. P. Chandra, Prof. A.K. Lal, Prof. V. Raghavendra, Prof. G. Santhanam, IIT Kanpur.

2. https://nptel.ac.in/courses/111106139, Laplace Transform, Prof. Indrava Roy, IIT Madras.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Determine eigenvalues and eigenvectors of real symmetric matrices and reduce the quadratic form to canonical form by orthogonal transformation.

CO2    Compute curvature, centre of curvature, evolute and envelope of curves.

CO3    Express functions of two variables in Taylor's series and compute Jacobians, maximum and minimum values.

CO4    Solve linear differential equations with constant coefficients and apply them in solving real problems.

CO5    Compute the solution for the standard forms of linear partial differential equations of first order and solve homogeneous partial differential equations of first and higher order with constant coefficients.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO 2 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO 3 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO 4 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO 5 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22PHT11**                    **ENGINEERING PHYSICS**                    **L   T   P   C**
                    (Common to all B.E/B.Tech Programmes)              **3   0   0   3**

**Pre-requisites : Nil**

**Preamble**
This course aims to impart the essential concepts of laser, fibre optics, ultrasonics, quantum physics and crystal structure and crystal defects.  It also describes the physical phenomena related to the above mentioned concepts and their applications in engineering and provides motivation towards innovations.

**UNIT I     LASER                                                              9**
Introduction –spontaneous emission and stimulated emission, population inversion, pumping. Einstein's coefficients - derivation. Types of lasers- Nd-YAG-$CO_2$, Semiconductor lasers (homojunction & heterojunction) – Industrial applications - lasers in welding, heat treatment, cutting- medical applications- holography-construction and reconstruction-Safety classes of laser.

**UNIT II    FIBRE OPTICS                                                       9**
Principle and propagation of light in optical fibres – numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – double crucible technique of fibre drawing - splicing, losses in optical fibre, dispersion - fibre optical communication system (Block diagram) - light sources - detectors - fibre optic sensors – temperature & displacement - endoscope.

**UNIT III    ULTRASONICS                                                      9**
Introduction – Production – magnetostriction effect – piezoelectric effect - piezoelectric generator- detection of ultrasonic waves properties – cavitations - velocity measurement – acoustic grating - Industrial applications – drilling, welding, soldering and cleaning – SONAR - non destructive testing – pulse echo system through transmission and reflection modes - A, B and C – scan displays, medical applications - sonograms.

**UNIT IV    QUANTUM PHYSICS                                                   9**
Black body radiation – Planck's theory (derivation) – deduction of Wien's displacement law and Rayleigh – Jeans' law from Planck's theory – Compton effect - theory and experimental verification – matter waves – Schrödinger's wave equation – time independent and time dependent equations – physical significance of wave function – particle in a one dimensional box.

**UNIT-V     CRYSTAL PHYSICS                                                   9**
Lattice – unit cell – Bravais lattice – lattice planes – Miller indices – d spacing in cubic lattice – calculation of number of atoms per unit cell – atomic radius – coordination number – packing factor for SC, BCC, FCC and HCP structures – NaCl, ZnS, diamond and graphite structures – polymorphism and allotropy - crystal defects – point, line and surface defects.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.   Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai publishers, 2009.
2.   Mani Naidu S., "Engineering Physics", 2nd Edition, Pearson Publishing, 2011.

**REFERENCES:**
1.   Serway and Jewett, "Physics for Scientists and Engineers with Modern Physics", 9th Edition, Thomson Brooks Cole, 2013
2.   Palanisamy P.K., "Engineering Physics", 2nd Edition, Scitech Publications, 2011
3.   Chitra Shadrach and Sivakumar Vadivelu, "Engineering Physics", 1st Edition, Pearson Education, 2007.

**e-Resources:**
1. http://oupinheonline.com/book/bhattacharya-tandon-engineering-physics/9780199452811.
2. https://www.khanacademy.org/science/physics/quantum-physics.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1     Compare Nd-YAG, $CO_2$ and Semiconductor lasers for welding, heat treatment, cutting, medical applications and holography using Stimulated Emission.
CO2     Demonstrate the knowledge of wave optics using light waves for communication system.
CO3     Describe the production and applications of ultrasonics.
CO4     Examine the dual nature of light waves using quantum theory for Black body radiation and Schrodinger's wave equations in particle in a    one and three dimensional box.
CO5     Explain the description of a crystal structure in terms of atom positions, unit cells, and crystal symmetry; and to relate the crystal symmetry to the symmetry observed in a diffraction experiment.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | 1 | - | - |
| CO 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | 1 | - | - |
| CO 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | 1 | - | - |
| CO 4 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | 1 | - | - |
| CO 5 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | - | - | 1 | 1 | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22CYT11**                         **ENGINEERING CHEMISTRY**                  **L   T   P   C**
                              (Common to all B.E/B.Tech Programmes)            **3   0   0   3**

**Pre-requisites : Nil**

**Preamble**
The study of water technology enables engineers to acquire skills to choose the appropriate method of water treatment for industrial and domestic purposes. Electrochemistry and corrosion explain the fundamentals, identification and corrosion prevention for solving electrochemical and corrosion problems. The study of energy storage devices exposes some of the most commonly used energy storage devices. Nanochemistry empowers engineers to acquire knowledge about nanomaterials and their applications in various fields. Polymeric materials aim to equip the engineering students to realize the importance of chemistry in composites and conducting polymers.

**UNIT 1    WATER TECHNOLOGY                                                     9**
Hardness – types and its units – Boiler troubles – scale and sludge, boiler corrosion, caustic embrittlement, priming and foaming – Internal conditioning – carbonate and calgon conditioning - External conditioning – demineralization process – Desalination – electrodialysis, reverse osmosis - Treatment of water for municipal water supply (Removal of suspended particles and disinfection methods – Ozonisation).

**UNIT 2    ELECTROCHEMISTRY AND CORROSION                                       9**
Electrochemistry – Emf Series and its applications. Metal Finishing – Manufacture of Printed Circuit Board.
Corrosion – mechanism – Galvanic, atmospheric ($O_2$) and Pitting corrosion. Protective coating – electroplating of nickel and electroless copper plating on printed circuit board.

**UNIT 3    ENERGY STORAGE DEVICES                                               9**
Batteries – types  – Construction and working of Primary battery – Zinc-Air/carbon, Secondary batteries – Lead-acid battery and Lithium-ion battery, Fuel cells – $H_2$-$O_2$ fuel cell and  Microbial fuel cell.

**UNIT 4    NANOCHEMISTRY                                                        9**
Nanomaterials –Types – Synthesis – sol-gel and laser ablation – Characterization – Scanning Electron Microscope and Transmission Electron Microscope – Principle and instrumentation (block diagram) – Properties – optical, electrical, mechanical and magnetic and Applications of nanomaterials – medicine, agriculture, electronics and catalysis.

**UNIT 5   POLYMERS                                                             9**
Polymers – thermoplastics and thermosetting plastics – polymerization – types  (definition only) – Compounding of plastics – fabrication – compression and injection – Composites – polymer matrix composites (Fibre reinforced composites) and metal matrix composites – Conduction polymers – General mechanism of conduction in polymers.

**Lecture : 45, Tutorial : 0, Total : 45**
**TEXT BOOKS:**
   1. Engineering Chemistry, 17th Edition. P.C. Jain & Monica Jain, Dhanpat Rai Publishing Company, 2021.
   2. Applied Chemistry, 2nd Edition. PN Palanisamy, P Manikandan, A Geetha, K Manjula Rani, McGraw Hill Education (India) Private Limited, 2019.

**REFERENCES:**
   1. Wiley Engineering Chemistry, 2$^{nd}$ Edition, Wiley,Wiley India Pvt. Ltd, New Delhi, 2014.
   2. Engineering Chemistry, 2$^{nd}$ Edition. O G Palanna, McGraw Hill Education (India) Private Limited, New Delhi, 2017.

3. A Textbook of NanoScience, 2$^{nd}$ Edition, Dr.Rakesh Kumar, Dr. Kamala Pati Tiwary, S.K.Kataria & Sons, New Delhi, 2013.

**e-Resources:**
1. http://nptel.ac.in/courses/113105028/, "Science and Technology of Polymers"- Prof. Basudam Adhikari, Materials Science Centre, IIT Kharagpur
2. https://archive.nptel.ac.in/courses/118/102/118102003/ , "Nano structured materials-Synthesis, Properties, Self-Assembly and Applications" - Prof. Ashok K Ganguli, Department of Chemistry, IIT Delhi

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Evaluate the process to purify hard water using internal and external treatment.
CO2 Apply the principle of electrochemistry in PCB etching and surface coating to prevent corrosion.
CO3 Compare and contrast the performance of primary, secondary and flow battery.
CO4 Analyze the characteristics of nanomaterials synthesized by top down and bottom-up process with the aid of SEM and TEM.
CO5 Categorize the types of polymeric materials and fabrication of plastic by injection and compression moulding for engineering applications.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | - | 1 | 1 | 1 | 1 | - | - |
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | - | 1 | 1 | 1 | 1 | - | - |
| CO3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | - | 1 | 1 | 1 | 1 | - | - |
| CO4 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | - | 1 | 1 | 1 | 1 | - | - |
| CO5 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | - | 1 | 1 | 1 | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22CST11 | PYTHON PROGRAMMING | L | T | P | C |
|---------|--------------------|---|---|---|---|
|         | (Common to all B.E/B.Tech Programmes) | 3 | 0 | 0 | 3 |

**Pre-requisites : Nil**

**Preamble**

Python is easy to use, powerful, and versatile, making it a great choice for beginners and experts alike. Python's readability makes it a great first programming language — it allows you to think like a programmer and not waste time understanding the mysterious syntax that other programming languages can require. The syntax in Python helps the programmers to do coding in fewer steps. Python is widely used in bigger organizations because of its multiple programming paradigms.

**UNIT I     COMPUTING FUNDAMENTALS                                          9**

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).

**UNIT II    INTRODUCTION TO PYTHON                                          9**

Python interpreter, data types: int, float, boolean, string, and list; variables, expressions, statements, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

**UNIT III    CONTROL FLOW, FUNCTIONS, STRINGS                              9**

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

**UNIT IV    LISTS, TUPLES, DICTIONARIES                                     9**

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

**UNIT-V     FILES, MODULES AND PACKAGES                                     9**

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages, Introduction to Pygame tool; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Reema Thareja, "Python Programming using Problem Solving Approach", Oxford University Press, 2017.
2. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.

**REFERENCES:**
1. E Balagurusamy," Problem Solving and Python Programming", McGraw Hill Education, 2018
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1stEdition, Notion Press, 2021.

**e-Resourses:**
1. https://swayam.gov.in/course/4178-spoken-tutorial-python-english, "Introduction to Python", Prof. Prabhu Ramachandran, IIT Bombay.

2. https://onlinecourses.nptel.ac.in/noc18_cs21, "Programming, Data Structures and Algorithms Using Python", Prof.Madhavan Mukund, IIT-Bombay.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Use the basics of algorithmic problem solving techniques (pseudo code, flow chart, language basics) for a given problem.
CO2 Apply suitable python conditional and looping statements to solve a given problem.
CO3 Define Python functions and use function calls to solve problems.
CO4 Use Python data structures (lists, tuples, and dictionaries) to represent complex data.
CO5 Create python packages, modules and files for a given scenario.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | - |
| CO2 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | - |
| CO3 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | - |
| CO4 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | - |
| CO5 | 3 | 2 | 2 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22HST11**          **HERITAGE OF TAMILS**          **L    T    P    C**
(Common to all B.E/B.Tech Programmes)          **1    0    0    1**
(For Students admitted from the AY 2023-24 onwards)

## UNIT 1   LANGUAGE AND LITERATURE                                    3
Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

## UNIT 2   HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE      3
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

## UNIT 3   FOLK AND MARTIAL ARTS                                       3
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

## UNIT 4   THINAI CONCEPT OF TAMILS                                    3
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

## UNIT 5   CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE          3
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

**Total : 15**

### TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித்தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொழியியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொழியியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**22PHL11**  **PHYSICS AND CHEMISTRY LABORATORY I**  **L  T  P  C**
(Common to all B.E/B.Tech Programmes)  **0  0  2  1**

**Pre-requisites : Nil**

**Preamble**

This course aims to impart knowledge in the determination of the physical parameters such as wavelength of laser and mercury spectrum, Numerical aperture and acceptance angle of an optical fiber, velocity of ultrasonic waves and thermal conductivity of bad conductor and additionally necessitate the practical skills in determination of rate of corrosion in mild steel, water quality parameters and amount of iron in the given sample.

**PHYSICS LABORATORY I**
**LIST OF EXPERIMENTS**

1. Determination of Optical property of Laser and Particle size of Lycopodium powder.
2. Determination of Numerical aperture and acceptance angle of an optical fiber.
3. Determination of velocity of ultrasonic waves- Ultrasonic Interferometer.
4. Determination of wavelength of mercury spectrum- Spectrometer grating.
5. Determination of Thermal conductivity of Bad conductor.

**CHEMISTRY LABORATORY I**
**LIST OF EXPERIMENTS**

1. Determination of alkalinity in water sample
2. Determination of Calcium and Magnesium hardness in water by EDTA method.
3. Determination of rate of corrosion in Mild steel by weight loss method.
4. Determination of iron content of the water sample using spectrophotometer (1,10-phenanthroline / thiocyanate method).
5. Determination of iron content of the given solution using a potentiometer

**Lecture : 0, Tutorial : 0, Practical: 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:

**CO1** Experiment and determine the optical property of light sources and acceptance angle of optical fiber using Laser and Spectrometer.

**CO2** Experiment and determine the velocity of ultrasonic waves and thermal conductivity of a given bad conductor using ultrasonic interferometer and Lee's disc.

**CO3** Experiment and estimate type and amount of alkalinity, Calcium and Magnesium hardness in water sample using titrimetry.

**CO4** Experiment and determine the rate of corrosion in mild steel by weight loss method.

**CO5** Experiment and determine the amount of iron content present in the given sample using potentiometer and spectrophotometer.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |
| CO 2 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |
| CO 3 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |
| CO 4 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |
| CO 5 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22CSL11**          **PYTHON PROGRAMMING LABORATORY**          L   T   P   C
                     (Common to all B.E/B.Tech Programmes)          0   0   2   1
                (For  Students admitted in the AY 2022-23 & 2023-24 only)

**Pre-requisites : Nil**

**Preamble**
Python is a dynamic and powerful programming language that focuses on code readability. The Python language has diversified application in the software development companies such as in gaming, web frameworks and applications, language development, prototyping, graphic design applications, etc. This provides the language a higher plethora over other programming languages used in the industry.

**LIST OF EXPERIMENTS**
1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
   (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions
   (exchange the values of two variables, circulate the values of n variables, distance between two points)
3. Scientific problems using Conditionals and Iterative loops.
   (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples.
   (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries.
   (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions.
   (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings.
   (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries
   Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling
10. Developing a game activity using Pygame like bouncing ball, car race

**SOFTWARE**
- Python 3 interpreter / open source IDE
- Raptor Tool
- Libre Office Packages

**Lecture : 0, Tutorial : 0, Practical: 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:
**CO1**   Design flowcharts using Raptor.
**CO2**   Develop programs using expressions and Control statements in Python.
**CO3**   Develop programs using functions, packages for a given problem..
**CO4**   Process compound data using Python data structures
**CO5**   Utilize Python packages in developing software applications.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |
| CO2 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |
| CO3 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |
| CO4 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |
| CO5 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22CSL11**  **PYTHON PROGRAMMING LABORATORY**      **L  T  P  C**
(Common to all B.E/B.Tech Programmes)           **0  0  2  1**
(For Students admitted in the AY 2024-25 onwards)

**Pre-requisites : Nil**

**Preamble**
Python is a dynamic and powerful programming language that focuses on code readability. The Python language has diversified application in the software development companies such as in gaming, web frameworks and applications, language development, prototyping, graphic design applications, etc. This provides the language a higher plethora over other programming languages used in the industry.

**LIST OF EXPERIMENTS**
1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
   (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions
   (exchange the values of two variables, circulate the values of n variables, distance between two points)
3. Scientific problems using Conditionals and Iterative loops.
   (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples.
   (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries.
   (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions.
   (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings.
   (reverse, palindrome, character count, replacing characters)
8. Implementation of searching algorithms using linear and binary search technique.
9. Implementation of sorting algorithms using selection sort and insertion sort method.
10. Implementing programs using written modules and Python Standard Libraries
    Libraries (pandas, numpy. Matplotlib, scipy)
11. Implementing real-time/technical applications using File handling.
12. Developing a game activity using Pygame like bouncing ball, car race.

**SOFTWARE**
- Python 3 interpreter / open source IDE
- Raptor Tool
- Libre Office Packages

**Lecture : 0, Tutorial : 0, Practical: 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:
**CO1**  Design flowcharts using Raptor.
**CO2**  Develop programs using expressions and Control statements in Python.
**CO3**  Develop programs using functions, packages for a given problem..
**CO4**  Process compound data using Python data structures
**CO5**  Utilize Python packages in developing software applications.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |
| CO2 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |
| CO3 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |
| CO4 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |
| CO5 | 2 | 2 | 2 | 3 | - | - | - | - | 1 | - | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22MCT02 | UNIVERSAL HUMAN VALUES | L | T | P | C |
|---|---|---|---|---|---|
| | (Common to all B.E/B.Tech Programmes) | 0 | 0 | 3 | 0 |

**Pre-requisites : Nil**

**Preamble**
Universal Human Values is a life skill necessary for all to develop physical health and factors for strengthening life force. This course aims to expose the students in the areas of mediation and impart the knowledge on social virtues and morals.

**UNIT I      PHYSICAL HEALTH                                                                          9**
SKY – Introduction – Education as a means for youth empowerment – Greatness of Education – Yoga for Youth Empowerment – Simplified Physical Exercises: Explanation – Hand, Leg, Breathing and Eye exercises – Kapalabathi, Makarasanam, Massaging, Acupressure and Relaxation practices –Yogasanas-Explanation – Benefits.

**UNIT II      STRENGTHENING LIFE FORCES                                               9**
Reasons for Diseases: Natural Reasons (Hereditary, Planetary Position, Natural Calamities and Climatic changes) – Artificial Reasons (Food, Thought, Deed).   Philosophy of Kayakalpa: Physical Body –Life Force – Biomagnetism – Mind. Maintaining Youthfulness – Postponing Aging – Transformation of Food into seven Body constituents.

**UNIT III      WELLNESS OF MIND                                                                9**
Classification of Mind Waves – Beta, Alpha, Theeta, Delta – Agna Meditation – Benefits.  Shanthi Mediation – Benefits.  Thuriya Meditation – Benefits.  Blessing and its Benefits: Auto Suggestion – Blessing the family and others – Blessings the World – Divine Protection.

**UNIT IV      VIRTUES                                                                                     9**
**Individual Virtues:** Self Control – Self Confidence – Speaking Truth – Contentment – Humility – Mind Control.  Tolerance – Adjustment – Sacrifice – Forgiveness.  Cleanliness (Body, Dress, Surrounding)-External, Mental, Inner Cleanliness. **Societal Virtues:** Ahimsa – Services, Patriotism – Equality, Respecting the parents and elders – Caring for them – Respecting Teachers. Punctuality – Time Management.

**UNIT-V      MORALS                                                                                      9**
 Importance of introspection:  I and Mine (Ego, Possessiveness), Six Temperaments: Greed – Anger – Miserliness – Immoral Sexual Passion – Inferior Superior complex – Vengeance.  Maneuvering the Six Temperaments: Contentment – Tolerance – Charity – Chastity – Parity – Forgiveness.  Five important Benefits of Meditation: Perspicacity – Magnanimity – Adaptability – Receptivity – Creativity. (Enhancing memory) (Effective Examination Preparation).

**Total : 30 Periods**

**TEXT BOOKS:**
1. "Yoga for Youth Empowerment" compiled by Vethathiri Maharishi Institute for Spiritual and Institutional Education, Aliyar, Pollachi, 1st Edition 2016.
2. "Yoga for Human Excellence", compiled by Vethathiri Maharishi Institute for Spiritual and Institutional Education, Aliyar,  Pollachi 1st Edition 2009.

**e-Resourses:**
1. www.online.vethathiri.edu.in  "online in (Virtual) Programme on Yoga and Human Excellence".

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Demonstrate the knowledge on physical health
CO2    Discuss the  factors for strengthening life force
CO3    Classify mind waves and explain the benefits of meditation
CO4    Explain individual and social virtues
CO5    Identify and explain the importance of morals.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | - | - | - | - | - | 3 | - | - | - | - | - | - | - | - |
| CO 2 | - | - | - | - | - | 3 | - | 2 | - | - | - | - | - | - |
| CO 3 | - | - | - | - | - | 3 | - | 2 | - | - | - | - | - | - |
| CO 4 | - | - | - | - | - | 3 | - | 2 | 2 | - | - | - | - | - |
| CO 5 | - | - | - | - | - | 3 | - | - | 2 | - | - | - | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22ENT21**         **PROFESSIONAL ENGLISH**      **L   T   P   C**
                (Common to all B.E/B. Tech Programmes)       **3   0   0   3**
                (For Students admitted in the AY 2022-23 only)

**Pre-requisites : 22ENT11 – Communicative English**

**Preamble**
The course Professional English aims at developing LSRW skills which are essential for the learners to communicative effectively and appropriately in professional contexts through acquisition of grammar and vocabulary.

**UNIT 1    ANALYTICAL READING                                9**
**Listenin**g: Listening to Podcasts - Anecdotes - Stories - Event Narration - Documentaries and Interviews with Celebrities - Evaluative Listening - Advertisements - Listening and Filling a Graphic Organizer **Speaking**: Conversation Skills – Opening - Turn Taking - Closing - Explaining how something works - Marketing a Product - Persuasive Speech Techniques   **Reading:** Reading Advertisements - User Manuals - Analytical Reading - Deductive and Inductive Reasoning   **Writing**: Professional E-mails – E-mail Etiquette - Compare and Contrast Essays **Grammar & Vocabulary**: Prepositional Phrases - Impersonal Passive Voice - Product Description.

**UNIT 2    SUMMARISING                                           9**
**Listening:** Listening to Lectures - Talks and Completing Gap Filling Exercises on Science and Technology - Listening Technical Information from Podcasts **Speaking**: Summarizing - Oral Reporting - Narrating Personal Experiences – Events - Interviewing a Celebrity **Reading:** Reading Scientific and Technical Articles - Texts **Writing:** Lab Reports - Summary Writing **Grammar & Vocabulary**: Purpose Expressions - Same Word used as Different Parts of Speech.

**UNIT 3    DESCRIBING VISUAL MATERIALS                        9**
**Listening**: Listening to the Panel Discussion **Speaking**: Speaking at Formal Situations - Mini Presentation and Making Recommendations **Reading:** Reading Journal Articles - Speed Reading - Interpretation of Graphics – Tables - Pie Chart - Flow Chart - Bar Chart **Writing**: Data Commentaries - Describing Visual Materials - Mechanics of Writing - Writing Complaints to Editorial Columns **Grammar & Vocabulary:** Subject-Verb Agreement - Pronouns - Relative Pronouns.

**UNIT 4    WRITING E-MAILS AND JOB APPLICATION LETTERS         9**
**Listening:** Listening to Model Interviews **Speaking**: Speaking at Different Types of Interviews - Role Play Practice **Reading:** Reading Job Advertisements and Company Profile - Statement of Purpose (SOP) **Writing:** Filling up the Job Application Letter – Cover Letter – Résumé Preparation - Internship Application **Grammar & Vocabulary:** Error Correction – 'If' Conditionals - Infinitives - Gerunds.

**UNIT 5    REPORT WRITING                                       9**
**Listening:** Viewing a Model Group Discussion **Speaking**: Participating in a Group Presentation - Presentation **Reading:** Cause and Effect Essays – Letters and E-mails of Complaint **Writing:** Types of Reports - Report Format - Industrial Accident Report - Industrial Visit Report - Feasibility Report - Designing and Reporting Surveys - Writing Discursive Essays **Grammar & Vocabulary:** Reported Speech - Numerical Adjectives - Idioms and Phrases.

                                                     **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. 'English for Engineers and Technologists' Volume 1 published by Orient Black Swan Limited 2019.
2. Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook, Oxford University Press, 2020.

**REFERENCES:**
1. Richards, Jack. C with Jonathan Hull and Susan Proctor New Interchange: English for International Communication. (Level1, Student's Book) Cambridge University Press, New Delhi: 2017.
2. J K Gangal, "A Practical course in Spoken English", PHI Learning Pvt. Ltd., 1st Edition, Delhi, 2014.

**e-Resources:**
1. https://www.eslgold.com
2. https://www.usingenglish.com
3. https://learnenglish.britishcouncil.org/intermediate-grammar
4. https://learnenglish.britishcouncil.org/speaking

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Read for gathering and understanding information using narrative techniques.
CO2    Develop and demonstrate listening skills for academic and professional purposes.
CO3    Apply apt vocabulary and construct grammatically correct sentences in professional situations.
CO4    Face interviews with communicative competence and confidence with a good knowledge of career skills.
CO5    Enhance writing skills for essays and for preparing reports.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | - | - | - | - | 1 | 3 | - | - | 2 | 3 | - | 1 | - | - |
| CO 2 | - | - | - | - | 1 | 3 | - | - | 2 | 3 | - | 1 | - | - |
| CO 3 | - | - | - | - | 1 | 3 | - | - | 2 | 3 | - | 1 | - | - |
| CO 4 | - | - | - | - | 1 | 3 | - | - | 2 | 3 | - | 1 | - | - |
| CO 5 | - | - | - | - | 1 | 1 | - | - | 2 | 3 | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22MAT21 | **CALCULUS AND COMPLEX ANALYSIS** | **L** | **T** | **P** | **C** |
|---------|-----------------------------------|--------|--------|--------|--------|
| | (Common to B.E. BM, EC, EE and MD Programmes in Second Semester) | **3** | **1** | **0** | **4** |

**Pre-requisites : 22MAT11 – Matrices and Differential Equations**

**Preamble**
Vector calculus is a form of mathematics that is focused on the integration of vector fields. An Engineer should know the Transformations of the Integrals, as Transformation of Line Integral to surface and then to volume integrals. Complex Integration approach is very useful to evaluate many improper integrals of a real variable.

**UNIT 1   INTEGRAL CALCULUS**                                                                                      **9+3**
Double and Triple Integrals in Cartesian coordinates – Evaluation of Double Integrals by Change of order of Integration – Applications of Multiple Integrals to find Area and Volume

**UNIT 2   DIFFERENTIATION OF VECTORS**                                                               **9+3**
Del Operator – Del applied to scalar point function: Gradient and its applications to find unit normal vector, Directional derivative and Angle between two surfaces – Del applied to vector point function: Divergence, Curl and their applications to find Irrotational and Solenoidal vector fields — Vector operator identities (Statement only) - Simple Problems.

**UNIT 3   INTEGRATION OF VECTORS**                                                                        **9+3**
Line, Surface and Volume integrals – Vector Integral Theorems (without proof): Green's theorem in a plane – Gauss Divergence Theorem – Stoke's theorem – Simple applications involving squares, rectangles, cubes and rectangular parallelepipeds.

**UNIT 4   ANALYTIC FUNCTIONS**                                                                                 **9+3**
Functions of a complex variable – Limit and continuity of f(z) – Derivative of f(z) – Cauchy-Riemann equations – Analytic functions – Harmonic and orthogonal properties of analytic function –Construction of analytic functions by Milne's method – Conformal mapping -Translation w=z+k, Magnification and Rotation w=kz, Inversion and Reflection w=1/z and bilinear transformation.

**UNIT 5   COMPLEX INTEGRATION**                                                                             **9+3**
Statement and applications of Cauchy's integral theorem and Cauchy's integral formula (excluding proof) –Power series expansions: Taylor's series and Laurent's series – Singularities – Residues– Cauchy Residue theorem (excluding proof) –  Evaluation of real definite integrals as contour integrals (around unit circle, semi-circle excluding poles on the real axis).

**Lecture : 45, Tutorial : 15, Total : 60**

**TEXT BOOKS:**
1. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. George B, Thomas, Joel Hass, Christopher Heil and Maurice D. Weir "Thomas' Calculus". Pearson 14 th Edition, 2018

**REFERENCES:**
1. N.P.Bali,Manish Goyal, "Engineering Mathematics",Lakshmi Publications(PVT) Ltd,4 th edition,2014.
2. Grewal B.S., "Higher Engineering Mathematics" 43rd Edition,Khanna Publishers, New Delhi, 2014.

**e-Resources:**
1. https://nptel.ac.in/courses/111105122 "Integral and Vector Calculus", Prof. Hari Shankar Mahato, Department of Mathematicss, IIT Kharagpur.

2.      https://nptel.ac.in/courses/111103070 "Complex Analysis" Prof. P. A. S. Sree Krishna, Department of Mathematics, IIT Guwahati.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Apply multiple integrals to determine area and volume in Cartesian coordinates.
CO2    Apply the concepts of vector calculus in vector differentiation.
CO3    Apply the concepts of vector calculus in vector integration.
CO4    Represent the analytic functions using conformal mapping and bilinear transformation.
CO5    Classify the singularities and evaluate complex integration.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO 2 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO 3 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO 4 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| CO 5 | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT21**                                    **MEDICAL PHYSICS**                                    **L    T    P    C**
                                    (Common to B.E. BM and MD Programmes**)**          **3    0    0    3**
**Pre-requisites : 22PHT11 – Engineering Physics**

**Preamble**
Medical Physics is an applied branch of Physics concerned with the application of the radiation concepts and methods of Physics in Medical science. This course accentuates the principle, effects and clinical applications of ionizing, non-ionizing electromagnetic radiation. This also enunciates the fundamentals of acoustic waves and their interaction with human tissues.

**UNIT 1    LOW ENERGY ELECTROMAGNETIC SPECTRUM AND ITS MEDICAL**          **9**
             **APPLICATION**
Physics of light, Intensity of light, limits of vision and color vision an overview, Non-ionizing Electromagnetic Radiation: Overview of non-ionizing radiation effects-Tissue as a leaky dielectric-Low Frequency Effects- Higher frequency effects, Ultraviolet radiation, Thermography– Application.

**UNIT 2    PRINCIPLES OF RADIOACTIVE NUCLIDES**                                    **9**
Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Kinetics of Radioactive decay – Decay equation, Half life, Mean life, Effective half life.  Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radionuclide-fission and neutron capture reaction, radionuclide Generator-Technetium generator.

**UNIT 3    INTERACTION OF RADIATION WITH MATTER**                                    **9**
Interaction of charged particles with matter –Specific ionization, Linear energy transfer, Range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter- Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation, Interaction of neutron with matter and their clinical significance.

**UNIT 4    RADIATION DOSE AND ITS EFFECTS**                                    **9**
Dose and Exposure measurements – Units (SI), Inverse square law, Maximum permissible exposure, relationship between the dosimetric quantities, Radiation biology – effects of radiation, direct and indirect actions of radiation, Cell survival curves,  concept of LD 50, Stochastic and Non-stochastic effects, Radiation Syndrome.

**UNIT 5    PRINCIPLES AND APPLICATIONS OF SOUND IN MEDICINE**                  **9**
Physics of sound, Normal sound levels, Measurement of hearing, ultrasound fundamentals, Generation of ultrasound (Ultrasound Transducer), Interaction of Ultrasound with matter- Cavitations, Reflection, Transmission, Scanning methods, Artifacts, Ultrasound- Doppler effect, Clinical Applications.

**Lecture : 45, Tutorial : 0, Total : 45**
**TEXT BOOKS:**
  1.  B.H. Brown, R.H. Smallwood, D.C. Barber, P.V. Lawford, D.R. Hose, ―Medical Physics and Biomedical Engineering, Institute of physics publishing, Bristol and Philadelphia, 1999. (Unit 1,4,5)
  2.  Gopal B. Saha ―Physics and Radiobiology of Nuclear Medicine Third edition Springer, 2006. (Unit 2,3,4)

**REFERENCES:**
  1.  W.J. Meredith and J.B. Massey ―Fundamental Physics of Radiology Varghese Publishing house. 1992.
  2.  Steve Webb, The Physics of Medical Imaging, Taylor & Francis, Newyork, 2010
  3.  R.S. Khandpur, ―Handbook of Biomedical Instrumentation, Tata McGraw-Hill, New Delhi, 2003.

**e-Resources:**
1. http://www.nptel.ac.in/courses/115102017/ , "Nuclear science and Engineering", Dr. Santanu Gosh, Department of Physics, IIT, Delhi.
2. http://www.uthgsbsmedphys.org/GS02-0093/ ," Introduction to Medical Physics I", Dr George Starkschall, The University of Texas at Houston.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1  Interpret the properties of electromagnetic radiations and its effect on human.
CO2  Describe the principles and production of radioactive nuclides.
CO3  Explain the interaction of radiation with matter.
CO4  Identify and explain the radiation quantities and its effects
CO5  Demonstrate the knowledge on the properties of sound and its application in medicine.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 3 | 2 |   | 2 | 2 |   |   |   |   | 2 |   |   |
| CO 2 | 2 | 3 | 3 | 2 |   | 2 | 2 |   |   |   |   | 2 |   |   |
| CO 3 | 2 | 3 | 3 | 2 |   | 2 | 2 |   |   |   |   | 2 |   |   |
| CO 4 | 2 | 3 | 3 | 2 | 2 | 2 | 2 |   |   |   |   | 2 |   |   |
| CO 5 | 2 | 3 | 3 | 2 | 2 | 2 |   |   |   |   |   | 2 |   |   |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22MET11**     **ENGINEERING GRAPHICS**     L   T   P   C
(Common to all B.E/B.Tech Programmes)     2   0   4   4

**Pre-requisites: Nil**

**Preamble**
The knowledge of Engineering graphics is essential for the Engineering graduates in proposing new product designs through drawings and interpreting data from existing drawings. Engineering Design inculcates into an Engineer the creativity and knowledge on various aspects to be considered while designing and realizing the functional products and processes. This course deals with Engineering curves, orthographic and pictorial projections, sectional views and development of surfaces.

**UNIT 1    INTRODUCTION AND PLANE CURVES                                  9+3**
Importance of graphics in Engineering applications – Use of drafting instruments – BIS conventions and specifications –Size, layout and folding of drawing sheets – Diagonal scales and vernier scales- Lines, lettering and dimensioning - Basic geometrical constructions (circular and polygonal surfaces). (PRACTICE ONLY AND NOT FOR EXAMINATIONS).

Curves used in Engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – Construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

**UNIT 2    PROJECTION OF POINTS, LINES AND PLANE SURFACES               9+3**
Orthographic projection- principles-Principal Planes - First angle projection- Projection of points in four quadrants – End point projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and trapezoidal method.
Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

**UNIT 3    PROJECTION OF SOLIDS                                          9+3**
Projection of simple solids- Cube, prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane and parallel to the other by rotating object method.

**UNIT 4    SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES                9+3**
Sectioning of above solids in simple vertical position when cut by a cutting plane which is inclined to one of the reference planes and perpendicular to the other – Obtaining true shape of section.
Development of lateral surfaces of simple and truncated solids in simple vertical position – Cube, prisms, pyramids, cylinder and cone.

**UNIT 5    ISOMETRIC AND FREE HAND SKETCHING                            9+3**
Principles of isometric projection – Isometric scale –Isometric projections of simple solids - Prisms, pyramids, cylinder and cone- Combination of two solid objects in simple vertical position.

Visualization concepts- Free hand sketching – Conversion of Isometric view to orthographic views. Perspective projection of simple solids (Qualitative only).

Introduction to CAD software (Not for Examinations)

**Lecture : 45, Practical : 15, Total : 60**

**TEXT BOOKS:**
1.    Venugopal K and Prabhu Raja V., "Engineering Graphics", New Age International (P) Ltd, 13th Edition, 2015.
2.    Jeyapoovan T, "Engineering Graphics with AUTOCAD", Vikas Publishing House Pvt., Ltd., 7th Edition, 2015.

**REFERENCES:**
1.   Bhatt N.D., Panchal, V.M. and Ingle P.R., "Engineering Drawing", Charotar Publishing House Pvt. Ltd., 53rd Edition, 2014.
2.   Parthasarathy N.S. and Vela Murali, "Engineering Drawing", Oxford University Press, 1st Edition, Second Impression 2015.
3.   Luzzader W.J. and Duff J.M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.

**e-Resources:**
1.   http://nptel.ac.in/courses/105104148, "Engineering Graphics" - Dr. Nihar Ranjan Patra , IIT Kanpur.
2.   http://cfd.annauniv.edu/webcontent.htm, "Engineering Graphics" - Dr. Velamurali.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Draw the various conic sections and Engineering curves
CO2    Sketch projections of lines and planes with vertical and inclined positions
CO3    Draw the projections of solids kept in various positions.
CO4    Sketch sectioned views of solids and development of surfaces.
CO5    Draw the isometric and orthographic views from given pictorial views.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 2 | 1 | | | | | | | 2 | | 1 | | |
| CO 2 | 3 | 2 | 1 | | | | | | | 2 | | 1 | | |
| CO 3 | 3 | 2 | 1 | | | | | | | 2 | | 1 | | |
| CO 4 | 3 | 2 | 1 | | | | | | | 3 | | 2 | | |
| CO 5 | 3 | 2 | 1 | | | | | | | 3 | | 2 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BMT22 | **HUMAN ANATOMY AND PHYSIOLOGY** | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisites: Nil**

**Preamble**

The prime concern of this syllabus is to integrate the individual functions of all the cells and tissues and organs into functional whole, the human body. Since function is dependent on a structure, the curriculum lays stress on functional anatomy of the organs. The course therefore emphasizes on the cardiovascular, respiratory, urinary and nervous system and their interrelatedness. Most of the topics are of introductory level and would stimulate the students to understand the basic functioning of every system and the resultant unified organization.

**UNIT 1   BASIC ELEMENTS OF HUMAN BODY                          9**

Cell – Cell Structure and organelles - Functions of each component in the cell. Cell membrane –transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions.

**UNIT 2   SKELETAL AND MUSCULAR SYSTEM                         9**

Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton -Types of joints and function – Types of cartilage and function. –Types of muscles – Structure and Properties of Skeletal Muscle- Changes during muscle contraction- Neuromuscular junction.

**UNIT 3   CARDIOVASCULAR AND RESPIRATORY SYSTEM              9**

Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood: Composition – Functions - Haemostasis – Blood groups and typing. Blood Vessels – Structure and types - Blood pressure - Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.

**UNIT 4   DIGESTIVE AND EXCRETORY SYSTEMS                      9**

Structure and functions of gastrointestinal system - secretory functions of the alimentary tract - digestion and absorption in the gastrointestinal tract - structure of nephron - mechanism of urine formation - skin and sweat gland - temperature regulation.

**UNIT 5   NERVOUS AND SENSORY SYSTEM                           9**

Structure and function of nervous tissue – Brain and spinal cord – Functions of CNS – Nerve conduction and synapse – Reflexaction– Somatic and Autonomic Nervous system. Physiology of Vision, Hearing, Integumentary, Olfactory systems. Taste buds.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.  Elaine.N. Marieb, "Essential of Human Anatomy and Physiology", Ninth Edition, Pearson Education, New Delhi, 2018.
2.  Gopal B. Saha ―Physics and Radiobiology of Nuclear Medicine Third edition Springer, 2006. (Unit 2,3,4)

**REFERENCES:**
1.  Guyton & Hall, "Text book of Medical Physiology", 13th Edition, Saunders, 2015.
2.  Ranganathan T S, "Text book of Human Anatomy", S.Chand& Co. Ltd., New Delhi, 2012.
3.  SaradaSubramanyam, K MadhavanKutty, Singh H D, "Textbook of Human Physiology", S. Chand and Company Ltd, New Delhi, 2012.

**e-Resources:**
1.  http://nptel.ac.in/courses/107103004/7 , "Human physical dimension concern",Prof.Mainak Das,IIT Kanpur.
2.  http://nptel.ac.in/courses/122103039/14 , "Nervous System",Prof.MainakDas,IITKanpur.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Identify and explain basic elements of human body
CO2   Explain the functions of skeletal and muscular system
CO3   Describe the structure, function of cardiovascular system  and respiratory system
CO4   Discuss the structure of digestive and excretory system.
CO5   Describe the physiological process of Nervous and sensory system

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 |  |  |  |  |  |  | 2 |  | 2 | 2 |  |
| CO 2 | 2 | 3 | 2 |  |  |  |  |  |  | 2 |  | 2 | 2 |  |
| CO 3 | 2 | 3 | 2 |  |  |  |  |  |  | 2 |  | 2 | 2 |  |
| CO 4 | 2 | 3 | 2 |  |  |  |  |  |  | 2 |  | 2 | 2 |  |
| CO 5 | 2 | 3 | 2 |  |  |  |  |  |  | 2 |  | 2 | 2 |  |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BMT23 | **BASIC ELECTRICAL ENGINEERING** | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisites : 22PHT11 – Engineering Physics**

**Preamble**
Electrical networks, systems and devices are the basic building blocks for today's most complex electrical and electronic systems. It is essential to understand these fundamentals to gain knowledge on solving circuits using network theorems and to obtain the transient responses of AC and DC circuits. As an electronics engineer has to work with many electrical systems, it is relevant to know the functional aspect of machines, wiring and other devices. This course is an introduction to all of them.

**UNIT 1    BASIC CIRCUIT ANALYSIS                                                                9**
Ohm's Law – Kirchhoff's laws – Network Elements- R,L,C-Elements in series and parallel –Mesh and nodal method of analysis for DC and AC circuits – voltage and current sources- Dependent and independent sources-series and parallel connection of independent sources.

**UNIT 2    NETWORK THEOREMS FOR DC CIRCUITS                                    9**
Network reduction: voltage and current division rule, source transformation – star -delta conversion. Thevenin's and Norton's Theorems – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem- Duality in circuits.

**UNIT 3    AC CIRCUITS                                                                                        9**
AC passing through pure R, L and C. Frequency response – Series and parallel resonances – Quality factor and Bandwidth - Self and mutual inductances – Dot Convention - Coefficient of coupling-series and parallel connection of coupled coils– Transient response of RL, RC and RLC Circuits using Laplace transform for DC inputs.

**UNIT 4    DC MACHINES, TRANSFORMERS AND INDUCTION MOTORS                9**
Construction and Principle of operation of DC Machines – EMF equation of DC Generator –shunt generator– DC motor- speed and torque characteristics of DC series and shunt motors- back EMF-Applications of series and shunt motors. 1 phase and 3 phase AC systems(for sine wave)- phasor notation- Single phase transformer- types: step down, step up, Auto and isolation transformers-Construction and principle of operation of 1 phase squirrel cage induction motors- Construction and operation of Stepper and BLDC Motors.

**UNIT 5    ELECTRICAL WIRING AND APPLIANCES                                            9**
Domestic wiring: Components of Distribution Board -Typical domestic distribution - stair case wiring – types of wires and their rating -Earthing- Fuse ratings –MCB-ELCB- Online UPS- rating of UPS and battery. Fluorescent and LED Lamps – Qualitative approach of Electrical appliances - Ceiling fan, mixie-Compressor, centrifugal and submersible pumps.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.  Sudhakar A and Shyammohan SP, "Circuits and Networks", McGraw Hill, 5thedn. 2015.
2.  V.N.Mittle&AravindMittal,"Basic Electrical Engineering", 2nd Edition, Tata McGraw Hill, 2006.

**REFERENCES:**
1.  Monograms prepared by the Faculty of ECE Dept.
2.  William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 6thedition, New Delhi, 2003.
3.  Vincent Del Toro, "Electrical Engineering Fundamentals", 2nd Edition, Pearson Edn, 2017.(3rd Reprint).

**e-Resources:**

1. http://www.nptel.ac.in/courses/108108076/1, Basic Electrical technology, Dr. L. Umanand, IISc, Bangalore

2. http://nptel.ac.in/courses/108105053/, Electrical Engineering, Prof. G.D. Roy, Prof. N.K. De & Prof. T.K. Bhattacharya ,IITKharagpur.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Identify and explain the different laws and theorems of electrical circuits.
CO2    Solve for network parameters using various circuit theorems
CO3    Demonstrate the knowledge on transient responses, resonance and coupled circuits.
CO4    Illustrate the construction and operation of motors and transformers.
CO5    Demonstrate the knowledge of the practices of wiring and operation of appliances.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | | | | 1 | | | 1 | | 1 | | |
| CO 2 | 2 | 3 | 2 | | | | 1 | | | 1 | | 1 | | |
| CO 3 | 2 | 3 | 2 | | | | 1 | | | 1 | | 1 | | |
| CO 4 | 2 | 3 | 2 | | | | 1 | | | 1 | | 1 | | |
| CO 5 | 2 | 3 | 2 | | | | 1 | | | 1 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22HST21**                **TAMILS AND TECHNOLOGY**         **L   T   P   C**
(Common to all B.E/B. Tech Programmes)       **1   0   0   1**
(For the Students admitted in the AY 2022-23 only)

## UNIT 1    WEAVING AND CERAMIC TECHNOLOGY             3
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW)– Graffiti on Potteries.

## UNIT 2    DESIGN AND CONSTRUCTION TECHNOLOGY          3
Designing and Structural construction House & Designs in household materials during Sangam Age-Building materials and Hero stones of Sangam age – Details of Stage Constructions inSilappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and otherworship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- ThirumalaiNayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

## UNIT 3    MANUFACTURING TECHNOLOGY                 3
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold Coins as sourceof history - Minting of Coins – Beads making-industries Stone beads -Glass beads- Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types describedin Silappathikaram.

## UNIT 4    AGRICULTURE AND IRRIGATION TECHNOLOGY         3
Dam, Tank, ponds, Sluice, Significance of KumizhiThoompu of Chola Period, Animal Husbandry -Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries –Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

## UNIT 5    SCIENTIFIC TAMIL & TAMIL COMPUTING           3
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development ofTamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

                                                   **Total : 15**

## TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித்தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொழியியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொழியியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology& Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**22HST11**          **HERITAGE OF TAMILS**                                    **L    T    P    C**
                  (Common to all B.E/B.Tech Programmes)                  **1    0    0    1**
                (For the Students admitted from the AY 2023-24 onwards)

**UNIT 1    LANGUAGE AND LITERATURE                                            3**
Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan**.**

**UNIT 2    HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE          3**
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

**UNIT 3    FOLK AND MARTIAL ARTS                                             3**
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

**UNIT 4    THINAI CONCEPT OF TAMILS                                          3**
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

**UNIT 5    CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND           3
            INDIAN CULTURE**
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

                                                                        **Total : 15**

**TEXT-CUM-REFERENCE BOOKS**

1   தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே  பிள்ளை (வெளியீடு: தமிழ்நாடு  பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).

2   கணினித்தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).

3   கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்  (தொழியியல் துறை வெளியீடு)

4   பொருநை – ஆற்றங்கரை நாகரிகம். (தொழியியல் துறை வெளியீடு)

5   Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6   Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.

7   Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8   The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

9   Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10  Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)

11  Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

12  Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**22PHL21**          **PHYSICS AND CHEMISTRY LABORATORY II**          L   T   P   C
                     (Common to all B.E/B.Tech Programmes)          0   0   2   1

**Pre-requisites: 22PHL11 – Physics and Chemistry Laboratory I**

**Preamble**

This course aims to impart knowledge in the determination of the physical parameters such as young's modulus, band gap, Co-efficient of viscosity, thickness of thin wire and Rigidity modulus of wire. This course also aims to impart the significance and estimation of DO and $Cl^-$ content in water sample by titrimetric method. Amount of $Na^+$, $Ba^{2+}$ and acid with electroanalytical techniques such as flame photometry, conductometry and pH meter in the aqueous solutions has been quantitatively analyzed

## PHYSICS LABORATORY II
**LIST OF EXPERIMENTS**
1. Determination of Young's modulus by Uniform bending method.
2. Determination of bandgap of semiconductors.
3. Determination of co-efficient of viscosity by Poiseuille's method.
4. Determination of thickness of thin wire by Air wedge method.
5. Determination of rigidity modulus-torsion pendulum.

## CHEMISTRY LABORATORY II
**LIST OF EXPERIMENTS**
1. Determination of Dissolved Oxygen content of waste water sample by Winkler's method.
2. Determination of chloride content of wastewater sample by Argentometric method.
3. Estimation of dissolved metal ions present in wastewater using flame photometer.
4. Conductometric precipitation titration of $BaCl_2$ vs $Na_2SO_4$ using conductivity meter.
5. Determination of acid strength in waste water using pH meter.

**Lecture : 0, Tutorial : 0, Practical: 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Experiment and determine the physical characteristics of given solid materials using Young's modulus-Uniform bending method, Air wedge and Torsion Pendulum.

CO2   Experiment and determine the band gap energy of a given semiconducting material using Zener diode.

CO3   Experiment and determine the physical characteristics of a given liquid using Poiseuille's method.

CO4   Experiment and estimate the amount of dissolved oxygen by Winkler's method and Chloride content by Mohr's method.

CO5   Analyse the concentration of metal ions and acid present in the wastewater with the aid of Flame photometer, Conductivity meter and pH meter.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |
| CO 2 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |
| CO 3 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |
| CO 4 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |
| CO 5 | 2 | 1 | - | 3 | - | 1 | 1 | - | 1 | 1 | 1 | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22MEL11 | **WORKSHOP PRACTICES LABORATORY** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | (Common to all B.E/B.Tech Programmes) | **0** | **0** | **2** | **1** |

**Pre-requisites: Nil**

**Preamble**

Workshop practices give hands-on training practice to Engineering students. This course includes carpentry, plumbing, welding, sheet metal forming and welding exercises. Also, this course will inculcate in the students the habit of selecting right tools, planning the job and its execution

## GROUP A
## CIVIL                                                                                    9

**Plumbing Works**:
- Study of plumbing tools, pipeline joints, its location, functions and safety aspects.
1. a. Distribution of water from sump to overhead tank and return to home tap with bye pass connection.
   b. Distribution of water in mixed pipes.

**Carpentry using Power Tools only:**
- Study of the carpentry tools, joints and processes in roofs, doors, windows and furniture and safety precautions.

Hands-on-exercise:
   a. Tee Lap joint
   b. Dove tail joint

## MECHANICAL                                                                      15

**Welding:**
1. Arc welding - Lap joint
2. Arc welding - Tee joint

**Basic Machining:**
3. Simple Turning and Facing
4. Drilling and Tapping

**Sheet Metal Work- Forming & Bending:**
5. Model making - Tray / Funnel

**Study Experiments:**
(a) Study of centrifugal pump
(b) Study of air conditioner

**Demonstration:**
- Gas welding practice

## GROUP B
## ELECTRICAL                                                                    12

1. Residential house wiring using switches, fuse, indicator and lamps.
2. Fluorescent lamp wiring.
3. Staircase wiring.
4. Reading of voltage, current, power, energy and other parameters with 1 phase digital energy meter.
5. Measurement of earth resistance.

## ELECTRONICS                                                                   9

1. Identification and Study of Electronic components and equipments – Resistors, capacitors, inductors, colour coding and measurement.
2. Measurement of AC signal parameters (peak-peak, RMS value, period, frequency) using CRO.
3. Verification of the truth tables of logic gates: AND, OR, XOR and NOT.
4. Construction of Half Wave and Full Wave Rectifiers and study their output waveforms.
5. Soldering practice – Using general purpose PCB.

**Lecture :0, Tutorial: 0, Practical: 45, Total : 45**

**REFERENCES:**
1. Manual prepared by the faculty of Mechanical Engineering Department, VCET.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Fabricate various joints by carpentry and to prepare plumbing line assemblies.
CO2 Fabricate various joints through arc welding and gas welding processes.
CO3 Perform metal forming and basic machining operations.
CO4 Construct various types of domestic wiring and measure the various electrical parameters.
CO5 Develop and test circuits with active elements and verify truth table of logic gates.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | 1 | 1 | | 3 | | | 2 | 2 | | 1 | | |
| CO 2 | 3 | 2 | 1 | 1 | | 3 | | | 2 | 2 | | 1 | | |
| CO 3 | 3 | 2 | 1 | 1 | | 3 | | | 2 | 2 | | 1 | | |
| CO 4 | 3 | 2 | 1 | 1 | | 3 | | | 2 | 2 | | 1 | | |
| CO 5 | 3 | 2 | 1 | 1 | | 3 | | | 2 | 2 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22MCT03**   **ENVIRONMENTAL SCIENCE AND ENGINEERING**   **L   T   P   C**
(Common to all B.E/B.Tech Programmes)   **2   0   0   0**

**Pre-requisites: Nil**

**Preamble**
The study of biodiversity reflects the level of national interest in natural resources and heritage, which is considered as an important part of a country's wealth. As India is one of the world's 12 giant diversity hubs, we need to focus on understanding, preserving and utilizing the biodiversity of our biological resources. Environmental protection is an important issue for today's society, as scientific research provides evidence of increased global warming, ozone depletion and increased pollution. Engineers need to learn the importance of green synthesis in the design, development and evaluation of structures, devices and systems to provide practical solutions to the problems caused by the pollution and depletion of natural resources.

**UNIT 1   NATURAL RESOURCES, ECOSYSTEM AND BIODIVERSITY**   **6**
Forest Resources – use and over exploitation – Water Resources – use and over utilization – Dams – benefits and problems – Ecosystem – structure and function – Biodiversity – types – threats to biodiversity –  Biodiversity conservation–In-situ and Ex-situ  – Role of an individual in conservation of natural resources.

**UNIT 2   ENVIRONMENTAL POLLUTION**   **6**
Definition – causes, effects and control measures – Air Pollution, Water Pollution, Soil Pollution – Solid waste – methods of disposal – sanitary landfill, incineration and composting – Environmental Impact Assessment and ISO 14000.

**UNIT 3   E-WASTE AND ITS MANAGEMENT**   **6**
E-Waste –  sources of e-waste – hazardous substances in e-waste – effects of e-waste on environment and human health – need for e-waste management – disposal treatment methods of e-waste – Global scenario of e-waste – e-waste in India- case studies.

**UNIT 4   SOCIAL ISSUES AND THE ENVIRONMENT**   **6**
Social issues – Sustainable development – Water conservation – rain water harvesting. Disaster Management – floods, earthquake, cyclone and landslides. Role of IT in environment and human health.

**UNIT 5   GREEN CHEMISTRY**   **6**
Green Chemistry – twelve principles of green chemistry – Importance of green synthesis – Green synthesis – dimethyl carbonate – Bio-catalysts – extraction of gold – Applications of green synthesis.
**Lecture : 30, Tutorial : 0, Total : 30**

**TEXT BOOKS:**
**1.**   Environmental Science, 5th Edition. PN Palanisamy, P Manikandan, A Geetha, K Manjula Rani, V.N. Kowshalya, Pearson India Education Service Pvt Ltd, 2020.
**2.**   Environmental Science and Engineering', 1st edition, Dr.Arun Luiz T, VK publications, 2018.

**REFERENCES:**
**1.**   Environmental Science and Engineering', 3[rd]reprint, Benny Joseph, McGraw Hill Education (India) Pvt.Ltd.,New Delhi, 2015.
**2.**   Engineering Chemistry, 1st Impression, K. Sesha Maheswaramma, Mridula Chugh, Pearson India Education Services Pvt. Ltd, 2016.
**3.**   Introduction to 'Environmental Engineering and Science', 2nd edition, Gilbert M.Masters, Prentice Hall of India Pvt. Ltd, 2015.

**e-Resources:**
**1.**   https://www.digimat.in/nptel/courses/video/105105169/L01.html, "Electronic waste management -issues and challenges"- Prof. Brajesh Kumar Dubey, Dept. of Civil Engineering, IIT Kharagpur.

**2.** https://archive.nptel.ac.in/courses/105/103/105103205/, "Municipal solid waste management"- Prof. Ajay Kalamdhad, Department of Civil Engineering, IIT Guwahati.

**Course Outcomes: Upon completion of this course, students will be able to:**

| | |
|---|---|
| CO1 | Recognize the biodiversity threats, overexploitation of forest and overutilization of water to conserve biodiversity |
| CO2 | Analyze sources, impacts, air and water pollution control measures, and solid waste management to maintain a green environment |
| CO3 | Identify the Environmental impacts of E-Waste and its management |
| CO4 | Explain human health, environment and disaster management through information technology |
| CO5 | Apply the principles of green chemistry to green synthesis for a sustainable environment. |

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | - | - |
| CO 2 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | - | - |
| CO 3 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | - | - |
| CO 4 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | - | - |
| CO 5 | 3 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 1 | 1 | 1 | 2 | - | - |

**1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).**

**22MAT31          TRANSFORM TECHNIQUES AND THEIR APPLICATIONS     L     T     P     C**
                     (B.E. BM Programme in Third Semester )              **3     1     0     4**

**Pre-requisites: 22MAT11 Matrices and Differential Equations, 22MAT21 Calculus and Complex Analysis**

**Preamble:**
Transform methods, like Laplace and Fourier are frequently used for analyzing the dynamical behavior of engineering and physical systems, based on their transfer function, and frequency response or the solutions of their corresponding differential equations. This course aims to provide sufficient knowledge to engineering students in the specific mathematical techniques such as Laplace Transform, Fourier series, Fourier transform and Z-transform.

**UNIT 1     LAPLACE TRANSFORM                                                    9+3**
Laplace Transform: Conditions for existence – Transform of elementary functions – Basic properties - Transform of periodic functions. Inverse Laplace transform: Inverse Laplace transform of elementary functions – Partial fraction method – Convolution theorem (Statement only) – Applications: Solution of linear ODE of second order with constant coefficients using Laplace Transform.

**UNIT 2     FOURIER SERIES                                                       9+3**
Odd and even functions - Dirichlet's conditions – General Fourier series – Half range sine series – Half range cosine series – Parseval's identity – Harmonic Analysis.

**UNIT 3     SOLUTION OF BOUNDARY VALUE PROBLEMS USING**
                     **FOURIER SERIES                                             9+3**
One dimensional wave equation: Transverse vibrations of a string – One dimensional equation of heat conduction – Steady state temperature distribution in a rod – Two dimensional steady state temperature distributions in a plate.

**UNIT 4     FOURIER TRANSFORM                                                    9+3**
Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Convolution theorem – Parseval's identity.

**UNIT 5    Z TRANSFORM                                                           9+3**
Z-transforms - Elementary properties – Inverse Z-transform (using Partial Fraction and Residues) – Convolution theorem - Formation of difference equations – Applications: Solution of difference equations using Z-transform.

                                                            **Lecture: 45; Tutorial: 15; Total: 60**

**TEXT BOOKS:**

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Tenth edition, Wiley Dream Tech India (P) Ltd. (2016).

2. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, University Press India (P) Ltd, Hyderabad (2015).

**REFERENCES:**

1. Ramana.B.V., "Higher Engineering Mathematics", First edition, Tata Mc-GrawHill Publishing Company limited, New Delhi, 2016

2. Grewal, B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna publishers, Delhi (2016)

1. http://nptel.ac.in/courses/111105035/27 , "Advanced Engineering Mathematics", Prof. Jitendra Kumar, Department of Mathematics, Indian Institute of Technology, Kharagpur
2. http://nptel.ac.in/courses/111106046, "Fourier Series", Prof.R.Radha, and Prof S. Thangavelu, Department of Mathematics, Indian Institute of Technology Madras, Chennai

**Course Outcomes:** Upon completion of the course, students will be able to:

CO1 Solve linear second order ordinary differential equations with constant coefficients using the properties of Laplace Transform.

CO2 Compute the trigonometric form of the Fourier series for periodic waveforms satisfying the Dirichlet's conditions and using them to evaluate infinite series.

CO3 Compute the analytical solution for the given physical model for the specified initial and boundary conditions in one dimensional and two dimensional distributions using Fourier Series.

CO4 Compute the Fourier transform of non-periodic waveforms using Fourier Transform properties.

CO5 Solve the difference equations of first and second order using Z-transform techniques.


**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO1** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| **CO2** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| **CO3** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| **CO4** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| **CO5** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |

1- Slight (Low), 2-Moderate (Medium), 3-Substantial (High)

**22BMT31**                     **SIGNALS AND SYSTEMS**         **L   T   P   C**
                                                                                 **3   1   0   4**

**Pre-requisites: Nil**

**Preamble**

Signals and systems concerns with analysis and synthesis of deterministic signals and their interaction with LTI systems.The analysis of Signals and its concepts play a vital role in signal processing, image and video processing and digital/analog communications. In order to understand the analysis of signals in the frequency domain it is essential to learn Fourier analysis, Laplace and Z transforms. The discrete time version of a signal is needed to make a filtering and further processing of a signal.

**UNIT 1    CLASSIFICATION OF SIGNALS AND SYSTEMS**             **9+3**

Continuous time signals - Discrete time signals – Impulse, Step, Ramp, Parabolic, Sinusoidal, Exponential, Pulse – Operations on Signals – Classification of CT and DT signals: Deterministic & Random signals, Periodic & Aperiodic signals, Energy & Power signals, Causal & Non-causal, Even & Odd signals – CT systems and DT systems – Classification of systems: Static & Dynamic, Linear & nonlinear, Time-variant & Time-invariant, Causal & non-causal, Stable & unstable – Signal Generation using Scilab.

**UNIT 2     ANALYSIS OF CONTINUOUS TIME SIGNALS**             **9+3**

Fourier series (Trigonometric and Exponential) – Spectrum of Continuous Time (CT) signals – Properties of Laplace Transform – Fourier and Laplace Transforms in CT signal analysis

**UNIT 3    LINEAR TIME INVARIANT- CONTINUOUS TIME SYSTEMS**      **9+3**

Differential Equations – Impulse response – Block diagram representation – Realization using Direct form I, Direct form II – Convolution integrals – Fourier and Laplace transforms in analysis of CT systems.

**UNIT 4    ANALYSIS OF DISCRETE TIME SIGNALS**                **9+3**

Sampling theorem – DTFT and Inverse DTFT– Properties of DTFT Transform – Z and Inverse Z Transform – Properties of Z Transform – DTFT and Z transforms in analysis of DT systems.

**UNIT 5   LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS**        **9+3**

Difference equations – Impulse response – Block diagram representation – Realization using Direct form I, Direct form II – Convolution – DTFT and Z Transform analysis of Recursive and Non-Recursive systems.

                                                       **Lecture : 45, Tutorial : 15, Total : 60**

**TEXT BOOKS:**

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", Pearson Education, India, 2ndEdn, reprint 2015.
2. P.Ramesh Babu and R.Anandanatarajan, "Signals and Systems", Scitech Publication, 2014.

**REFERENCES:**

1. B. P. Lathi , "Principles of Linear Systems and Signals", Second Edition, Oxford, 2009.
2. M.J.Roberts, "Signals and Systems Analysis using Transform methods and MATLAB", McGraw Hill, 2nd Edition,2010.
3. A.Nagoorkani, "Signals and Systems", McGraw Hill, Second Edition, 2010.

**e-Resources:**

1. http://www.nptel.in/courses/117101055, "Signals and systems", Prof.V.M.Gadre, IIT Bombay.
2. http://www.nptel.in/courses/117104074, "Signals and systems", Prof.K.S.Venkatesh, IIT Kanpur.
3. http://www.scilab.org

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1  Verify the linearity, stability, causality and time invariance properties of CT and DT systems.

CO2  Compute the frequency spectrum of the periodic CT signals using Fourier series and aperiodic CT signals using Fourier & Laplace transforms.

CO3  Realize the Direct Form I & II structures of the given LTI-CT systems and compute the impulse response.

CO4  Determine the frequency response of the given DT sequences using Z transform and DTFT.

CO5  Develop the Direct Form I & II structures of the given LTI-DT systems and determine the impulse response.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 3 | 2 | 1 | 2 |   |   |   |   | 1 |   | 2 |   |   |
| CO 2 | 3 | 3 | 2 | 1 |   |   |   |   |   |   |   | 2 |   |   |
| CO 3 | 3 | 3 | 2 | 1 |   | 1 | 1 |   |   |   | 1 |   |   |   |
| CO 4 | 3 | 3 | 2 | 1 |   | 1 | 1 |   |   | 1 |   | 2 |   |   |
| CO 5 | 3 | 3 | 2 | 1 |   | 1 | 1 |   |   |   | 1 |   |   |   |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| **22BMT32** | **BIOCHEMISTRY** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | **3** | **0** | **0** | **3** |

**Pre-requisites:** 22CYT11 Engineering Chemistry ,  22BMT22 Human Anatomy And Physiology

**Preamble**
Biomedical Engineering is an interdisciplinary course. Biochemistry is to provide grounding in the basic principles of Life Sciences. The course provides a description of the principal biochemical components of cells and demonstrates how energy is produced, converted and stored in cell and then released into high-energy compounds capable of driving biochemical reactions. The course educates basic chemical properties of molecules and how these properties relate to specific macromolecular structures and functions and imparts knowledge in principle, instrumentation and applications of bioanalytical techniques used for the separation of biomolecules.

**UNIT 1    INTRODUCTION TO BIOCHEMISTRY                                                                 9**
Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson-Hasselbalch equation, physiological buffers-phosphate buffer, bicarbonate buffer, heamoglobin buffer, fitness of the aqueous environment for living organism . Principle and biological applications of viscosity, surface tension, adsorption, diffusion and osmosis. Important noncovalent forces – Hydrogen bonds, electrostatic, hydrophobic & vanderwaals forces.

**UNIT 2     CARBOHYDRATES                                                                                                    9**
Classification of carbohydrates – Structure and properties of mono, di, oligo and polysaccharides. Isomerism, racemisation and mutarotation. Metabolic pathways and bioenergetics – Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle and electron transport chain. Oxidative phosphorylation.

**UNIT 3    LIPIDS                                                                                                                         9**
Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat. Saponification number, Reichert- Meissl number and iodine number. Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism and ketogenesis. Transport of lipids. Structural architecture and significance of biological membrane.

**UNIT 4    NUCLEIC ACID & PROTEIN                                                                                    9**
Structure of purines and pyrimidines, nucleoside, nucleotide, DNA act as a genetic material, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Classification, structure and properties of proteins, structural organization of proteins, classification and properties of aminoacids. Separation of protein: gel filtration, electrophoresis and ultracentrifugation.

**UNIT 5    ENZYME AND ITS KINETICS                                                                                 9**
Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Kinetics of enzymes - Michaelis- Menten equation and Lineweaver- burk equation. Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Inhibitors of enzyme action: Competitive, non- competitive, uncompetitive,  irreversible. Enzyme: Mode of action, allosteric and covalent regulation. Clinical significance of enzymes. Measurement of enzyme activity, Enzymatic Biosensorss: Principles and Application.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Biochemistry, U.Satyanarayana, Arunabha Sen Books and Allied (p) Ltd, Kolkatta, 2005, Second Edition.
2. Harper's Illustrated Biochemistry By Robert K. Murray, Daryl K. Granner, Peter A. Mayes, Victor W. Rodwell,Twenty-sixth edition, International Edition,  McGraw-Hill, 2003.

**REFERENCES:**
1. David L Nelson, Michael M Cox, Albert L Lehninger "Lehninger principles of biochemistry", New York: W.H. Freeman, 2006.
2. Medical Biochemistry, N.V.Bhagavan, Fourth edition, Academic Press An Imprint of Elsevier, 2004

**e-Resources:**
1. https://youtu.be/jLyi2K-29xU,"Biochemistry-1", Professor S. Dasgupta, Department of Chemistry, IIT, Kharagpur.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1 Apply the fundamental knowledge of chemistry and biology to solve biochemical problems.
CO2 Describe the structure, classification and metabolic regulation of carbohydrates.
CO3 Identify structural levels, stabilization factors and bioenergetics of protein.
CO4 Recognize the properties and functions of lipids in biological system.
CO5 Analyze the mechanism, activity, assay techniques, kinetics and applications of enzymes.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 3 | |
| CO 2 | 2 | 3 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| CO 3 | 2 | 1 | 2 | 1 | 1 | | | | | 2 | | 2 | 3 | |
| CO 4 | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 3 | |
| CO 5 | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 3 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT33**                          **SEMICONDUCTOR DEVICES**                  **L   T   P   C**
                                                                              **3   0   0   3**

**Pre-requisites: Nil**

**Preamble**
The invention of solid state diodes and transistors has revolutionized the world. All the developments in the applications of electronics started with these. The fundamental components spawned into a range of signal and power devices. An engineer has to understand these devices which the building blocks of the circuits and systems.

**UNIT 1   PN JUNCTION DIODE                                                      9**
Construction, Theory and operation of PN junction diode – VI Characteristics – current equation – Diode resistances and capacitances – Ratings – Energy band diagram of PN junction diode – Applications - Zener diode and its characteristics – voltage regulation using zener diodes.

**UNIT 2    BJT TRANSISTOR                                                        9**
Principle of operation of PNP and NPN transistors – study of CE, CB and CC configurations and comparison of their characteristics – Transistor as amplifier.

**UNIT 3   FET AND MOSFET                                                         9**
Construction, Operation, Characteristics and Application of JFET - JFET Parameters -JFET as VVR. Construction, Operation, Characteristics and Application of MOSFETs - EMOSFET and DMOSFET.

**UNIT 4   SPECIAL PURPOSE DIODES                                                 9**
Construction, Operation, Characteristics and Application of Tunnel diode, Varactor diode, LED, Laser diode, Photodiode, Gunn diode, Schottky Diode.

**UNIT 5   POWER DEVICES AND DIODE APPLICATIONS                                   9**
Construction, Operation, Characteristics and Application of SCR, DIAC, TRIAC-IGBT. Operation and Analysis of Rectifiers: Half-Wave and Full-Wave (both centre-tapped and bridge types) Rectifiers with capacitor filters.

                                                              **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.   Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2009.
2.   Salivahanan S. &Sureshkumar N. "Electronic Devices and Circuits", McGraw Hill Education, 3rd Edition, Fifth Reprint, 2014.

**REFERENCES:**
1.   V.K.Mehta, Principles of Electronics, S.Chand& Co., 2011.
2.   J. Millman , C CHalkias&SatyabrataJit, "Electronic Devices & Circuits", Tata McGraw Hill, 4thEdition, 2015.
3.   David A. Bell, "Electronic Devices and Circuits", Fifth Edition, Oxford University Press, 2008.

**e-Resources:**
1.   http://nptel.ac.in/courses/117101106/1, Analog Circuits,Prof. A N Chandorkar, IIT Bombay.
2.   http://nptel.ac.in/courses/117103063/2,      "Basic Electronics",   Dr.ChitralekhaMahanta, IIT, Guwahati.

**Course Outcomes:** Upon completion of this course, students will be able to:

| CO1 | Analyze the characteristics of PN junction diode and Zener diode under forward bias and reverse bias condition. |
| CO2 | Analyze the input and output characteristics of CB, CE and CC configurations of BJT. |
| CO3 | Discuss the Construction, Operation, Characteristics and Application of JFET and MOSFETs. |

CO4    Discuss the Construction, Operation, Characteristics and Application of Tunnel diode, Varactor diode, LED, Laser diode, Photodiode, Gunn diode, Schottky Diode.

CO5    Analyze the characteristics of SCR, DIAC and TRIAC.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | 1 | | | | | | 1 | | 1 | | |
| CO 2 | 2 | 3 | 2 | 1 | | | | | | 1 | | 1 | | |
| CO 3 | 2 | 3 | 2 | 1 | | | | | | 1 | | 1 | | |
| CO 4 | 2 | 3 | 2 | 1 | | | | | | 1 | | 1 | | |
| CO 5 | 2 | 3 | 2 | 1 | | | | | | 1 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT34**                    **SENSORS AND MEASUREMENTS**                    **L    T    P    C**
                                                                              **3    0    0    3**

**Pre-requisites : Nil**

**Preamble**
To develop the understanding of measurement systems, and the characteristics of instruments and to classify transducers to identify the biomedical applications. To understand the signal conditioning principles and to describe the display/recording devices.

**UNIT 1    FUNDAMENTALS OF MEASUREMENTS                                       9**
Significance of measurements - Functional elements of a generalized Instrument – Classification of measuring Instruments - Definition of sensor/Transducer - Classification of sensors/transducers - Selection criteria - Performance characteristics: static and dynamic characteristics. SI units, Types of errors, Methods of error analysis - Propagation of errors - Calibration and Standards.

**UNIT 2    RESISTIVE & TEMPERATURE TRANSDUCERS                                9**
Measurement principle, Characteristics,and Clinical applications: Resistive transducers: Resistance potentiometer, Strain gauge-Gauge factor- Types of strain gauges.Thermoelectric sensors- Resistance thermometers, Thermistor, Thermocouples. Non-contact type temperature measurement techniques: Total Radiation pyrometer, Optical pyrometer - Biomedical applications.

**UNIT 3    INDUCTIVE, CAPACITIVE& DIGITAL TRANSDUCERS                         9**
Inductive: Concepts of self-inductance and mutual inductance, Linear Variable Differential Transformer, Rotary Variable Differential Transformer. Capacitive: Basic principle – Variable area type – Variable air gap type – Variable permittivity type –Capacitive pressure sensors – Biomedical applications, Digital displacement transducers: Incremental type, Tachometer type.

**UNIT 4    OPTICAL &PIEZOELECTRIC SENSORS                                     9**
Photo emissive tubes –Photo Multiplier Tube (PMT) – scintillation counter – Photo conductive cells– phototransistor – comparison of photoelectric transducers – Spectro photometric applications of photo electric transducers, Piezoelectric transducers: Modes of operation of piezoelectric crystals – Uses of piezoelectric materials and transducers, Biomedical applications as ultrasound transducers.

**UNIT 5    SIGNAL CONDITIONING SYSTEM AND DATA ACQUISITION SYSTEMS           9**
DC Bridges: Wheat stone bridge – Kelvin Bridge, AC Bridges: Maxwell – Schering - Anderson's Bridges. Cathode Ray Oscilloscope (CRO), Digital Storage Oscilloscope (DSO). Data acquisition System: Analog Input subsystem – Analog output subsystem – Digital Input and output subsystem.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.    Doebelin E.O. and Manik D.N., "Measurement Systems", Tata McGraw-Hill Education Pvt. Ltd., 6 th Edition, 2011.
2.    L.A Geddes and L.E.Baker , "Principles of Applied Biomedical Instrumentation", – John Wiley and sons, 3 rd Edition, Reprint 2008.

**REFERENCES:**
1.    A.K.Sawhney, "Electrical & Electronics Measurement and Instrumentation", DhanpatRai&Co, New Delhi, 17th Edition, Reprint  2015.
2.    PrithwirajPurkait, Budhaditya Biswas, Santanu Das, ChiranjibKoley, Electrical and Electronic Measurements and Instrumentation, Tata McGraw-Hill, New Delhi, 2013.
3.    Khandpur R.S, Handbook of Biomedical Instrumentation‖, Tata McGraw-Hill, New Delhi, 2014.
4.    Joseph J.Carr and John M Brown, Introduction to Biomedical Equipment Technology, 4/E, Pearson education India, 2001.

**e- RESOURCES:**
1.  http://nptel.ac.in/courses/112103174/3, Sensors and Transducers by Prof. AlokBarua, IIT, Kharagpur.
2.  http://nptel.ac.in/courses/108105064/1, Classification of Instruments by Prof. AlokBarua, IIT, Kharagpur.
3.  http://www.nptelvideos.in/2012/11/industrial-instrumentation.html,Piezoelectric

**Course Outcomes: Upon completion of the course, students will be able to:**
1.  Describe the purpose and methods of measurements and the errors associated with measurement.
2.  Identify the biomedical applications of Resistive and Temperature transducers using their principles of operation.
3.  Explain the biomedical applications of Inductive, Capacitive, and Digital transducers using their principles of operation.
4.  Illustrate the concepts of Optical and Piezoelectric transducers for biomedical applications.
5.  Interpret the principles of signal conditioning systems and data acquisition systems.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 1 | 3 | | | 2 | 1 | | | | | 2 | 3 | |
| **CO 2** | 3 | 1 | 3 | | | 2 | 1 | | | | | 2 | 3 | |
| **CO 3** | 3 | 1 | 3 | | | 2 | 1 | | | | | 2 | 3 | |
| **CO 4** | 3 | 1 | 3 | | | 2 | 1 | | | | | 2 | 3 | |
| **CO 5** | 3 | 1 | 3 | | | 2 | 1 | | | | | 2 | 3 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT35**       **BIOMATERIALS AND ARTIFICIAL ORGANS**       **L   T   P   C**
(For Students admitted in the AY 2022-23 & 2023-24 only)       **3   0   0   3**

**Pre-requisites: Nil**

**Preamble**
This course is to develop the understanding of classification, biocompatibility and properties of biomaterials. Biomaterials are synthesized biologically and chemically by utilizing metallic components, polymers, ceramics or composite materials. It is used in orthopedic application, dental, retinal applications and artificial organs.

**UNIT 1   STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY             9**
Definition and classification of bio-materials, mechanical properties of biomaterials, structure property relationship of biological and biomaterials visco elasticity, wound-healing process, body response to implants, blood compatibility, HLA compatibility, carcinogenicity.

**UNIT 2    IMPLANT MATERIALS I                                            9**
Metallic implant materials: stainless steels, cobased alloys, Ti-based alloys, Dental metals, Deterioration of metallic implant materials-ceramic implant materials: Structure–Property Relationship of Ceramics, aluminum oxides, zirconia, hydroxyapatite, glass ceramics, carbons.

**UNIT 3   IMPLANT MATERIALS II                                           9**
Polymerization, polyamides, Acryrilic polymers, Hydrogels, rubbers, high strength thermoplastics, Deterioration of polymers - Bio polymers: Collagen and Elastin. Medical Textiles: silica, chitosan, PLA, composites, Sutures, wound dressings. Composites – structure, mechanics,biocompatibility, applications. Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and blood oxygenation.

**UNIT 4   TISSUE REPLACEMENT IMPLANTS                                    9**
Soft tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial, craniofacial augmentation, Vascular grafts, hard tissue replacement Implants, internal fracture fixation devices, joint replacements.

**UNIT 5   ARTIFICIAL ORGANS                                              9**
Blood substitutes, Artificial skin, Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane), Artificial Pancreas, Dental Implants, Retinal Implants.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Park,J.B and Lakes,R.S.,"Biomaterials An Introduction", Springer Publications, 3$^{rd}$ edition, USA, 2007.
2. Sujata V. Bhatt, "Biomaterials", Narosa Publishing House, 2$^{nd}$ Edition, 2005.

**REFERENCES:**
1. Joseph D.Bronzino "Tissue Engineering and Artificial Organs", 3$^{rd}$Edition,Taylor and Francis,2006.
2. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, Elsevier, "Introduction to Biomedical Engineering", 2$^{nd}$ Edition, 2005.
3. BD Ratner, AS Hoffmann,FJ Schoen, JE Lemmons, "An introduction to Materials in Medicine" Academic Press, 2$^{nd}$Edition, 1996.

**e-Resources:**
1. http://nptel.ac.in/courses/113104009/, Introduction to Biomaterials, Prof.Bikramjit Basu, Prof.KanteshBalani, Department of Materials and Metallurgical Engineering, Indian Institute of Technology, Kanpur

2.  http://nptel.ac.in/courses/113108071/, Biomaterials for bone tissue engineering applications, Prof.BikramjitBasu, Materials research centre, Indian Institute of Science, Bangalore.
3.  https://ocw.mit.edu/courses/biological-engineering/20-441j-biomaterials-tissue-interactions-fall-2009/index.htm, Biomaterials tissue interactions, Prof. IoannisYannas, Prof. Myron Spector, Department of biological engineering, MIT.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1     Categorize the structure of biomaterials using its bio-compatibility, mechanical properties and to study wound-healing process

CO2     Characterize the nature and structural properties of metallic and ceramic implant materials.

CO3     Explore the nature and structural characteristics of polymers and composite biomaterials using its properties for biomedical applications

CO4     Identify the metallic, ceramic, polymer and composite biomaterials that could be used to replace tissues in the body during tissue replacement implants

CO5     Illustrate the design procedure of artificial organs using biomaterials.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |
| **CO 2** | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |
| **CO 3** | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |
| **CO 4** | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |
| **CO 5** | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BMT35 | **BIOMATERIALS AND ARTIFICIAL ORGANS** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | (For Students admitted in the AY 2024-25 onwards) | **3** | **0** | **0** | **3** |

**Pre-requisites: Nil**

**Preamble**
This course is to develop the understanding of classification, biocompatibility and properties of biomaterials. Biomaterials are synthesized biologically and chemically by utilizing metallic components, polymers, ceramics or composite materials. It is used in orthopedic application, dental, retinal applications and artificial organs.

**UNIT 1   STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY                9**
Definition and classification of bio-materials, mechanical properties of biomaterials, structure property relationship of biological and biomaterials visco elasticity, wound-healing process, body response to implants, blood compatibility, HLA compatibility, carcinogenicity.

**UNIT 2    IMPLANT MATERIALS I                9**
Metallic implant materials: stainless steels, cobased alloys, Ti-based alloys, Dental metals, Deterioration of metallic implant materials-ceramic implant materials: Structure–Property Relationship of Ceramics, aluminum oxides, zirconia, hydroxyapatite, glass ceramics, carbons.

**UNIT 3   IMPLANT MATERIALS II                9**
Polymerization, polyamides, Acryrilic polymers, Hydrogels, rubbers, high strength thermoplastics, Deterioration of polymers - Bio polymers: Collagen and Elastin. Medical Textiles: silica, chitosan, PLA, composites. Composites – structure, mechanics,biocompatibility, applications. Materials for ophthalmology: contact lens, intraocular lens.

**UNIT 4   TISSUE REPLACEMENT IMPLANTS                9**
Soft tissue replacements, sutures, wound dressings, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, internal fracture fixation devices, joint replacements.

**UNIT 5   ARTIFICIAL ORGANS                9**
Blood substitutes, Artificial skin, Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane), Artificial Pancreas, Dental Implants.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Park,J.B and Lakes,R.S.,"Biomaterials An Introduction", Springer Publications, 3rd edition, USA, 2007.
2. Sujata V. Bhatt, "Biomaterials", Narosa Publishing House, 2nd Edition, 2005.

**REFERENCES:**
1. Joseph D.Bronzino   "Tissue Engineering and Artificial Organs", 3rd Edition,Taylor and Francis,2006.
2. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, Elsevier, "Introduction to Biomedical Engineering", 2nd Edition, 2005.
3. BD Ratner, AS Hoffmann,FJ Schoen, JE Lemmons, "An introduction to Materials in Medicine" Academic Press, 2ndEdition, 1996.

**e-Resources:**
1. http://nptel.ac.in/courses/113104009/, Introduction to Biomaterials, Prof.Bikramjit Basu, Prof.KanteshBalani, Department of Materials and Metallurgical Engineering, Indian Institute of

Technology, Kanpur
2. http://nptel.ac.in/courses/113108071/, Biomaterials for bone tissue engineering applications, Prof.BikramjitBasu, Materials research centre, Indian Institute of Science, Bangalore.
3. https://ocw.mit.edu/courses/biological-engineering/20-441j-biomaterials-tissue-interactions-fall-2009/index.htm, Biomaterials tissue interactions, Prof. IoannisYannas, Prof. Myron Spector, Department of biological engineering, MIT.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Categorize the structure of biomaterials using its bio-compatibility, mechanical properties and to study wound-healing process

CO2   Characterize the nature and structural properties of metallic and ceramic implant materials.

CO3   Explore the nature and structural characteristics of polymers and composite biomaterials using its properties for biomedical applications

CO4   Identify the metallic, ceramic, polymer and composite biomaterials that could be used to replace tissues in the body during tissue replacement implants

CO5   Illustrate the design procedure of artificial organs using biomaterials.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |
| CO 2 | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |
| CO 3 | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |
| CO 4 | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |
| CO 5 | 2 | 3 | 2 | | | | | | | 2 | | 2 | 2 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22HST21**                    **TAMILS AND TECHNOLOGY**                    **L    T    P    C**
                    (Common to all B.E/B.Tech Programmes)                    **1    0    0    1**
                    (For Students admitted from the AY 2022-23 only)

**UNIT 1    WEAVING AND CERAMIC TECHNOLOGY**                                                    **3**
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW)– Graffiti on Potteries.

**UNIT 2    DESIGN AND CONSTRUCTION TECHNOLOGY**                                                    **3**
Designing and Structural construction House & Designs in household materials during Sangam Age- Building materials and Hero stones of Sangam age – Details of Stage Constructions inSilappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and otherworship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- ThirumalaiNayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

**UNIT 3    MANUFACTURING TECHNOLOGY**                                                    **3**
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold Coins as sourceof history - Minting of Coins – Beads making-industries Stone beads -Glass beads- Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types describedin  Silappathikaram.

**UNIT 4    AGRICULTURE AND IRRIGATION TECHNOLOGY**                                                    **3**
Dam, Tank, ponds, Sluice, Significance of KumizhiThoompu of Chola Period, Animal Husbandry -Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries –Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

**UNIT 5    SCIENTIFIC TAMIL & TAMIL COMPUTING**                                                    **3**
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development ofTamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries –Sorkuvai Project.
**Total : 15**
**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே  பிள்ளை (வெளியீடு: தமிழ்நாடு  பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித்தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம்  (தொழியியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொழியியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology& Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

**22BML31**       **CIRCUITS AND DEVICES LABORATORY**      L   T   P   C
                                                                     0   0   2   1

**Pre-requisites: Nil**

**Preamble**

The goals are to supplement the theory courses Semiconductor Devices and Basic Electrical Engineering to assist the students in obtaining a better understanding of the operation of electronic circuits and devices and to provide experience in analyzing network theorems.

**LIST OF EXPERIMENTS**

1. Verification of KVL and KCL.
2. Verification of Thevenin's and Norton's Theorems.
3. Verification of superposition Theorem.
4. Verification of Maximum power transfer and reciprocity theorems.
5. Frequency response of RLC series and parallel resonance circuits.
6. Characteristics of PN and zener diode.
7. Characteristics of CE, CB configurations.
8. Characteristics of JFET.
9. Characteristics of SCR.
10. Half wave and Full wave rectifier with capacitor filter.
11. Voltage regulation using zener diode.
12. Study of characteristics of photo diodes.
13. Study of Transient analysis of RL and RC circuits.

**Lecture :0, Tutorial: 0, Practical: 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Experiment and test the given electric circuit using Kirchhoff's laws and obtain the mesh current & node voltage and obtain the load current for the given circuit using Superposition, Thevenin's, and Norton's and Reciprocity theorems.

CO2   Construct and test RLC series and parallel circuits to compute the resonant frequency and bandwidth by plotting the frequency response.

CO3   Experiment and determine the VI characteristics of given PN junction diode, Zener diode, Photo diode and Silicon Controlled Rectifier.

CO4   Experiment and determine the Input & output characteristics of BJT and drain & transfer characteristics of JFET.

CO5   Experiment and test half wave and full wave rectifier circuit using PN Junction diode and obtain the ripple factor, rectifier efficiency and experiment and test voltage regulation characteristics using Zener diode voltage regulator circuit.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 3 | 1 | 1 | | | | | 2 | 2 | | 3 | | |
| CO 2 | 3 | 3 | 1 | 1 | | | | | 2 | 2 | | 3 | | |
| CO 3 | 3 | 3 | 1 | 1 | | | | | 2 | 2 | | 3 | | |
| CO 4 | 3 | 3 | 1 | 1 | | | | | 2 | 2 | | 3 | | |
| CO 5 | 3 | 3 | 1 | 1 | | | | | 2 | 2 | | 3 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BML32**      **BIOCHEMISTRY AND HUMAN PHYSIOLOGY**      **L  T  P  C**
                 **LABORATORY**                            **0  0  2  1**

**Pre-requisites:** 22BMT22 Human Anatomy And Physiology,  22BM31 Biochemistry

**Preamble**

Biochemistry and Human physiology Laboratory is structured to train the students in clinical laboratory analysis concerned with the diagnosis, treatment and prevention of diseases. A Biomedical Engineer need to know these tests for analyzing body fluids, tissues, blood typing, chemical analyses, cell counts of blood, system and organ functions etc.

**LIST OF EXPERIMENTS**

1. General tests for carbohydrates, proteins and lipids.
2. Estimation of blood glucose.
3. Estimation of creatinine
4. Estimation of urea
5. Virtual analysis: Effect of Substrate Concentration on Enzyme Kinetics || Effect of temperature  || Effect of pH on enzyme kinetics
6. Determination of sodium and potassium by flame photometry
7. Separation of amino acids by thin layer chromatography
8. ESR , PCV, MCH , MCV ,MCHC , total count of RBCs and hemoglobin
9. Ishihara chart for color blindness and Snellen's chart for myopia and hyperopia –by letters reading and ophthalmoscope to view retina.
10. Weber's and Rinne's test for auditory conduction

**Lecture :0, Tutorial: 0, Practical: 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Experiment and Identify the chemical components of biological samples under different physiological conditions |
| CO2 | Experiment and quantify the abnormal constituents in biological samples and interpret common result<br>Patterns related to different pathological conditions. |
| CO3 | Perform physiological tests that examine the function of various components of a body system. |
| CO4 | Experiment and study steady state kinetics of clinically important enzymes. |
| CO5 | Use common analytical instruments in clinical laboratory |

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 2 | 1 | 3 | | | | | 2 | 2 | | | 1 | 3 |
| **CO 2** | 2 | 2 | 1 | 3 | | | | | 2 | 2 | | | 1 | 3 |
| **CO 3** | 2 | 2 | 1 | 3 | | | | | 2 | 2 | | | 1 | 3 |
| **CO 4** | 2 | 2 | 1 | 3 | 2 | | | | 2 | 2 | | | 1 | 3 |
| **CO 5** | 2 | 2 | 1 | 3 | | | | | 2 | 2 | | | 1 | 3 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22MCL04**                  **ENGLISH FOR PROFESSIONALS**          **L T P C**

(Common to all B.E/B.Tech Programme in       **0  0  2  0**

Third / Fourth Semester)

(For Students admitted from the AY 2022-23 only)

**Preamble  :**

Communicative English is a life skill necessary for all students of Engineering and Technology.  The course Essential English for Professionals aims at enabling the learners to communicate effectively and appropriately in professional contexts by exposing them to LSRW tasks.

**UNIT 1**        **LISTENING**                                  **5**

Listening to Casual Conversation- Note-Taking on TED Talks – Summarizing

**UNIT 2**        **READING**                                      **7**

Poem - Robert Frost's Road Not Taken- Decision Making- Biographies of  Famous Personalities - Reading and Note Making on News Articles

**UNIT 3**        **WRITING**                                      **5**

Letter Writing - Letters Seeking Permission- Letters Seeking Apology - Letters Requesting Certificates – Analytical Writing

**UNIT 4**        **SPEAKING**                                    **9**

Watching Presentations - Presentation Techniques - Group Presentation - Group Discussion

**UNIT 5**        **VERBAL ABILITY**                              **4**

Parajumbles - Sentence Completion  - Identifying Common Errors

**TOTAL:  30 PERIODS**

**REFERENCES:**

1. M Ashraf Rizvi "Effective Technical Communication", Tata McGraw-Hill, 2st Edition, New Delhi, 2018.
2. Meenakshi Raman and Sangeetha Sharma., "Technical Communication: English Skills for Engineers" Oxford University Press, 1st Edition, New Delhi, 2008.

**e. RESOURCES :**

1. https://agendaweb.org/listening/audio-books-mp3.html
2. https://www.ndtv.com/world-news
3. http://learnenglishteens.britishcouncil.org/skills/reading
4. https://www.bbc.com/

**Course Outcomes:** Upon completion of the course, students will be able to:

**CO1**  Analyze the given listening material and answer the questions correctly employing listening techniques.

**CO2**  Analyze the given reading material and answer the questions correctly employing reading techniques.

**CO3**  Write within the stipulated time syntactically and semantically correct sentences to present ideas in the form of essays and letters.

**CO4**  Take part effectively in group discussion, conforming to professional norms and to give extemporaneous presentation.

**CO5**  Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|------|-------|-------|-------|-------|-------|
| CO 1 | - | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - |
| CO 2 | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - |
| CO 3 | - | - | - | - | - | - | - | - | 3 | 3 | - | 1 | - | - |
| CO 4 | - | - | - | - | - | - | - | - | 3 | 3 | - | 1 | - | - |
| CO 5 | - | - | - | - | - | - | - | - | - | 3 | - | 1 | - | - |

1 - Slight (Low),  2 - Moderate (Medium), 3 - Substantial (High).

**22MCL04** (III / IV Semester) **0 0 2 0**
(For  Students admitted in the AY 2024-25 onwards)

**Preamble  :**
Communicative English is a life skill necessary for all students of Engineering and Technology.  The course Essential English for Professionals aims at enabling the learners to communicate effectively and appropriately in professional contexts by exposing them to LSRW tasks.

| UNIT 1 | LISTENING | 5 |
|---|---|---|

 Listening to Casual Conversation- Note-Taking on TED Talks – Summarizing

| UNIT 2 | READING | 7 |
|---|---|---|

Reading for gist - Biographies of  Famous Personalities - Reading and Note Making on News Articles

| UNIT 3 | WRITING | 5 |
|---|---|---|

 Letter Writing -  Seeking Permission- Seeking Apology - Letters Requesting Certificates – Analytical Writing and Issue based writing

| UNIT 4 | SPEAKING | 9 |
|---|---|---|

 Presentation Techniques - Presentation with visual aids – Extempore and Impromptu talk

| UNIT 5 | VERBAL ABILITY | 4 |
|---|---|---|

Parajumbles - Sentence Completion  - Identifying Common Errors

**TOTAL:  30 PERIODS**

**REFERENCES:**
1. M Ashraf Rizvi "Effective Technical Communication", Tata McGraw-Hill, 2st Edition, New Delhi, 2018.
2. Meenakshi Raman and Sangeetha Sharma., "Technical Communication: English Skills for Engineers" Oxford University Press, 1st Edition, New Delhi, 2008.

**e. RESOURCES :**
1. https://agendaweb.org/listening/audio-books-mp3.html
2. https://www.ndtv.com/world-news
3. http://learnenglishteens.britishcouncil.org/skills/reading
4. https://www.bbc.com/

**Course Outcomes:** Upon completion of the course, students will be able to:
**CO1** Analyze the given listening material and answer the questions correctly employing listening techniques.
**CO2** Analyze the given reading material and answer the questions correctly employing reading techniques.
**CO3** Write within the stipulated time syntactically and semantically correct sentences to present ideas in the form of essays and letters.
**CO4** Take part effectively in group discussion, conforming to professional norms and to give extemporaneous presentation.
**CO5** Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises.

| Cos/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | - | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - |
| CO 2 | - | - | - | - | - | - | - | - | - | 3 | - | - | - | - |
| CO 3 | - | - | - | - | - | - | - | - | 3 | 3 | - | 1 | - | - |
| CO 4 | - | - | - | - | - | - | - | - | 3 | 3 | - | 1 | - | - |
| CO 5 | - | - | - | - | - | - | - | - | - | 3 | - | 1 | - | - |
| Mapping Average | - | - | - | - | 3 | - | - | - | 3 | 3 | - | 1 | - | - |

1 - Slight (Low),  2 - Moderate (Medium), 3 - Substantial (High).

**22MAT41**                    **PROBABILITY AND RANDOM PROCESSES**          **L   T   P   C**
                    (B.E. Bio Medical Engineering  Programme in Fourth Semester )     **3   1   0   4**

**Pre-requisites:**
 22MAT11 Matrices and Differential Equations, 22MAT21 Calculus and Complex Analysis

**Preamble**
Probability theory is used extensively in the design of modern communication systems in order to understand the behavior of noise in the system. It is concerned with the study of one dimensional random variables. The concept of random process deals with time varying function and plays a vital role in modeling physical phenomenon. The language of signal coding is primarily that of random processes and linear systems. The response of an LTI system to random signals plays an important role in signal analysis.

**UNIT 1   ONE DIMENSIONAL RANDOM VARIABLES**                                **9+3**
Axioms – conditional Probability –Discrete and continuous random variables  – Distributions: Discrete distributions – Binomial, Poisson – Continuous distributions –Uniform, Exponential ,Normal and Weibull(introduction only) distributions.

**UNIT 2   TWO DIMENSIONAL RANDOM VARIABLES**                                **9+3**
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and Linear regression

**UNIT 3    RANDOM PROCESSES**                                              **9+3**
Classification – Stationary process – First order , Second order Stationary Process , SSS Process , WSS Process – Markov Process – Poisson Process

**UNIT 4   CORRELATION AND SPECTRAL DENSITIES**                             **9+3**
Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties (Excluding Proof)

**UNIT 5   LINEAR SYSTEMS WITH  RANDOM  INPUTS**                            **9+3**
Linear time invariant system – System transfer function – Linear systems with random inputs – Autocorrelation and Cross correlation functions of input and output.

                                                    **Lecture : 45; Tutorial : 15; Total : 60**
**TEXT BOOKS:**
  1.   Ibe.O.C., "Fundamentals of Applied Probability and Random Processes", Elsevier, 2nd Edition 2022.
  2.   Hwei Hsu, " Probability, Random Variables and Random Processes", Tata Mc Graw Hill Edition, New Delhi, 3rd Edition 2018

**REFERENCES:**
  1.   Jay L. Devore .,"Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning 2016.
  2.   Saeed Ghahramani., "Fundamentals of  Probability with Stochastic Processes", 3rd Edition, Cengage Learning 2016.
  3.   Ronald E.Walpole , Raymond H. Myers, Sharon  L. Myers, Keying ye., " Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, 2011.
  4.   Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata Mc Graw Hill, 4th Edition, New Delhi, 2012.

**e-Resources:**
1. http://nptel.ac.in/courses/117105085/7, "Probability and Random Variables", Prof. M. Chakraborty, Department of Electronics and Electrical Communication Engineering, Indian Institute of Technology, Kharagpur.
2. http://nptel.ac.in/courses/111102014/, "Stochastic Processes", Prof. Dr. S. Dharmaraja , Department of Mathematics, Indian Institute of Technology, Delhi

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Compute moments and moment generating functions of one dimensional random variables and solve the problems involving discrete and continuous distributions. |
| CO2 | Measure the degree of relationship between the two dimensional random variables using correlation and regression. |
| CO3 | Classify the first and second order stationary processes and solve the problems involving Markov and Poisson processes. |
| CO4 | Solve problems involving correlation and spectral densities of random processes. |
| CO5 | Analyze the response of random inputs to linear time invariant systems |

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| **CO 2** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| **CO 3** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| **CO 4** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |
| **CO 5** | 3 | 3 | 1 | 1 | - | - | - | - | - | - | - | 1 | - | - |

1 - Slight (Low),  2 - Moderate (Medium), 3 - Substantial (High).

| 22ITT44 | DATA STRUCTURES USING C | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisites : -**
**Preamble**
Data structure is an arrangement of data in computer's memory in such a way that it could make the data quickly available to the processor for required calculations. Lists, arrays, stacks, queues, heaps, trees, and graphs are the more commonly used data structures. Choosing an appropriate data structure to solve the given problem greatly influences the characteristics of the obtained solution.

**UNIT 1    BASICS OF C PROGRAMMING                                        7**
Introduction to C - Structure of C program – Compilation and Execution - C Tokens –Keywords, Variables, Constants - Data Types – Input/output statements - Operators - Decision control and Looping statements - Preprocessor directives.

**UNIT 2    ARRAYS, STRINGS AND FUNCTIONS                                11**
Introduction to Arrays: Declaration, Initialization – One dimensional array-Two dimensional arrays – Matrix Operations (Addition, Multiplication and Transpose) – Strings - String operations. Introduction to functions - Built-in functions- User-defined functions - Function prototype, function definition, function call – Parameter passing: Pass by value, Pass by reference - Recursion.

**UNIT 3    POINTERS AND STRUCTURES                                       9**
Pointers – Declaration – Pointer expression and Pointer arithmetic – Array of pointers –Function Pointers. Structure - Nested structures – Pointer and Structures – Array of structures – Structure and Functions – Union.

**UNIT 4    LINEAR DATA STRUCTURE                                         9**
Introduction to Data Structures and Algorithms- Abstract Data Types (ADT) – List ADT –Linked Lists- Applications of Lists. Stack ADT – Queue ADT – Applications of Stacks and Queues. Searching –Linear and Binary search. Sorting- Bubble, Insertion, Quick, Heap and Merge Sort.

**UNIT 5    NON LINEAR DATA STRUCTURE                                     9**
Trees: Binary Tree-Binary Tree Traversal-Binary Search Tree, Graphs: Definitions-Graph Representation - Graph Traversal.

**Total : 45 Periods**

**TEXT BOOKS:**
1.    Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
2.    Reema Thareja, "Data Structures Using C", Second Edition, Oxford University Press, 2014.
3.    M. A. Weiss, "Data Structures and Algorithm Analysis in C", Second Edition, Pearson Education, 2015.

**REFERENCES:**
1.    Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
2.    Richard F. Gilberg, and Behrouz A. Forouzan, "Data Structures - A Pseudocode Approach with C", Second Edition, Thomson Brooks/cole, 2011.
3.    Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein, "Introduction to Algorithms", Third Edition, PHI Learning, 2010.

**e-RESOURCES:**
1.    http://www.nptel.ac.in/courses/106102064, Introduction to data structure
2.    http://nptel.ac.in/courses/106102064, Video Lectures

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Develop program in C, equivalent to a given problem statement and solve it by applying appropriate data types and control statements.

CO2    Build modules for a given problem and synthesize a complete program in C language using Array, String and functions.

CO3    Apply pointers, user defined data types like structures and unions to solve problems.

CO4    Create Linked list, Stack and Queue Abstract Data Type for the given problem statement using an array.

CO5    Construct tree and graph Abstract Data Type for the given list of data by ensuring tree properties and analyze the tree and graph traversal for the constructed tree and graph Abstract Data Type.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO1** | 3 | 2 | 2 | 3 | - | 1 | - | - | - | 1 | - | 1 | - | - |
| **CO2** | 3 | 2 | 2 | 3 | - | 1 | - | - | - | 1 | - | 1 | - | - |
| **CO3** | 3 | 2 | 2 | 3 | - | 1 | - | - | - | 1 | - | 1 | - | - |
| **CO4** | 3 | 2 | 2 | 3 | - | 1 | - | - | - | 1 | - | 1 | - | - |
| **CO5** | 3 | 2 | 2 | 3 | - | 1 | - | - | - | 1 | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BMT41 | ELECTRONIC CIRCUITS | L | T | P | C |
|---------|---------------------|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**Pre-requisites: 22BMT33 Semiconductor Devices**

**Preamble**

The course introduces the biasing of BJTs ,FETs and MOSFETs in constructing amplifiers. It also details the structure and properties of feedback for analysing amplifiers and oscillators. Additionally the course exposesthe analysis and design of waveshaping and multivibrator circuits.

**UNIT 1    BIASING OF BJT AND FET**         **9+3**

Bias Stability – Need for biasing – quiescent point – DC load line and AC load line – Thermal runaway. Stability factors, Different types of biasing circuits – Fixed bias – Collector to base bias – Voltage divider bias. Biasing the FET.

**UNIT 2    AMPLIFIERS**         **9+3**

Differential amplifier - Class A amplifiers: Direct coupled, Transformer coupled – efficiency – Class B amplifier: push-pull amplifier – complementary symmetry amplifier – efficiency – Cross over distortion. Class AB amplifier, Class C amplifier.

**UNIT 3    FEEDBACK AMPLIFIERS**         **9+3**

General Feedback Structure, Determining the Loop Gain, Basic Feedback Topologies. Method of identifying feedback topology and feedback factor – Voltage Series Feedback – Current Series Feedback –Voltage Shunt Feedback, Current Shunt feedback amplifier

**UNIT 4    OSCILLATORS**         **9+3**

Classification, Barkhausen Criterion, General form of an LC Oscillator, Hartley, Colpitts. RC Oscillators – Phase Shift – Wien bridge. Frequency range of RC and LC Oscillators, Crystal Oscillators – Quartz Crystal Construction, Miller and Pierce Crystal oscillators, Frequency stability of oscillator.

**UNIT 5    WAVE SHAPING AND MULTIVIBRATOR CIRCUITS**         **9+3**

RC Integrator and Differentiator circuits – Storage, delay and calculation of transistor switching times – Speed–up capacitor – Diode clippers, Clampers – Collector coupled  Astable  multivibrator and Monostable multivibrator, Bistable multivibrator, Schmitt trigger circuit.

**TOTAL (L: 45+T: 15): 60 PERIODS**

**TEXT BOOKS:**
1. Salivahanan S. & Sureshkumar N. "Electronic Devices and Circuits", McGraw Hill Eduation, 3$^{rd}$Edition,Fifth Reprint, 2014.
2. Adel S. Sedra and Kenneth C. Smith, "Microelectronic Circuits", 6$^{th}$ Edition, Oxford University Press,2011.

**REFERENCES:**
1. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", 10$^{th}$ Edition,Pearson Education / PHI, 2009.
2. J. Millman , C CHalkias&SatyabrataJit, "Electronic Devices & Circuits", Tata McGraw Hill, 4$^{th}$Edition,2015.
3. David A. Bell, "Electronic Devices and Circuits", 5$^{th}$ Edition, Oxford University Press, 2008.

**e-Resources:**
1. http://nptel.ac.in/courses/117103063/2, "Basic Electronics", Dr.ChitralekhaMahanta, IIT, Guwahati.
2. httyp://nptel.ac.in/courses/117101106/1, "Analog Circuits" Prof.A.N.Chandorkar, IIT Bombay.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Design transistor amplifier circuits with Fixed, Collector to Base, Voltage divider biasing techniques.

CO2 Evaluate Class A, B, AB, C amplifiers for a given load with respect to its efficiency.

CO3 Analyze feedback amplifiers and identify suitable amplifier for a given application using gain, input-output resistance and bandwidth.

CO4 Analyze the performance and characteristics of RC and LC oscillator circuits.

CO5 Design wave shaping and multivibrator circuits using active and passive components for a given application.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | | | | | | | | | | 1 | | |
| **CO 2** | 2 | 3 | | | | | | | | | | 1 | | |
| **CO 3** | 2 | 3 | 2 | | | | | | | | 1 | 1 | | |
| **CO 4** | 2 | 3 | 2 | | | | | | | | 1 | 1 | | |
| **CO 5** | 2 | 3 | | | | | | | | | 1 | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT42**          **ANALOG AND DIGITAL INTEGRATED CIRCUITS**          **L    T    P    C**
                                                                         **3    1    0    4**

**Pre-requisites: 22BMT33 – Semiconductor Devices**

**Preamble**
This course introduces the basic building blocks of the integrated circuits along with fundamental concepts in digital logic systems and linear integrated circuits. It also provides knowledge in code conversion,  Boolean simplification using karnaugh map and designing of simple IC based circuits.

**UNIT 1    NUMBER SYSTEMS AND LOGIC GATES                              9+3**
Decimal, Binary, Octal and Hexadecimal Numbers-Conversion between these number systems – r"s Complements and (r-1)"s complements-subtraction using complements-Encoding numbers and characters using Binary digits –Binary coded Decimal- Gray code- Binary to Gray code conversion –ASCII Code. The Karnaugh Map – Half adder and Full adder- Half subtractor and Full subtractor -Multiplexers and Demultiplexers –  Decoders  and  Encoders. Coding  of Combination Circuits in Verilog.

**UNIT 2     REGISTERS AND COUNTERS                                      9+3**
Flip Flops-RS ,D,T,JK Flip Flops- Characteristics equations, exciting tables,JK Master Slave Flip Flop,Universal shift register, Design of modulo – N counters, counter design using state diagram, sequential circuit design with verilog.

**UNIT 3    OPERATIONAL AMPLIFIERS                                       9+3**
The characteristics of Ideal Operation, Slew rate, Offset voltage, Bias current, CMRR, Bandwidth, Equivalent circuit of an op-amp, Virtual ground concept, Linear application of op-amp - inverting and non inverting amplifiers, summing, subtracting, averaging amplifiers, Voltage to current converter, current to voltage converter, Differential amplifiers, Differentiator and Integrator. Non Linear applications- Comparator, Schmitt triggers, Precision Diode Half wave and Full wave rectifiers, Peak detector.

**UNIT 4    ACTIVE FILTERS AND SIGNAL GENERATORS                         9+3**
Active Filters (First and Second order)- Low pass , High pass, Band pass ,Band reject filters (Notch Filters). Oscillators – RC phase shift and Wein-Bridge. Waveform generators – Square , Triangular and Sawtooth.

**UNIT 5    TIMER, PLL, A/D AND D/A CONVERTERS                           9+3**
555 Timer -internal diagram and its applications- monostablemultivibrator, astablemultivibrator,Phase Locked Loop(565)- block diagram approach and its applications- Frequency multiplication,Frequency translation, Voltage to frequency and Frequency to voltage converters, Binary weighted DAC and R-2R DAC - 0808DAC,Successive approximation ADC - 0809ADC.

**Lecture : 45, Tutorial : 15, Total : 60**

**TEXT BOOKS:**
1.    M. Morris Mano and Michael D. Ciletti, "Digital design" 5th EditionPearsonEducation, New Delhi, 2013.
2.    Ramakant A. Gayakwad , "Op-AMP and Linear Ics", 4th Edition, Prince Hall, 2016.

**REFERENCES:**
1.    S.Salivahanan& S.Arivazhagan,"Digital Circuits and Design" , 4th edition,Vikas publishing house Pvt. Ltd,2012.
2.    Charles H. Roth Jr, "Fundamentals of Logic Design", 7th Edition, Jaico Publishing House, Mumbai, 2014.
3.    Robert  B.Northrop,  "Analysis  and  Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, 2004.

**e-Resources:**
1.  http://nptel..iitm.ac.in/courses/117106086, "Digital Circuits and Systems-video", Prof.S.Srinivasan, IITM.
2.  http://www.satishkashyap.com/2012/02/digital-electronic-circuits-by-shouri.html, "Digital Electronics", Dr.Shouri Chatterjee, IIT- Delhi.
3.  http://nptel.ac.in/courses/117103063/26, "Ideal op-amp and its applications" Dr.Chitralekha Mahanta Department of Electrical and Communication Engineering Indian Institute of Technology, Guwahati.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Simplify the given boolean expression using karnaugh map and implement using universal logic gates.

CO2    Design a modulo N counter using state diagrams.

CO3    Design a linear and non-linear circuits using op amp.

CO4    Design a first order and second order active filters and signal generators using op-amp.

CO5    Design application circuits using 555 Timer, 565 PLL, 0808DAC, 0809ADC.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 3 | | | | | | | 2 | | 2 | | |
| CO 2 | 2 | 3 | 3 | | | | | | | 2 | | 2 | | |
| CO 3 | 2 | 3 | 3 | | | | | | | 2 | | 2 | | |
| CO 4 | 2 | 3 | 3 | | | | | | | 2 | | 2 | | |
| CO 5 | 2 | 3 | 3 | | | | | | | 2 | | 2 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMC43**                **PATHOLOGY AND MICROBIOLOGY**            **L   T   P   C**
                                                                      **3   0   2   4**
**Pre-requisites :** 22CYT11 Engineering Chemistry ,  22BMT22 Human Anatomy And Physiology, 22BMT32 Biochemistry

**Preamble**
The purpose of course is to provide guidelines to interpret and correlate clinical and laboratory data so that clinical manifestations of diseases can be explained. Diagnose routine and complex clinical problems on the basis of histopathology and cytopathology. Microbiology deals with study of microscopic organisms that include bacteria, algae, protozoa, fungi and protozoa and their complex mechanism. They study the laboratory techniques used for characterizing the microorganism and body's defense system (immune system) against various pathogens.

**UNIT 1   CELL DEGENERATION, REPAIR AND NEOPLASIA                         9**
Cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification, cellular adaptations of growth and differentiation, Inflammation and Repair - fracture healing, Neoplasia-Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours.

**UNIT 2   HEMODYNAMIC AND HEMATOLOGICAL DISORDERS                        9**
Edema, normal hemostasis, hemorrhage, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas.

**UNIT 3   MICROSCOPY AND MICROORGANISM                                   9**
Light microscope – bright field, dark field, phase contrast, fluorescence, Electron microscope (TEM & SEM). Preparation of samples for electron microscope. Morphology and Physiology of bacteria and virus.

**UNIT 4   MICROBIAL CULTURES AND STAINING TECHNIQUES                     9**
Sterilization and disinfection, Culture media and its types, culture techniques and observation of culture, Bacterial growth curve, identification of bacteria. Staining methods – simple, gram staining and AFB staining.

**UNIT 5   IMMUNOLOGY                                                     9**
Immune response -Natural and artificial immunity, opsonization, phagocytosis, monoclonal antibodies, hypersensitivity reactions, antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, Disease caused by bacteria, fungi and virus.

**EXPERIMENTS:**

| | | |
|---|---|---|
| **1.** | i.ABO and Rh blood grouping | |
| | ii. Determination of Bleeding Time and Clotting Time | (3Hours) |
| **2.** | i.Simple staining | |
| | ii. Gram staining | (3Hours) |
| **3.** | AFB staining | (3Hours) |
| **4.** | Enumeration of microorganisms-Direct Count Using a Counting Chamber | (3Hours) |
| **5.** | i. Testing sensitivity to antimicrobial substances | |
| | ii.Study of histopathological slides of tumors( benign and malignant), leukemia and lymphoma and Manualparaffin tissue processing and section cutting (demonstration) | (3Hours) |

**Lecture : 45, Tutorial : 15, Total : 60**

**TEXT BOOKS:**
1.  Vinay Kumar, AbulK.Abbas, "Robbins and Cotran Pathologic Basis of Diseases", 7th edition, Elsevier, 2006.

2. Ananthanarayanan and Paniker's,"Textbook of Microbiology" Orient Longman Private Limited,7th edition, 2005.

**REFERENCES:**
1. BN Datta, "Text book of Pathology", Jaypee Medical Publications, 2nd edition, New Delhi, 2004.
2. Michael J. Pelczar, JR., E.C.S. Chan and Noel R. Kries "Microbiology", Tata McGraw-Hill, New Delhi, 5th edition,2006.
3. Kathleen Park Talaro, "Fundamentals of Microbiology", McGraw Hill Higher education, 5th Edition 2005.
4. BN Datta, "Text book of Pathology", Jaypee Medical Publications, 2nd edition, New Delhi, 2004.

**e-Resources:**
1. Microbiology and Immunology On -line from the Department of Pathology, Microbiology and Immunology at the University of South Carolina School of Medicine, http://pathmicro.med.sc.edu/book/welcome.htm comprehensive list of lectures, quizzes and other learning material.
2. http://emedicine.medscape.com/infectious_diseases (very comprehensive website listing numerous infectious

    disease agents, with background, differential diagnoses, treatment and follow up)
3. http://onlinevideolecture.com/?course_id=700&lecture_no=21, "Introduction to Microbiology", Prof.Venkobachar, IIT, Chennai.

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Elucidate the role of physiological system in maintaining homeostasis and pathogenesis of common and important diseases. |
| CO2 | Correlate the important clinical features of the hematological disorders with Normal hemodynamic. |
| CO3 | Analyze the structural organization and microscopic appearances of microorganism by using microscope. |
| CO4 | Identify the disease causing microbes in the biological samples. |
| CO5 | Apply modern techniques to study the characteristics of immune system and immunological reactions with regard to infection. |

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 3 | |
| CO 2 | 2 | 3 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| CO 3 | 2 | 1 | 2 | 1 | 1 | | | | | 2 | | 2 | 3 | |
| CO 4 | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 3 | |
| CO 5 | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 3 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT44**                          **HOSPITAL MANAGEMENT**                    **L   T   P   C**
                                                                                **3   0   0   3**
**Pre-requisites: Nil**

**Preamble**
The course helps in understanding the functioning of the hospital. It covers various departments of a health care unit, like clinical, non-clinical and supporting departments with comprehensive, preventive, curative and rehabilitative services. It also covers topics on planning, organizing, directing and controlling and the descriptions on individual clinical and other departments. The course also covers hospital safety and security**.**

**UNIT 1   PLANNING AND ORGANIZATION OF THE HOSPITALS                             9**
Distinction between Hospital and Industry, Planning a new Hospital– Guiding Principles in Planning Hospital Facilities and Services , Preliminary Survey, Financial Planning , Equipment Planning-Purchase of Capital Equipment, Organizational structure -  Management Structure – Organizational  Charts.

**UNIT 2    PROFESSIONAL AND FINANCIAL MANAGEMENT                                 9**
Introduction – Two lines of authority in the hospital, Professional management – Recruitment and Selection – Orientation, Training and Selection, Financial Management.

**UNIT 3   MEDICAL AND SUPPORTIVE SERVICES                                        9**
Outpatient services – Clinical Laboratory services – Surgical Department – Hospital Information System - General Nursing units – Intensive care units - Medical Records - Pharmacy – Central Sterile Supply Department (CSSD) - Materials Management - Hospital linen and Laundry services – Housekeeping.

**UNIT 4   HOSPITAL FACILITY AND FUNCTIONAL SERVICES                              9**
Engineering departments – Maintenance management- Clinical engineering - Electrical system- Air Conditioning system- Water Supply and Sanitary System – Centralized Medical Gas System- Process- Purchasing – Inventory – Issue and Distribution.

**UNIT 5   COMMUNICATION AND SAFETY ASPECTS IN HOSPITALS                          9**
Purposes - Planning of Communication, Modes of Communication – PACS, Telephone, ISDN, Public Address and Piped Music - CCTV. Safety in hospital – Security and Loss Prevention Programme – Fire safety - Alarm system- Disaster and Disaster Preparedness Plan.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. G.D.Kunders, "Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007.
2. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006.

**REFERENCES:**
1. B.M. Sakharkar, "Principles of hospital administration and planning*"*, Jaypee Brothers Medical Publishers Pvt Limited, 2$^{nd}$ edition, 2009.
2. Cesar A.Caceres and Albert Zara, "The Practice of Clinical Engineering, Academic Press, New York, 1977.

**e-Resources:**
1. https://www.youtube.com/watch?v=ZZS8-ySBNFM, "Organization and Management of Hospital", Prof. S.B.Aroara, Professor, School of Health Sciences, Indira Gandhi National Open University (IGNOU), MaidanGarhi, New Delhi.
2. http://www.nptelvideos.in/2012/11/human-resource-management-i.html, "Lecture Series on Human Resource Management-I", Prof. Kalyan Chakravarti, Vinod Gupta School of Management, IIT Kharagpur.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1 Discuss about the basic planning and organization of hospitals.
CO2 Explain the principles and practices involved in Hospital Administration, Human Resource management and finance management.
CO3 Identify and explain the role of medical and support services used for proper functioning of the hospitals.
CO4 Classify administrative services functional organization and engineering services of a hospital.
CO5 Identify and explain the key elements of security and safety management in Hospitals.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 2 | | | | 1 | | 1 | 2 | 2 | 3 | 2 | 1 | |
| CO 2 | 2 | 2 | | | | 1 | | 2 | | 2 | 3 | 2 | 1 | |
| CO 3 | 2 | 2 | | | | 2 | | 1 | | 2 | 3 | 2 | 1 | |
| CO 4 | 2 | 2 | | | | 2 | | 1 | | 2 | 3 | 2 | 1 | |
| CO 5 | 2 | 2 | | | | 2 | | 1 | | 2 | 3 | 2 | 1 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BML41**                     **ELECTRONIC CIRCUITS LABORATORY**              L   T   P   C
                                                                                        0   0   2   1

**Pre-requisites:** 22BML31 Circuits and Devices Laboratory

**Preamble**

The course introduces the fundamental principles of amplifier circuits and to familiarize feedback amplifiers and oscillators. It also gives insight into SPICE simulation of electronic circuits.

**LIST OF EXPERIMENTS**

1. Differential Amplifier - CMRR measurement.
2. Class A and Class B power amplifiers.
3. Frequency response of voltage shunt feedback amplifier.
4. Frequency response of current series feedback amplifier.
5. RC Phase shift oscillator and Wien bridge oscillator.
6. Hartley oscillator and Colpitts oscillator.
7. RC Integrator and Differentiator circuits.
8. Clippers and Clampers.
9. Astable Multivibrator and Schmitt trigger circuit.
10. SPICE Simulation of Monostable and Bistable Multivibrators.

**Lecture :0, Tutorial: 0, Practical: 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Measure CMRR of a differential amplifier, experiment and determine the frequency response of class A and class B power amplifiers. |
| CO2 | Experiment and determine the frequency response of feedback amplifiers. |
| CO3 | Design and test RC and LC oscillators. |
| CO4 | Construct and test wave-shaping circuits. |
| CO5 | Simulate Monostable and Bistable Multivibrators using SPICE Tool. |

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 1 | 2 | 3 | 3 | | | | | 2 | 2 | | 1 | | |
| **CO 2** | 1 | 2 | 3 | 3 | | | | | 2 | 2 | | 1 | | |
| **CO 3** | 1 | 2 | 3 | 3 | | | | | 2 | 2 | | 1 | | |
| **CO 4** | 1 | 2 | 3 | 3 | | | | | 2 | 2 | | 1 | | |
| **CO 5** | 1 | 2 | 3 | 3 | 2 | | | | 2 | 2 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BML42**    **ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY**    | L | T | P | C |
|---|---|---|---|
| 0 | 0 | 2 | 1 |

**Pre-requisites: 22BMT33 – Semiconductor Devices**

**Preamble**
This course is to provide practice in designing of combinational and sequential logic circuits. It also gives design experience in analog circuits in implementing amplifiers, active filters, waveform generators, comparator, multivibrators.

**LIST OF EXPERIMENTS**

1. Half adder, Full adder, Half subtractor and Full subtractor.
2. Encoder and Decoder, Multiplexer and Demultiplexer using logic gates.
3. Universal shift register using flip flops.
4. Design of Mod-N counter.
5. Inverting and Non-inverting amplifier, Integrator and Differentiator using IC741.
6. Second order low pass and high pass active filters using IC741.
7. Comparator, Peak detector using IC 741.
8. Wein Bridge Oscillator.
9. Multivibrator using IC 555 Timer.
10. Analog to Digital Converter using 0809ADC and Digital to Analog Converter using 0808DAC.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Design and Test adder, subtractor, decoder, encoder, multiplexer, demultiplexer using logic gates.
CO2    Design and Test Sequential circuits using flip flops.
CO3    Design and Test inverting, non inverting amplifier, integrator, differentiator, active filters, comparator and peak detector circuits using IC741.
CO4    Design and test multivibrator circuits using IC 555.
CO5    Experiment and Test Analog to Digital & Digital to Analog Converter ICs.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | 2 | 3 | | | | | 2 | 2 | | 1 | | |
| **CO 2** | 2 | 2 | 2 | 3 | | | | | 2 | 2 | | 1 | | |
| **CO 3** | 2 | 2 | 2 | 3 | | | | | 2 | 2 | | 1 | | |
| **CO 4** | 2 | 2 | 2 | 3 | | | | | 2 | 2 | | 1 | | |
| **CO 5** | 2 | 2 | 2 | 3 | | | | | 2 | 2 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22ITL43**     **DATA STRUCTURES USING C LABORATORY**     **L T P C**
                                                           **0 0 2 1**

**Preamble:**
This laboratory course is intended to provide students with opportunities to get hands on training to implement various data structures like lists, arrays, stacks, queues, trees, and graphs using C programming language.

**LIST OF EXPERIMENTS**
   1. C programs that involve data types,looping and decision statements.
   2. C programs using one dimensional and two dimensional arrays.
   3. C programs for String manipulation operations.
   4. C programs using Functions
   5. Program to implement Singly Linked List of ordered integers (ascending/descending) with insert, search and display operations.
   6. Program to simulate Stack and queue using array
   7. Program to perform Searching operations such as linear search and binary search.
   8. Program to perform sorting operations such as bubble, quick and insertion sort.
   9. Program to traverse a binary tree in preorder, in-order and post-order.
   10. Program to insert, delete and search for a node in a Binary Search Tree.
**SOFTWARE**
   • Turbo C / Code blocks

**TOTAL:  45 PERIODS**

**Course Outcomes: Upon completion of the course, students will be able to:**

CO1   Develop and test C program to solve a given problem statement using suitable datatypes, decision making, control statements and array

CO2   Develop and test C progra m to solve a given problem using String manipulation operations and functions.

CO3   Implement Singly Linked List of ordered integers in C with insert, search and display operations.

CO4   Write a C program to perform linear, binary search and sort the given list of data using bubble, quick and insertion sort.

CO5   Develop a solution using C program to traverse a binary tree in preorder, in-order and post-order and to insert, delete and search for a node in a BST.

**Mapping of COs with POs and PSOs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | - | - | 1 | - | - |
| **CO2** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | - | - | 1 | - | - |
| **CO3** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | - | - | 1 | - | - |
| **CO4** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | - | - | 1 | - | - |
| **CO5** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | - | 1 | - | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22ITT31**　　　　**OBJECT ORIENTED PROGRAMMING USING JAVA**　　　L　T　P　C
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　3　0　0　3

**Pre-requisites: Nil**
**Preamble**
This course focuses on the fundamentals of object-oriented programming and Java programming language. Students will also be able to understand the fundamentals of packages, inheritance, and interfaces. The ability to create Java applications with threads, generic classes, exceptions, and I/O streams will be taught to the students. Additionally, using JAVAFX, students will be able to create graphic user interface applications.

**UNIT 1　INTRODUCTION TO OOP AND JAVA　　　　　　　　　　　　　9**
Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors-Methods -Access specifiers - Static members- JavaDoc comments- I/O Basics – Reading and Writing Console I/O.

**UNIT 2　INHERITANCE, PACKAGES AND INTERFACES　　　　　　　　9**
Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch – Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access – Importing Packages – Interfaces.

**UNIT 3　EXCEPTION HANDLING AND MULTITHREADING　　　　　　9**
Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java's Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread CommunicationSuspending –Resuming, and Stopping Threads –Multithreading. Wrappers – Auto boxing.

**UNIT 4　FILE I/O, GENERICS, STRING HANDLING　　　　　　　　9**
Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class.

**UNIT 5　JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS　9**
JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, ToggleButton – RadioButtons – ListView – ComboBox – ChoiceBox – Text Controls – ScrollPane. Layouts – FlowPane – HBox and VBox – BorderPane – StackPane – GridPane. Menus – Basics – Menu – Menu bars – MenuItem.

**Total : 45 Periods**

**TEXT BOOKS:**
1. Herbert Schildt, "Java: The Complete Reference", 11 th Edition, McGraw Hill Education, New Delhi, 2019
2. Herbert Schildt, "Introducing JavaFX 8 Programming", 1 st Edition, McGraw Hill Education, New Delhi, 2015

**REFERENCES:**
1. Cay S. Horstmann, "Core Java Fundamentals", Volume 1, 11 th Edition, Prentice Hall, 2018

**e-RESOURCES:**
1. https://archive.nptel.ac.in/courses/106/105/106105191/
2. https://www.w3resource.com/java-tutorial/java-object-oriented-programming.php

**Course Outcomes:** Upon completion of this course, students will be able to

CO1 Apply the concepts of classes and objects to solve simple problems.

CO2 Demonstrate the principles of inheritance, packages and interfaces in Java programming for a real world problem.

CO3 Apply exception handling mechanisms and multithreaded model to solve real world problems using Java.

CO4 Develop a Java application using I/O packages, string classes, generics concepts for the given problem.

CO5 Integrate the concepts of event handling, JavaFX components and controls for developing GUI based applications.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1 | 1 | 3 | 2 | 3 | 1 | 1 | 1 | - | - | - | - | 2 | - | - |
| CO2 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | - | - | - | - | 3 | - | - |
| CO3 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | - | - | - | - | 2 | - | - |
| CO4 | 2 | 3 | 2 | 3 | 1 | 1 | 1 | - | - | - | - | 3 | - | - |
| CO5 | 1 | 3 | 2 | 3 | 1 | 1 | 1 | - | - | - | - | 2 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT51**                         **MEDICAL INSTRUMENTATION – I**                    L   T   P   C
                                                                                     3   0   0   3

**Pre-requisites: Human Anatomy and Physiology.**

**Preamble**
The course is designed to make the student acquire an adequate knowledge of the physiological systems of the human body and relate them to the parameters that have clinical importance. The fundamental principles of equipment that are actually in use at the present day are introduced.

**UNIT 1   BIO POTENTIAL ELECTRODES                                               9**
Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, polarization electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits.

**UNIT 2   CARDIAC MEASUREMENTS                                                   9**
Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, Plethysmography. Fetal monitoring instruments- cardiotocograph – methods of monitoring foetal heart rate – Abdominal foetal electrocardiogram ( AFECG) – Foetal phonocardiogram – FHR measurement from ultrasound doppler foetal signal – FHR measurement with direct FECG.

**UNIT 3   NEUROLOGICAL MEASUREMENTS                                              9**
EEG -10-20 electrode system- Montage- Multi-channel EEG recording system, sleep patterns, Evoked Potential- EMG - unipolar and bipolar mode- Apex cardiograph – Ballistocardiograph(BCG) - Electro occulograph (EOG), Electro retinography (ERG), Audiometer-Pure tone, Speech. Galvanic skin resistance (GSR) - Bio feedback instrumentation.

**UNIT 4   MEASUREMENT OF NON ELECTRICAL PARAMETERS                               9**
Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - auscultatory method, oscillometric method, direct methods: electronic manometer, Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, - Measurement of continuous cardiac output derived from the aortic pressure waveform - Impedance technique.

**UNIT 5   EXTRA CORPOREAL DEVICES AND PATIENT SAFETY                             9**
Patient monitoring systems, ICU/CCU Equipments, Infusion pumps-syringe pumps- Macro shock – Micro shock hazards – Patient's electrical environment – Isolated Power system – Conductive surfaces – Electrical safety codes and standards – Basic Approaches to Protection against shock, Protection equipment design, Electrical safety analyzer – Testing the Electric system.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
  1.   John G. Webster,"Medical Instrumentation Application and Design",John Wiley and sons, New York, 2019.
  2.   Khandpur R.S,"Handbook of Biomedical Instrumentation",Tata McGraw-Hill,3rd Edition, New Delhi, 2014.

**REFERENCES:**
  1.   Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2016
  2.   Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2016.
  3.   L.A Geddes and L.E.Baker "Principles of Applied Biomedical Instrumentation"Wiley India Edition. 2018.

**e-Resources:**
1. https://www.youtube.com/watch?v=XEv4K1gHUEo, "Recording a 12 lead ECG", Nick smith, Central Manchester University hospitals.
2. https://www.youtube.com/watch?v=2Cs4CJBaTN4, "Introduction to Biopotentials", Sarwar K, University of Texas.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1  Illustrate the bio electric phenomena and electrical models of electrode electrolyte interface.

CO2  Describe the diagnostic measurement method for identification of human biopotentials and their necessary instrumentation.

CO3  Discuss the recording and analysis of electrical and non electrical bio signals and its characteristics.

CO4  Interpret the parameters and operation of non electrical diagnostic Modalities.

CO5  Evaluate the need and application of Intensive care equipments and patient safety.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | | | 2 | | | | 2 | | 2 | 2 | 1 |
| CO 2 | 2 | 3 | 2 | | | 2 | | | | 2 | | 2 | 2 | 1 |
| CO 3 | 2 | 2 | 2 | | | 2 | | | | 2 | | 2 | 2 | 1 |
| CO 4 | 2 | 2 | 2 | | 2 | 2 | | | | 2 | | 2 | 2 | 1 |
| CO 5 | 2 | 2 | 2 | | 2 | 2 | | | | 2 | | 2 | 2 | 1 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT52**                    **BIOSIGNAL PROCESSING**                    L   T   P   C
                                                                          3   1   0   4

**Pre-requisites: 22BMT31-Signals and Systems**

**Preamble**
Biomedical Signal Processing provides an introduction to the basic concepts of signal processing methods and to acquire knowledge of analysis of systems using various transformation techniques. It provides students to realize about different filter structure and also to develop algorithm for signal processing. This course gives an in-depth analysis of the origin and processing of bioelectrical signals in humans.

**UNIT 1   DISCRETE AND FAST FOURIER TRANSFORM**                                    **9+3**
Introduction to DFT – Efficient computation of DFT – Properties of DFT – FFT Algorithms – Decimation in Time (DIT) and Decimation in Frequency (DIF) Algorithms – Linear and Circular Convolution – Overlap save and add methods. Application: Identification of Heart Sounds.

**UNIT 2   IIR FILTER DESIGN**                                                      **9+3**
Analog filter design – Discrete time IIR filter from analog filter – IIR filter design: Impulse Invariance, Bilinear transformation technique – Realization using Direct form – Cascade and Parallel forms.

**UNIT 3   FIR FILTER DESIGN**                                                      **9+3**
Linear phase FIR filters – Filter design: Windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques – Design of Hilbert Transformers – Realization of FIR filters Transversal – Linear phase and Poly phase structures. Application: Removal of Artifacts in the ECG.

**UNIT 4   ADAPTIVE FILTERING AND WAVELET DETECTION**                               **9+3**
Filtering – LMS adaptive filter, Adaptive noise canceling in ECG, Improved adaptive filtering in ECG, Wavelet detection in ECG – Structural features, Matched filtering, Adaptive wavelet detection, Detection of overlapping wavelets.

**UNIT 5   ANALYSIS OF BIOMEDICAL SIGNALS**                                         **9+3**
Nature of Biomedical Signals - Objectives of Biomedical Signal Analysis– Detection of events and waves of P wave and QRS in ECG – ECG Rhythm Analysis – Morphological analysis of ECG signals – Normal and Ectopic Beats – Analysis of Exercise ECG and respiration – Correlation analysis of EEG rhythms – Spectral Modelling and Analysis of PCG Signals.

**Lecture : 45, Tutorial : 15, Total : 60**

**TEXT BOOKS:**
1.  John G. Proakis & Dimitris G.Manolakis, "Digital Signal Processing – Principles, Algorithms & Applications", Pearson Education, Fourth Edition, 2007.
2.  Rangaraj M Rangayyan,"Biomedical Signal Analysis A Case Study Approach" John Wiley, 2015.

**REFERENCES:**
1.  Sanjit K.Mitra,"Digital Signal Processing–A Computer Based Approach",Mc Graw Hill,4<sup>th</sup> Edition 2013.
2.  Reddy D C, "Biomedical Signal Processing -Principles and Techniques", The McGraw Hill Publishing Company Limited, New Delhi, 2005.
3.  Willis J. Tompkins,"Biomedical Digital Signal Processing", Prentice Hall of India Publications, 1995.
4.  Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida, 1999.

**e-Resources:**
1. http://www.nptelvideos.in/2012/12/digital-signal-processing.html, "Digital Signal Processing", Prof. S.C Dutta Roy, IIT Delhi.
2. http://www.nptelvideos.in/2012/11/digital-signal-processing.html, "Digital Signal Processing", Prof.T.K.Basu, IIT Kharagpur.
3. https://nptel.ac.in/courses/108/105/108105101/Biomedical Signal Processing, "Biomedical Signal Processing", Prof.Sudipta Mukhopadhyay, IIT Kharagpur.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Acquire the knowledge of DFT properties and implement DFT using FFT.
CO2    Design IIR filters using Impulse invariance and Bilinear transformation techniques.
CO3    Design FIR filters using the windowing and sampling techniques.
CO4    Apply Adaptive Filters and Wavelet detection techniques in ECG signals.
CO5    Analyze the Biomedical Signals - ECG, EEG and PCG.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 3 | 3 | 2 | | | | | 1 | 1 | | 1 | | |
| CO 2 | 3 | 3 | 3 | 2 | | | | | 1 | 1 | | 1 | | |
| CO 3 | 3 | 3 | 3 | 2 | | | | | 1 | 1 | | 1 | | |
| CO 4 | 3 | 3 | 3 | 2 | | | | | 1 | 1 | | 1 | 2 | |
| CO 5 | 3 | 3 | 3 | 2 | | | | | 1 | 1 | | 1 | 2 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22ITL31**          **OBJECT ORIENTED PROGRAMMING LABORATORY**          **L  T  P  C**
                                                                        **0  0  2  1**

**Preamble:**
The goal of the course is to give students the ability to construct software using Java programming for practical applications. The ideas of classes, packages, interfaces, inheritance, exception handling, and file processing will be understood and applied by the students. Students are also capable of creating applications using event handling and general programming.

**LIST OF EXPERIMENTS**

1. Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion)

2. Develop stack and queue data structures using classes and objects.

3. Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.

4. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea( ) that prints the area of the given shape.

5. Solve the above problem using an interface.

6. Implement exception handling and creation of user defined exceptions.

7. Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number.

8. Write a program to perform file operations.

9. Develop applications to demonstrate the features of generics classes.

10. Develop applications using JavaFX controls, layouts and menus.

**SOFTWARE**
  ● Operating Systems: Linux / Windows
  ● Front End Tools: Eclipse IDE / Netbeans IDE

                                                        **TOTAL:  45 PERIODS**

**Course Outcomes: Upon completion of the course, students will be able to:**
 CO1   Develop simple Java programs to implement searching, sorting and linear ADT.
 CO2   Design and develop Java programs using stack, queue, inheritance and abstract class.
 CO3   Develop simple applications to demonstrate the use of exceptions and multithreading.
 CO4   Implement files and generics concepts for the given problem.
 CO5   Create GUIs and event driven programming applications for real world problems.

**Mapping of COs with POs and PSOs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 2 | 1 | - | 1 | 1 | - | 1 | 2 | 2 | 2 | - | - |
| **CO2** | 2 | 1 | 3 | 1 | - | 1 | 1 | - | 2 | 3 | 3 | 2 | - | - |
| **CO3** | 2 | 2 | 1 | 2 | 1 | 1 | 1 | - | 1 | 2 | 1 | 3 | - | - |
| **CO4** | 2 | 2 | 1 | 3 | - | 1 | 1 | - | 3 | 1 | 1 | 1 | - | - |
| **CO5** | 1 | 3 | 3 | 1 | 3 | 2 | 2 | - | 1 | 1 | 1 | 1 | - | - |

1 - Slight (Low),  2 - Moderate (Medium), 3 - Substantial (High).

**22BML51**     **BIOSIGNAL PROCESSING LABORATORY**     L   T   P   C
                                                                0   0   2   1

**Pre-requisites: 22BMT31-Signals and Systems**

**Co-requisites: 22BMT61-Biosignal Processing**

**Preamble**

The Biosignal Processing Laboratory is to give hands on training to the students in understanding the theory of signal processing and practicing the algorithms used in Biosignal Processing. This will improve the understanding capability of the Biomedical signal theory and simulation capability of the signal processing algorithms.

**LIST OF EXPERIMENTS**

1. Generation of impulse, sinusoidal, saw tooth, square and exponential signals.
2. Linear convolution and circular convolution
3. Implement DFT and FFT algorithms for the given signal.
4. Design of IIR Butterworth filter using bilinear transformation method.
5. Design of Chebyshev IIR filter using one to one mapping method.
6. Design of FIR filter using Hamming window.
7. Analysis of ECG and EEG signal using MATLAB.
8. Detection of the dicrotic notch in the carotid pulse signal.
9. Design and Implement the Pan–Tompkins method for QRS detection.
10. Design of cross-correlation for EEG spike and Wave detection using template matching.

**Practical : 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1  Generate basic signals using Scilab.

CO2  Perform convolution, DFT and FFT operations using Scilab.

CO3  Design FIR and IIR filter for the specification derived from the given problem and simulate the frequency response using MATLAB.

CO4  Analyze ECG and EEG signal using MATLAB.

CO5  Design Algorithm to detect the dichotic notch in the carotid pulse, spikes and waves in EEG and the peaks in ECG signals using MATLAB.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 3 | 2 | 3 | 3 |  |  |  | 2 | 1 |  | 1 |  |  |
| **CO 2** | 3 | 3 | 2 | 3 | 3 |  |  |  | 2 | 1 |  | 1 |  |  |
| **CO 3** | 3 | 3 | 2 | 3 | 3 |  |  |  | 2 | 1 |  | 1 |  |  |
| **CO 4** | 3 | 3 | 2 | 3 | 3 |  |  |  | 2 | 1 |  | 1 | 2 | 2 |
| **CO 5** | 3 | 3 | 2 | 3 | 3 |  |  |  | 2 | 1 |  | 1 | 2 | 2 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **22MCT05**   **APTITUDE AND LOGICAL REASONING** | **2** | **0** | **0** | **0** |

**Preamble:**

**Aptitude tests** are used to determine an individual's ability/potential to succeed in a certain task, with no prior knowledge or training and are frequently used as part of a pre-employment assessment. Aptitude tests are a proven tool used to identify those who are best equipped to carry out any given role.

A **logical reasoning test** is a form of testing that is widely used by corporate employers to help assess candidates during their recruitment process.

| | | |
|---|---|---|
| **UNIT 1**    **Unitary methods** | | **6** |
| Number System, Time and Work, Pipes And Cisterns | | |
| **UNIT 2**    **Numerical Computation** | | **6** |
| Ratio and Proportion, Problems on Ages | | |
| **UNIT 3**    **Numerical Estimation I** | | **6** |
| Time and Distance, Problems on Trains, Boats and Streams | | |
| **UNIT 4**    **Numerical Estimation II** | | **6** |
| Percentage, Profit and Loss, Simple Interest and Compound Interest | | |
| **UNIT 5**    **Logical Reasoning** | | **6** |
| Direction Sense, Seating Arrangements, Coding and Decoding | | |

**TOTAL :   30 PERIODS**

**REFERENCES:**

1   Dr.R.S.Aggarwal, "Quantitative Aptitude for Competitive Examination", S.Chand Publications, 2022

2   Dr.R.S.Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", S.Chand Publications, 2022

**Course Outcomes :** Upon completion of the course, students will be able to

1. Solve the given equation using appropriate simplification methods and compute time, work, capacity and identify the pattern by analyzing the given problem/scenario
2. Apply aptitude method of ratio and proportion to solve the given scenario.
3. Calculate time, speed, distance by applying suitable aptitude method for the given problem statement.
4. Calculate percentage and profit & loss for the given problem statement and Compute simple interest, compound interest for the given problem/scenario.
5. Use their logical thinking abilities to solve given problem involving direction sense, seating arrangement and coding & decoding.

**22MCL07**          **COMMUNICATION SKILLS LABORATORY**          **L    T    P    C**
                          (Fifth / Sixth Semester)                          **0    0    2    0**

**Preamble**
Communication Skill is a life skill necessary for all students of Engineering and Technology. The course Communicative Skills Laboratory aims at developing effective oral and written communication to facilitate their success in competitive examinations, and recruitment screening thereby ensuring professional success and progress.

**UNIT 1    RECEPTIVE SKILLS                                                                        6**
**LISTENING & READING** – Developing Listening & Reading Skills - Comprehension and Analysis – Listening & Reading  for Main Idea - Specific Information - Cloze Test- Rearranging words and sentences

**UNIT 2    PRODUCTIVE SKILLS                                                                     8**
**SPEAKING & WRITING -** Group Discussion and Practice  – Mock GD - Structure – Types - Techniques - Keywords -Vital qualities - Attitude and Opinion - Expository  and Persuasive Paragraphs – Picture Description.

**UNIT 3    ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS          4**
Orientation to International English Language Testing System (IELTS) and other  Competitive Examinations – MCQs

**UNIT 4    CAREER SKILLS                                                                              6**
Types of Interviews -  FAQ's - Mock Interviews - Body Language - Team Work -  Managing Time - Managing Stress - Negotiation Skills - Networking – Profile Creation (Linked in, Portfolio)

**UNIT 5   VERBAL ABILITY                                                                            6**
Synonyms and Antonyms - Idioms and Phrases - Sentence Construction and Improvement-  Paraphrasing -  Contextual Vocabulary  - Verbal Analogy

**Lecture : 30, Tutorial : 0, Total : 30**

**REFERENCES:**
1. M Ashraf Rizvi "Effective Technical Communication", Tata McGraw-Hill, 2st Edition, New Delhi, 2018.
2. Koneru Aruna 'Professional Communication' MC Graw Hill Education, Chennai, 2008.
3. Upadhyay Meenakshi & Arun Sharma 'Comprehension Interpersonal & Communication Skills for General Studies Civil Services Preliminary Examination' MC Graw Hill Education, New Delhi, 2012.

**e-Resources:**
1. https://www.teachingenglish.org.uk/article/email-writing
2. http://www.oxforddictionaries.com/words/writing-job-applications
3. https://www.fresherslive.com/online-test/verbal-ability-test/questions-and-answers
4. www.cambridgeenglish.org

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Respond quickly and correctly to questions from  different types of scripts, exhibiting   good comprehension  and analyzing skills |
| CO2 | Participate effectively in formal group discussions and prepare professional e mails, persuasive and expository paragraphs to establish and meet organizational needs and goals. |
| CO3 | Fare well in IELTS and other English language assessment segments of competitive examinations within the stipulated time. |
| CO4 | Write effective résumés, and face interviews with communicative competence and confidence, with a good knowledge of  career skills . |

CO5   Select appropriate vocabulary and idiomatic expressions, identify errors in syntax, and arrange sentences to make meaningful paragraphs, without any aid.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | - | - | - | - | 3 | - | - | - | - | 3 | - | - | - | - |
| CO 2 | - | - | - | - | - | - | - | - | 3 | 3 | - | - | - | - |
| CO 3 | - | - | - | - | - | - | - | - | - | 3 | - | 1 | - | - |
| CO 4 | - | - | - | - | - | - | - | - | 3 | 3 | - | 1 | - | - |
| CO 5 | - | - | - | - | - | - | - | - | - | 3 | - | 1 | - | - |

1 Slight (Low), 2 Moderate (Medium), 3 Substantial (High).

**22BMT61**                    **BIO CONTROL SYSTEMS**                    **L   T   P   C**
                                                                         **3   1   0   4**

**Pre-requisites: 22MAT31- Transform Techniques and Applications, 22BMT31-Signals and Systems**

**Preamble**
This course is to understand the concept behind feedback and continuum in various systems and subsystems. Analyze the system in time domain, frequency domain and understand the concept of stability. Apply the mathematical modeling principles in understanding the various fundamental biological systems.

**UNIT 1   MODELING OF SYSTEMS**                                                    **9+3**
Terminology and basic structure of control system, examples of a control system, transfer functions, modeling of electrical systems, translational and rotational mechanical systems, and electromechanical systems, block diagram and signal flow graph representation of systems, conversion of block diagram to signal flow graph, reduction of block diagram and signal flow graph.

**UNIT 2    TIME RESPONSE ANALYSIS**                                                **9+3**
Test input signals, Step and impulse responses of first order and second order systems, determination of time domain specifications of first and second order systems from its output responses, definition of steady state error constants and its computations.

**UNIT 3   STABILITY ANALYSIS**                                                     **9+3**
Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus, study of stability, Nyquist stability criterion, definition of dominant poles and relative stability.

**UNIT 4   FREQUENCY RESPONSE ANALYSIS**                                            **9+3**
Frequency response, definition of gain margin and phase margin, determination of gain margin and phase margin using Bode plot, Polar plot, determination of closed loop response using M and N circles, Nichol‟s chart to compute response frequency and bandwidth.

**UNIT 5   PHYSIOLOGICAL CONTROL SYSTEM**                                           **9+3**
Example of physiological control system, difference between engineering and physiological control systems, generalized system properties, models with combination of system elements, linear models of physiological systems-Examples, introduction to simulation, Static Analysis of Physiological Systems-Regulation of Cardiac Output and Regulation of Glucose.

                                                         **Lecture : 45, Tutorial : 15, Total : 60**

**TEXT BOOKS:**
1.   M. Gopal "Control Systems Principles and Design", Tata McGraw Hill, Kourth Edition, 2002.
2.   Michael C K Khoo, "Physiological Control Systems", IEEE Press, Prentice Hall of India, 2001.

**REFERENCES:**
1.   Benjamin C. Kuo, "Automatic Control Systems", Prentice Hall of India, Ninth Edition, 1995.
2.   John Enderle Susan Blanchard, Joseph Bronzino "Introduction to Biomedical Engineering", second edition, Academic Press, 2005.
3.   Richard C. Dorf, Robert H. Bishop, "Modern control systems", Pearson, 2004.

**e-Resources:**
1.   https://nptel.ac.in/courses/107/106/107106081/, 'Control systems', Prof. C.S. Shankar ram Department of Design Engineering IIT Madras.
2.   https://www.edx.org/course/system-dynamics-health-sciences-witsx-hsd101x#!,"System dynamics for Health Sciences", David Rubin Adjunct Professor, Biomedical Engineering University of the Witwatersrand.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Identify and explain the open loop and closed loop control systems, using block diagram and signal flow graph reduction techniques.

CO2    Determine the time domain specifications for the closed loop transfer function with the given standard test input signals.

CO3    Analyze the stability of the given system using Routh Hurwitz criteria, Root locus and Nyquist stability criteria techniques.

CO4    Determine the frequency domain of the given system using bode and polar graphical plots.

CO5    Design the models of physiological control system using the concepts of engineering control systems.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | | | | | | 1 | 2 | | 2 | | |
| CO 2 | 2 | 3 | 2 | | | | | | 1 | 2 | | 2 | | |
| CO 3 | 2 | 3 | 2 | | 2 | | | | 1 | 2 | | 2 | | |
| CO 4 | 2 | 3 | 2 | | 2 | | | | 1 | 2 | | 2 | | |
| CO 5 | 2 | 3 | 2 | | | | | | 1 | 2 | | 2 | 2 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT62**                          **MEDICAL INSTRUMENTATION – II**                    **L    T    P    C**
                                                                                        **3    0    0    3**

**Pre-requisites: Medical Instrumentation - I**

**Preamble**
This course is designed to make the student obtain the extended knowledge of the biological systems and its parameters for designing and interpreting the diagnostic and therapeutic equipments. Understand the fundamental principle and working of the biomedical instruments involved in the measurement using optics.

**UNIT 1    PULMONARY FUNCTION ANALYZERS                                     9**
Pulmonary Function Analysers: Pulmonary function Measurements – Spirometry – Machine wedge spirometer, Ultrasonic spirometer - Pneumotachometers - Impedance pneumograph – Respiratory gas analyzers – ventilators – types of ventilators – Anesthesia Ventilators: Artificial ventilation, classification of Ventilators, Pressure-volume-flow diagrams, Modern ventilators.

**UNIT 2    PATIENT MONITORING AND TELEMETRY                                9**
Patient monitoring systems: Cardiac monitors using digital memory, Bedside patient monitoring systems, Central monitors. Biotelemetry: Wireless telemetry, Single channel telemetry systems, Multichannel wireless telemetry systems, Implantable telemetry systems.

**UNIT 3    ENDOSCOPES AND ELECTROTHERAPY EQUIPMENTS                        9**
Diagnostic and Therapeutic Instruments: Principles and description of Endoscopes- Fibre optic endoscopes – Laparoscopes – Cystoscopes -  Pain reliever- Ultrasonic stimulators, diathermy equipment, Electrosurgical stimulators and analyzers, Functional electrical stimulators -TENS.

**UNIT 4    BLOOD FLOW METERS AND ANALYTICAL INSTRUMENTS                    9**
Electromagnetic blood flowmeter Ultrasonic blood flow meters –Doppler shift flow velocity meters- Range gated pulsed Doppler meters- Blood flow measurement Doppler imaging- NMR blood flow meters – Laser Doppler blood flow meters. pH meters, Glucometer, Spectrophotometer.

**UNIT 5    LASERS AND THERAPEUTIC EQUIPMENTS                              9**
Basic principles of biomedical laser, $CO_2$ laser, He – Ne laser, Nd – YAG laser and ruby laser. Basic principle of Hemodialysis and its type - Membrane, Dialysate, Lithotripters- Extracorporeal shock wave therapy- Anaesthesia Machine.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.   Andrew G. Webb, "Principles of Biomedical Instrumentation", Cambridge university press, 2018.
2.   Joseph D.Bronzino "Biomedical engineering fundamentals" The biomedical Engineering handbook, third Edition, CRC Taylor and Francis.2019

**REFERENCES:**
1.   Joseph J.carr and John M. Brown, "Introduction to Biomedical equipment technology", John Wiley and sons, New York, 2019

2.   John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2019.
3.   L.A Geddes and L.E.Baker "Principles of Applied Biomedical Instrumentation" Wiley India Edition. 2018.

**e-Resources:**
1.   https://www.youtube.com/watch?v=mNadr6bGEMU " spirometer" – Zach Murphy -Philadelphia College of Osteopathic Medicine

2. https://www.youtube.com/watch?v=GZeFkCGClSU – Ventilators-  Dr.Waqas fazal - St Andrew's Ipswich Private Hospital

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Explain spirometer and ventilator using wedge, ultrasonic and artificial, modern ventilators used for diagnostic and therapeutic function of respiration measurement

CO2    Illustrate diagnostic function of patient monitoring system and biotelemetry using cardiac, bedside, wireless, single channel, multi channel and implantable units used in ICU Department.

CO3    Describe the key aspects involved in using endoscopes for doing surgery and discuss the usage of surgical simulators.

CO4    Discuss the characteristics of blood flow and its measurement using analyzers.

CO5    Illustrate the use of various lasers in biomedical engineering and functions of hemodialyzers.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | | | 2 | | | | 2 | | 2 | 2 | 2 |
| CO 2 | 2 | 3 | 2 | | | 2 | | | | 2 | | 2 | 2 | 2 |
| CO 3 | 2 | 2 | 2 | | | 2 | | | | 2 | | 2 | 3 | 2 |
| CO 4 | 2 | 2 | 2 | | | 2 | | | | 2 | | 2 | 3 | 2 |
| CO 5 | 2 | 1 | 2 | | 2 | 2 | | | | 2 | | 2 | 3 | 2 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMT63**                    **MICROPROCESSORS AND MICROCONTROLLERS**                **L    T    P    C**
                                                                                       **3    0    0    3**

**Pre-requisites: 22BMT42 - Analog and Digital Integrated circuits**

**Preamble:**
This course provides the fundamental concepts of microprocessor and microcontroller architectures. It describes the interfacing of memory and peripheral devices with microprocessor and microcontroller. The students showcase their skills in embedded applications development with microprocessor and microcontroller.

**UNIT 1    INTRODUCTION TO MICROPROCESSOR                                              9**
Introduction to microprocessor - Register Organization – Architecture of 8086 – Memory segmentation – Memory Banking – Pin Diagram of 8086 –Instruction set.

**UNIT 2    PERIPHERALS AND THEIR INTERFACING WITH 8086                                 9**
Programmable peripheral Interface 8255 – Interfacing of ADC 0809 and DAC 0808 using 8255 – The matrix keyboard and seven segment display interfacing using 8255 – Stepper motor Interface – Programmable interval timer 8254.

**UNIT 3    ARM PROCESSOR ARCHITECTURE                                                  9**
ARM Architecture-ARM programmer's model - ARM development tools. Pipelining -3-stage pipeline ARM organization, 5-stage pipeline ARM organization. ARM instruction execution, ARM Instruction Set.

**UNIT 4    8051  INSTRUCTION SET AND ASSEMBLY LANGUAGE  PROGRAMMING          9**
8051 Architecture – 8051 Memory organization – Structure of internal ROM and RAM – 8051 registers – Addressing modes – 8051 instruction set – 8051 Timer section and programming – Serial port programming – 8051 I/O programming-Interrupts.

**UNIT 5    INTERFACING MICROCONTROLLERS                                                9**
Seven segment display interfaces – Keyboard interfacing –ADC Interfacing – DAC interfacing –DC Motor - Stepper motor interfacing and applications.

                                                                **Lecture:45,Tutorial:0, Total: 45**

**TEXT BOOKS:**
1.    Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, New Delhi, 2012.
2.    Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely 'The 8051 Micro Controller and Embedded Systems', PHI Pearson Education, 2014.
3.    Steve Furber, ARM system - on - chip architecture, second edition, Addison Wesley, 2000.

**REFERENCES:**
1.    Yu-Cheng Liu, Glenn A. Gibson, "Microcomputer Systems: The 8086/8088 Family Architecture, Programming and Design", Pearson, 2$^{nd}$ Edition, 2015.
2.    Kenneth J. Ayala, "8051 Microcontroller: Architecture, Programming and Applications", West publishing company, 3$^{rd}$ Edition, 2007.
3.    Andrew N. Sloss, Donimic Symes, Chris Wright, : "ARM System Developer's Guide", Elsevier Inc,2004

**e-RESOURCES:**
1.    https://swayam.gov.in/nd1_noc20_ee42/,"Microprocessors And Microcontrollers", Prof. SantanuChattopadhyay, Department of Computer Science and Engineering, IIT Kharagpur.
2.    https://swayam.gov.in/nd1_noc20_ee11, "Microprocessors and Interfacing", Prof. Shaik Rafi Ahamed, Department of Computer Science and Engineering, Indian Institute of Technology, IIT Guwahati.

**Course Outcomes: Upon completion of the course, students will be able to:**
1. Illustrate the Architecture and Memory segmentation of 8086 Microprocessor.
2. Identify the pin configurations of interfacing IC's for the peripherals devices.
3. Describe the Architecture and pipeline organization of ARM processor.
4. Develop Assembly programs for the given problems using 8051 Instruction set.
5. Design circuits to implement simple embedded applications using microcontroller.

**Mapping of Cos with Pos and PSOs Mapping:**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO1** | 2 | 2 | 2 | | | | | | | 1 | | 1 | | |
| **CO2** | 2 | 2 | 2 | | | | | | | 1 | | 1 | | |
| **CO3** | 2 | 2 | 2 | | | | | | | 1 | | 1 | | |
| **CO4** | 2 | 2 | 3 | 3 | | | | | | 1 | | 1 | | |
| **CO5** | 2 | 2 | 3 | 3 | | | | | | 1 | | 1 | | |

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)     "-" No correlation

**22BML61**          **MEDICAL INSTRUMENTATON LABORATORY**          L  T  P  C
                                                                   0  0  2  1

**Pre-requisites: 22BMT51 -  MEDICAL INSTRUMENTATON -  I**

**Co-requisites: 22BMT62 -  MEDICAL INSTRUMENTATON -  II**

**Preamble**
The course is designed to make the student acquire an adequate knowledge of record and measure the physiological systems of the human body and relate them to the parameters that have clinical importance.

**LIST OF EXPERIMENTS**
1. Recording of ECG signal and Analysis.
2. Recording of EMG and EEG signal.
3. Recording of various physiological parameters using real time patient monitoring system.
4. Measurement of Galvanic Skin Resistance (GSR).
5. Measurement and Recording of peripheral blood flow using blood flow meter
6. Measurement of Flow rate using Syringe pump and Infusion pump.
7. Measurement of Heart Rate using EKG sensor in LabVIEW.
8. Recording and Analysis of ECG signals using LabVIEW.
9. Determination of hearing loss by obtaining audiogram using audiometer.
10. Analyze the respiratory parameters using Spirometer.
11. Study of Shortwave and surgical diathermy.

**Practical : 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Record the ECG, EEG and EMG signals using surface electrodes and real time patient monitoring system. |
| CO2 | Measure the blood flow using ultrasonic blood flow meter and Record and measure Galvanic Skin Resistance. |
| CO3 | Experiment and Determine the flow rate for safer micro administration of doses. |
| CO4 | Acquire and analyze the characteristics of biosignals using LabVIEW. |
| CO5 | Experiment and verify the hearing acuity using audiometer and Measure the lung volumes, lung capacities using spirometry. |

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 2 | 2 | 3 | | | | | 2 | 2 | 1 | 2 | 2 | 3 |
| CO 2 | 2 | 2 | 2 | 3 | | | | | 2 | 2 | 1 | 2 | 2 | 3 |
| CO 3 | 2 | 2 | 2 | 3 | | | | | 2 | 2 | 1 | 2 | 2 | 3 |
| CO 4 | 2 | 2 | 2 | 3 | 2 | | | | 2 | 2 | 1 | 2 | 2 | 3 |
| CO 5 | 2 | 2 | 2 | 3 | | | | | 2 | 2 | 1 | 2 | 2 | 3 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BML62      MICROPROCESSORS AND MICROCONTROLLERS LABORATORY    L   T   P   C**

**0   0   2   1**

**Pre-requisites : 22BML42-    Analog and Digital Integrated circuits Lab**
**Preamble:**
Microprocessor and Microcontroller laboratory course provides fundamental knowledge on programming of 8086 microprocessor, 8051 microcontroller and ARM processor. The student develops their skills in simple application development using the interfacing of microprocessor and microcontroller.

**LIST OF EXPERIMENTS**
1.   Arithmetic, Logic and Matrix operations using 8086 microprocessor.
2.   Sorting and Searching using 8086 microprocessor.
3.   Arithmetic and Logic Operations with 8051 microcontroller.
4.   Block data transfer between internal and external memory including overlapping blocks with 8051 microcontroller.
5.   Interrupts Handling with 8051 microcontroller.
6.   Stepper Motor and Speed Control of DC Motor using 8051 microcontroller.
7.   Square waveform and Saw tooth waveform generation using 8051 microcontroller.
8.   Keyboard and seven segment display interface using 8051 microcontroller.
9.   Time delay generation using 8051 microcontroller.
10.  Stepper Motor interface using ARM
11.  DC Motor interface using ARM
12.  Interface a simple Switch and display its status through LED using ARM.

**Course Outcomes: Upon completion of the course, students will be able to:**
1.   Experiment & Verify Arithmetic & Logic Operations, Matrix operations, sorting and searching among an array of integers using 8086 microprocessor.
2.   Experiment & Verify Arithmetic and Logic Operations using 8051 microcontroller.
3.   Experiment & test interfacing of stepper motor, DC motor, Keyboard and seven segment display interface using 8051 microcontroller.
4.   Experiment & test Stepper Motor and DC motor interfacing using ARM Processor.
5.   Experiment & test switch interfacing using ARM Processor.

**Practical :45, Total: 45**

**Mapping of Cos with Pos and PSOs Mapping:**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1 | 1 | 2 | 3 | 3 | 3 | | | | 2 | 1 | | 1 | | |
| CO2 | 1 | 2 | 3 | 3 | 3 | | | | 2 | 1 | | 1 | | |
| CO3 | 1 | 2 | 3 | 3 | 3 | | | | 2 | 1 | | 1 | | |
| CO4 | 1 | 2 | 3 | 3 | 3 | | | | 2 | 1 | | 1 | | |
| CO5 | 1 | 2 | 3 | 3 | 3 | | | | 2 | 1 | | 1 | | |

**1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)      "-" No correlation**

| | | L | T | P | C |
|---|---|---|---|---|---|
| **22BML63** | **MINI PROJECT** | **0** | **0** | **6** | **3** |

**Pre-requisites: Nil**

**Preamble:**
The course enables the students to estimate the ability of the student in transformning the theoretical knowledge studied so far into a working model of a Biomedical/ Electronics/ Mechatronics/ Instrumentation System.

**Lecture : 60, Tutorial : 0, Total : 60**

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Apply engineering fundamentals to analyze domain specific Issues to identify problem statement with objective and scope.

CO2    Investigate the identified problem and review state of the art literature survey to synthesis system requirements.

CO3    Identify the risk/impact/technique and interpret the suitable standards related to the problem statement and design appropriate procedures/methods.

CO4    Develop modules using discipline specific tools and implement the modules to achieve valid conclusion.

CO5    Prepare documents related to their findings for detailed presentation, Defend the findings and conclude with oral / written presentation.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 2** | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO 4** | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 5** | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22ITT71**     **ECONOMICS AND MANAGEMENT FOR ENGINEERS**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre-requisites : Nil**
**Preamble**
The main aim of this course is to understand the concepts of Economics with respect to the demand and supply analysis. This course makes the students to analyze the theory of production and the analysis of the cost parameter by using the Elasticity. This course will enable the students to manage and plan the situation with the help of the available strategies to support the decision making process.

**UNIT 1    INTRODUCTION TO ECONOMICS                                        9**
Introduction toEconomics – Scope of Economics – Positive and Normative Science – Methodology of Economics – Economic Laws - Economy and its basic problems: Economy and its working – Kindsof economy systems – Basic problems of economy.

**UNIT 2    DEMAND AND SUPPLY ANALYSIS                                        9**

The Law of Demand – The Law of Supply – Elasticities of Demand and Supply: Price Elasticity of Demand - Price Elasticity and Consumption Expenditure- Cross Elasticity of Demand – Income Elasticity of Demand – The Elasticity of Price Expectations – The uses of Elasticity– Price Elasticity of Supply.

**UNIT 3    THEORY OF PRODUCTION AND ANALYSIS OF COST                      9**
Meaning of Production – Production concepts – Production Function – Laws of Production – Cost Concepts - Short-Run Cost Output Relations – Long Run Cost output relations – Economics of Scale

**UNIT 4    INTRODUCTION TO MANAGEMENT                                        9**
Management: An Overview – Management Defined – Managerial skills – Managerial roles – Management responsibilities – Management functions. Evolution of Management: Classical approaches to Management – Contemporary Management Perspectives.

**UNIT 5   PLANNING                                                            9**
Planning and Forecasting: Importance of Planning – Principles of effective Planning – Planning process – Types of Plans. Strategic Planning: Strategic Planning process – Rational decision making.

**Total : 45 Periods**

**TEXT BOOKS:**
1. D.N.Dwivedi, "Principles of Economics", Second Edition, Vikas Publishing House (P) Limited, NewDelhi, 2012.
2. J.S.Chandan, "Management Concepts and Strategies", Vikas Publishing House (P) Limited, NewDelhi, Reprint 2009.

**REFERENCES:**
1. Ranbir Singh," Principles of Engineering Economics and Management", S .K.Kataria& Sons, New Delhi, 2013.
2. Manish Varshney and VidhanBanerjee,"Engineeringand Managerial Economics",First Edition, CBSPublishers and Distributors Pvt. Ltd., 2015.

**e-RESOURCES:**
1. http://nptel.ac.in/courses/110101005/, Prof.Trupti Mishra, S.J.M. School of Management, IIT Mumbai, Managerial Economics.
2. https://nptel.ac.in/courses/122106031/slides/3_1s.pdf, Dr.M.Thenmozhi, Professor, IIT Madras.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Explain how to use economics principles to solve economic problems in engineering discipline by satisfying the economic laws.

CO2 Discuss the demand and supply process for a market analysis using Price elasticity, Cross elasticity and Income elasticity.

CO3 Interpret short run and long run costs in the process of production for carrying out a business.

CO4 Apply managerial skills to make decisions and solve problems for achieving organizational objectives.

CO5 Express the principles of effective planning for survival and success of all organizations usingstanding and single use planning methods.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1 | 2 | 3 | 2 | 2 | - | 2 | 1 | 1 | - | 1 | - | - | - | - |
| CO2 | 2 | 3 | 2 | 2 | - | 2 | 1 | 1 | - | 1 | - | - | - | - |
| CO3 | 2 | 3 | 2 | 2 | - | 2 | 1 | 1 | - | 1 | - | - | - | - |
| CO4 | 2 | 3 | 2 | 2 | - | 2 | 1 | 1 | - | 1 | - | - | - | - |
| CO5 | 2 | 3 | 2 | 2 | - | 2 | 1 | 1 | - | 1 | - | - | - | - |

1 - Slight (Low),  2 - Moderate (Medium), 3 - Substantial (High).

**22BMT71**                    **MEDICAL IMAGE PROCESSING**                    **L    T    P    C**
                                                                              **3    0    0    3**

**Pre-requisites: 22BMT52 - Biosignal Processing**

**Preamble**
To provide the knowledge about image fundamentals, mathematical transforms, image enhancement techniques, restoration procedures, and segmentation techniques, image compression methods and to familiarize theconcepts on various image representation and image recognition methods.

**UNIT 1    DIGITAL IMAGE FUNDAMENTALS                    9**
Introduction – Origin – Fundamental Steps in Digital Image Processing – Components – Elements of Visual Perception, Image Sensing and Acquisition, Image Sampling and Quantization, Relationships between pixels, Color models – RGB color model – HIS color model. Mass dimension measurement in Ultrasound images.

**UNIT 2    IMAGE ENHANCEMENT                    9**
Spatial Domain: Basic intensity transformation of mammograms, Histogram equalization, Matching, fundamentals of Spatial Filtering, Smoothing and Sharpening Spatial Filtering. Frequency Domain: Sampling - Fourier Transform – Sampling theorem and aliasing, DFT, DCT, Smoothing and Sharpening in the frequency domain filters.

**UNIT 3    IMAGE SEGMENTATION AND RESTORATION                    9**
Fundamentals, Point, line and Edge detection, Thresholding, Region Based segmentation, Morphological processing- erosion and dilation – Active contour. Noise models – Mean Filters – Order Statistics – Inverse Filtering. MRI Image Restoration using Wiener filter.

**UNIT 4    IMAGE COMPRESSION                    9**
Need for compression - Lossy Vs lossless compression, Huffman, Run Length Encoding, Arithmetic coding, Vector Quantization, Transform coding, JPEG standard, MPEG. Wavelet based Medical Image compression.

**UNIT 5    IMAGE REPRESENTATION AND RECOGNITION                    9**
Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments – Boundary description – Shape number – Fourier Descriptor, moments- Regional Descriptors – Topological feature, Object Recognition – Case study on Object recognition. Shape and texture analysis of tumours.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Rafael C, Gonzalez and Richard E Woods, "Digital Image Processing*"*, Pearson Education Asia, FourthEdition, 2021.
2. Anil K Jain, "Fundamentals of Digital Image Processing*"*, Prentice Hall of India, 2nd edition 2015.

**REFERENCES:**
1. William K. Pratt, "Digital Image Processing: PIKS Scientific Inside", Wiley Student Edition, 2010.
2. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", 2011, 2 nd edition, McGraw Hill Pvt. Ltd., New York.
3. Munesh.C. Trivedi and Dr. Sanjay. M. Shah, "Digital Image Processing", Khanna publications, 2007.
4. Milan Sonka,Roger Boyle and Vaclav Hlavac, ―Image Processing, Analysis, and Machine Vision, 4th Edition, Cengage Learning, 2015

**e-Resources:**
1.   http://nptel.ac.in/courses/106105032/, "Digital Image Processing", Prof.G. Harit, Indian Institute of Technology, Kharagpur.
2.   https://nptel.ac.in/courses/117/105/117105079/, "Digital Image Processing", Prof. P.K. Biswas, Indian Institute of Technology, Kharagpur.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Illustrate the image formation and color models with image sampling and quantization methods.

CO2   Analyze intensity transformation techniques to enhance the medical images in spatial and frequency domain.

CO3   Develop an algorithms employed for segmentation and restoration of medical images using spatial filtering techniques.

CO4   Categorize compression methods to decompose the medical images using Image compression techniques.

CO5   Interpret the image representation methods and apply object recognition based on matching algorithm.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 3 | 2 | | | | | | 1 | 1 | | 1 | 3 | |
| CO 2 | 3 | 3 | 2 | | | | | | 1 | 1 | | 1 | 3 | |
| CO 3 | 3 | 3 | 2 | | 2 | | | | 1 | 1 | | 1 | 3 | |
| CO 4 | 3 | 3 | 2 | | 2 | | | | 1 | 1 | | 1 | 3 | |
| CO 5 | 3 | 3 | 2 | | 2 | | | | 1 | 1 | | 1 | 3 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22HST71**          **HUMAN VALUES AND PROFESSIONAL ETHICS**      **L   T   P   C**
                                                                            **1   0   0   1**

**Pre-requisites:** Universal Human Values

**Preamble**
Universal Human Values is a life skill necessary for all students of Engineering and Technology. The course aims to identify the values and skills, and to realize the need, basic guidelines, content and process of value education. Professional Ethics For Engineers deals with the human values, integrity and work ethics in the common world. This course is mainly concerned about the theories of ethics, which form the basis for the understanding and responsibility of the various groups encountered in Engineering.

**UNIT 1   INTRODUCTION TO UNIVERSAL HUMAN VALUES**                **3**
Understanding the need, basic guidelines, content and process for Value Education. Self Exploration– Mechanism for self-exploration. Continuous Happiness and Prosperity- Basic Human Aspirations and its requirements for fulfillment of Human Aspirations understanding and living in harmony at various levels.

**UNIT 2   HARMONY IN ONESELF, FAMILY AND SOCIETY**                     **3**
Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding harmony in the Family- the basic unit of human interaction. Understanding values in human-human relationships. Trust and Respect- values of relationship. Difference between intention and competence. Difference between respect and differentiation

**UNIT 3   HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS**     **3**
Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in Professional Ethics. Ability to utilize the professional competence for augmenting universal human order, Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models.

**UNIT 4   ENGINEERING ETHICS**                                                  **3**
Senses of Engineering Ethics– Variety of moral issues – Types of inquiry – Moral dilemmas – Moral autonomy – Kohlberg's theory – Gilligan's theory – Consensus and controversy – Models of professional roles –Professional responsibility - Moral reasoning - Theories about right action – Self-interest – Self respect – Duty ethics – Customs and religion.

**UNIT 5   ENGINEERING AS SOCIAL EXPERIMENTATION**                       **3**
Engineering as experimentation – Engineers as responsible experimenters – Role of codes- Codes of Ethics – Sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers (IETE) – A balanced outlook on law - Safe exits -The Bhopal gas tragedy and Challenger case study.

                                                                      **Lecture: 15, Total: 15**

**TEXT BOOKS:**
1.     Gaur R R, Sangal R, Bagaria G P, "A Foundation Course in Human Values and Professional Ethics". 3rd Revised Edition, 2023
2.     Govindarajan M, Natarajan S and Senthil Kumar V. S, "Engineering Ethics", PHI Learning Pvt. Ltd, New Delhi, 2017.

**REFERENCES:**
1.     Banerjee B P, "Foundations of Ethics and Management", Excel Books. 2005.

2. Bajpai B L, "Indian Ethos and Modern Management", New Royal Book Co., Lucknow. Reprinted 2008.
3. Subramanian R, "Professional Ethics", Oxford university press, 2017.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Relate the significance of value inputs in a classroom and start applying them in their life and profession.

CO2 Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.

CO3 Interpret the value of harmonious relationships based on the trust and respect in their life and profession.

CO4 Discuss the ethical issues related to Engineering.

CO5 Discuss Engineer's work in the context of its impact on society.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | | | | | | 2 | 3 | 2 | 2 | | | 2 | | |
| **CO 2** | | | | | | 3 | | 3 | 1 | | | 2 | | |
| **CO 3** | | | | | | 2 | 2 | 3 | 3 | 3 | | 2 | | |
| **CO 4** | 1 | 2 | | | | 3 | | 2 | | | | 2 | | |
| **CO 5** | 2 | 2 | 1 | | | 3 | 2 | 2 | | | | 2 | | |

1 - Slight (Low),    2 - Moderate (Medium),    3 - Substantial (High).

**22BML71**　　　　　**MEDICAL IMAGE PROCESSING LABORATORY**　　　L　T　P　C
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　0　0　2　1

**Pre-requisites: 22BMT52 - Biosignal Processing**

**Co-requisites: 22BMT71 – Medical Image Processing**

**Preamble**
The goals are to supplement the theory course that provides medical image processing concepts for the students to develop an application software program in MATLAB/OpenCV. It also demonstrates the medical image transformation, enhancement, segmentation techniques and feature extraction techniques with associated programs.

**LISTOFEXPERIMENTS**
1. Perform fundamental operations like Resizing, Cropping, Image conversion and basic arithmetic operations using OpenCV.
2. Implementation of image augmentation to increase medical image data set using OpenCV.
3. Develop an algorithm for Medical Image Enhancement using histogram equalization.
4. Preprocessing of ultrasound image using Discrete Wavelet Transform.
5. Removal of noise for medical images – MRI, Ultrasound, X-Ray and CT.
6. Apply Gray level transformation in spatial domain for X-Ray image.
7. Perform the medical image analysis using frequency domain filters – LPF, HPF, BPF and BSF.
8. Create an algorithm to segment an image using edge detection, line detection and boundary detection for medical image.
9. Perform the Morphological Operations for ultrasound image using Dilation, Erosion, Opening and Closing.
10. Perform Thresholding Function of medical image using optimal thresholding technique.
11. Develop an algorithm to extract the features of MRI image.

**Mini Project**

**Software**
　　MATLAB/ OpenCV

**Practical : 45, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Develop a program using medical image processing concepts to perform fundamental operations and image augmentation using Open CV. |
| CO2 | Implement a program to enhance quality of image and to perform DWT for medical images. |
| CO3 | Create an algorithm using intensity transformation and apply different filtering operation for medical image |
| CO4 | Apply segmentation, morphological operations and thresholding techniques to obtain the region of interest of a medical image. |
| CO5 | Develop a program to extract features from the given image. |

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 2 | 1 | 3 | 2 | | | | 1 | 1 | | 1 | 1 | 2 |
| CO 2 | 3 | 2 | 1 | 3 | 2 | | | | 1 | 1 | | 1 | 1 | 2 |
| CO 3 | 3 | 3 | 1 | 3 | 2 | | | | 1 | 1 | | 1 | 1 | 2 |
| CO 4 | 3 | 3 | 1 | 3 | 2 | | | | 1 | 1 | | 1 | 1 | 2 |
| CO 5 | 3 | 3 | 1 | 3 | 2 | | | | 1 | 1 | | 1 | 1 | 2 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**HOSPITAL TRAINING**

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

**Pre-requisites: Nil**

**Preamble:**
To develop the practical experience at place where biomedical equipment's are utilized.

**LIST OF EXPERIMENTS**
1. Study of Ventilator functioning, Ultrasound machine and Heart Lung Model.
2. Troubleshooting, maintenance, and servicing of medical equipment.
3. Study of Reverse Engineering
4. Medical Device Regulation and Safety
5. Presentation on various departments and equipment in the Hospital.

Students have to undergo two weeks of practical training in hospitals with prior approval from the institution during the semester holidays of that particular academic year. At the end of the training student will submit a report as per the prescribed format to the department.

**Lecture : 45, Tutorial : 0, Total : 45**

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1   Implement a patient-centered approach in healthcare
CO2   Communicate with other health professionals in a respectful and responsible manner
CO3   Demonstrate the maintenance and service of diagnostic and therapeutic equipment.
CO4   Propose a patient-centered inter-professional health improvement plan based upon the patient's perceived needs.
CO5   Demonstrate patient care in hospital setting and provide access to healthcare professionals to get a better understanding of their work

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |
| CO 2 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |
| CO 3 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |
| CO 4 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |
| CO 5 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22MCT07**       **INDIAN CONSTITUTION AND TRADITIONAL**     **L   T   P    C**
                                   **KNOWLEDGE**                        **3   0   0    0**

**Preamble:**The course provides basic information on Indian Constitution and Indian Traditional knowledge.This is essential for all citizens and especially for engineers so that they become aware of Indian polity and governance. This also reminds the citizen about their obligation, adherence and upkeeping of   Constitutional rights.

**UNIT 1**                                                            **6**
Constitution' meaning of the term, Indian Constitution:Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy - Structure of the Indian Union: Federalism, Centre- Staterelationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha

**UNIT 2**                                                            **6**
Governor: Role and Position, CM and Council ofministers, State Secretariat: organisation, Structure andFunctionsDistrict's Administration head: Role and Importance,Municipalities: Introduction, Mayor and role of ElectedRepresentative, CEO of Municipal Corporation,

**UNIT 3**                                                            **6**
Panchayatraj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role, Blocklevel: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials,Importance of grass root democracy

**UNIT 4**                                                            **6**
Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, StateElection Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women

**UNIT 5**                                                            **6**
BasicstructureofIndianKnowledgeSystem-Modern     Science     and     Indian     Knowledge     – PhilosophicalTradition - Indian Linguistic Tradition (Phonology, morphology, syntax and semantics) – IndianArtisticTradition

                                                             **TOTAL: 30 PERIODS**

**TEXT BOOKS:**
1.   M.Rajaram, Indian Constitution, New Age International, 2009
2.   V.Sivaramakrishnan(Ed.) Cultural Heritage of India (CourseMaterial),Bharatiya Vidya Bhavan, Mumbai. 5thEdition,2014

**Course  Outcomes:** Upon completion of the course, students will be able to:
1.   Outline the evolution of Indian constitution and Federal structure
2.   List the functions of Centre, States and District Administrations
3.   Elaborate the roles of Panchayatiraj
4.   Explain the powers and roles of Election Commission
5.   Illustrate the Indian traditional knowledge and elucidate their recovery

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | | | | | | 3 | 1 | 2 | 1 | 1 | | 1 | | |
| CO 2 | | | | | | 3 | 1 | 2 | 1 | 1 | | 1 | | |
| CO 3 | | | | | | 3 | 1 | 2 | 1 | 1 | | 1 | | |
| CO 4 | | | | | | 3 | 1 | 2 | 1 | 1 | | 1 | | |
| CO 5 | | | | | | 3 | 1 | 2 | 1 | 1 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BML81** INTERNSHIP L T P C
- - - 2

**Pre-requisites:** Knowledge of Biomedical Engineering and Software Packages.

**Preamble**
Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important, as employers arelooking for employees who are properly skilled and have awareness about the industry environment, practices, and culture. The internship is structured, short-term, supervised training often focused on particular tasks or projects with defined time scales.

**GUIDELINE FOR REVIEW AND EVALUATION**
Students have to undergo four-week practical training in Biomedical Engineering related organizations of their choice but with the prior approval from the institution. At the end of the training student will submit a report as per the prescribed format to the department. The student shall make a power point presentation before a committee constituted by the department which will assess the student based on thereport submitted and the presentation made.

**Evaluation of Project Report and Viva voce examination: 100 marks**
(The student will be evaluated based on the report and the viva voce examination by an internal examiner)

**Total: 30**

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Apply the acquired knowledge in the design of components and systems to solve the real-life problems.

CO2 Solve the given problems by applying the concepts of living and nonliving systems.

CO3 Apply the biomedical engineering concepts to solve the engineering problems.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO 2** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO 3** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 3 | 3 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| | L | T | P | C |
|---|---|---|---|---|
| **22BML82** **PROJECT WORK** | - | - | 20 | 10 |

**Pre-requisites: Nil**

**Preamble:**
This course is designed to develop the ability to solve a specific problem right from its identification and literature review till the successful solution for the same. This course also trains the students in preparing project reports and in facing reviews and viva voce examination.

**GUIDELINE FOR REVIEW AND EVALUATION**
The students in a group of 3 to 4 work on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee shall be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department. Progressive weightage shall be assigned to the project reviews as decided by the project review committee.

**Lecture : 120, Tutorial : 0, Total : 120**

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1   Discover potential research areas in the field of Biomedical Engineering.
CO2   Compare and contrast the several existing solutions for the problems identified.
CO3   Formulate and propose a plan for creating a solution for the research plan identified.
CO4   Conduct the experiments as a team and interpret the results.
CO5   Report and present the findings of the work conducted.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 2** | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 3** | 2 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |
| **CO 4** | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO 5** | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME11**                    **BIOSENSORS AND TRANSDUCERS**                  L  T  P  C
                                                                              3  0  0  3

**Pre-requisites : Nil**

**Preamble**
Biosensors and Transducers course presents the rapidly evolving methodologies that are relevant tobiosensors and transducers fabrication and characterization. It provides a comprehensiveunderstanding of the functionality of Nanotechnology based biosensors and applications.

**UNIT 1    INTRODUCTION TO BIOSENSORS                                               9**
Basic principle of a biosensor, Components of a biosensor, Molecular recognition, Classification ofbiosensors based on transducers, Piezoelectric biosensors, Magneto elastic biosensors, Field effect transistor-based biosensor, Calorimetric biosensor, Noninvasive biosensors.

**UNIT 2    ELECTROCHEMICAL BIOSENSORS AND IMMUNOSENSORS                              9**
Electrochemical techniques, Electroanalytical characteristics of biosensors, Membranes used in biosensors for selectivity, Biosensor electrode fabrication techniques.Immunosensors: Introduction, Antibody as biorecognition element, Types of antibodies and antibody fragments, Types of immunosensors, Labelled and label-free immunosensors.

**UNIT 3    ENZYMATIC BIOSENSORS                                                      9**
Enzymatic biosensors, Enzymatic and nonenzymatic biosensors for various diseases, Biomarkers for diagnosis of diseases, Glucose oxidase-based glucose biosensors for diabetes: Noninvasive glucose biosensor, Implantable glucose biosensors. Cholesterol biosensor, Apoptosis marker. Biomedical applications of enzyme biosensors.

**UNIT 4    OPTICAL AND FIBER OPTIC TRANSDUCERS                                       9**
Radiation and its Measurements: Emissivity, Methods of sensing Temperatures: Photoconductors, Photovoltaic sensors – Single colour Pyrometers, Fiber Optic Sensors: Basic Principle and Design – Fiber optic strain sensor – Fiber optic temperature sensor – Components for Optical Fiber sensors – Biomedical Applications.

**UNIT 5   SMART SENSORS                                                              9**
Introduction, Primary Sensors, Excitation, Amplification, Filters, Converters, Compensations, Data Communication - Standards for Smart Sensor Interfacing - Features of Smart Sensors – Architecture of a Smart sensor - Evolution and applications of Smart Sensor.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.    Chandran Karunakaran Kalpana Bhargava Robson Benjamin,Biosensors and Bioelectronics, 1st Edition, Hardcover ISBN: 9780128031001, Imprint: Elsevier, Published Date: 29th July 2015.
2.    D.V.S.Murthy, Transducers and Instrumentation, Second Edition, PHI Learning Private Limited, 2012.

**REFERENCES:**
1.    KeithBrindley,Sensors&Transducers, HeinemannNewnes, GreatBritain,1988
2.    Harry Thomas, Handbook of Bio medical Instrumentation, Reston, Virginia 2000.
3.    XuejiZhan , Electrochemical Sensors, Biosensors and their Biomedical Applications 1st Edition, Elsevier Science Publishing Co, 2008.
4.    M. G. Joshi, Transducers for Instrumentation, Lakshmi Publications (P) Limited, New Delhi, 2005.

**e-RESOURCES:**
1.  https://www.scienceabc.com/innovation/what-are-biosensors.html
2.  https://wisilica.com/company/smart-sensors-its-applications-benefits-and-working/

**Course Outcomes: Upon completion of the course, students will be able to:**
1.  1. Describe the principle, components and classification of Biosensors.
2.  2. Identify and explain the fabrication of Electrochemical and Immunosensors.
3.  3. Develop an appropriate protocol for identifying biomarkers using enzymatic biosensors.
4.  4.Explain the Principle and applications of Optical transducers and Fiber optic transducers.
5.  5. Illustrate the features and applications of Smart sensors.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1    | 2    | 3    | 2    |      |      | 2    |      |      |      | 2     |       | 2     | 3     |       |
| CO 2    | 2    | 3    | 2    |      |      | 2    |      |      |      | 2     |       | 2     | 3     |       |
| CO 3    | 2    | 3    | 2    |      |      | 2    |      |      |      | 2     |       | 2     | 3     |       |
| CO 4    | 2    | 3    | 2    |      |      | 2    |      |      |      | 2     |       | 2     | 3     |       |
| CO 5    | 2    | 3    | 2    |      |      | 2    |      |      |      | 2     |       | 2     | 3     |       |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BME12 | RADIOLOGICAL EQUIPMENT | L | T | P | C |
|---------|-----------------------|---|---|---|---|
|         |                       | 3 | 0 | 0 | 3 |

**Pre-requisites: 22BMT51- Medical Instrumentation - I**

**Preamble**
This course provides an introduction to biomedical imaging and modern imaging modalities. It enables students to develop an understanding of the physics principles underlying these imaging techniques and an awareness of their clinical applications.

**UNIT 1   MEDICAL X-RAY EQUIPMENT                                               9**
History of X-ray- generation & Production, Nature of X-Ray, Xray Equipment -block diagram-ray tube, collimator, bucky grid, Power supply. Digital Radiography- discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes- fluoroscopy – Digital subtraction Angiography, Mammography.

**UNIT 2   COMPUTER TOMOGRAPHY                                                   9**
Principles of tomography, CT Generations,-Source and Detectors in CT-Viewing systems- spiral CT scanning – Ultra fast CT scanners- Image reconstruction techniques- Filtered Back Projection reconstruction and iterative method

**UNIT 3   MAGNETIC RESONANCE IMAGING                                          9**
Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave rotation and precession – bulk magnetization -NMR pulse sequences –T1 & T2 relaxation process- Block Diagram approach of MRI system- system magnet (Permanent, Electromagnet and Super conductors)- generations of gradient magnetic fields-Radio Frequency coils (sending and receiving)-shim coils- Electronic components.

**UNIT 4   NUCLEAR MEDICINE SYSTEMS                                             9**
Radio Isotopes- alpha, beta, and gamma radiations- Radio Pharmaceuticals- Radiation detectors –gas based detectors-ionization chambers, proportional counter and GM counter - scintillation Detectors-Gamma camera- Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit-pulse height analyzer -Principles of SPECT and PET.

**UNIT 5   RADIATION THERAPY AND RADIATION SAFETY                              9**
Radiation therapy – linear accelerator, Telegamma Machine,-Recent Techniques in radiation therapy - 3DCRT – IMRT – IGRT and Cyber knife- radiation measuring instruments-Dosimeter, film badges, Thermo Luminescent dosimeters- electronic dosimeter- Radiation protection in medicine.

**Lecture : 45, Total : 45**

**TEXT BOOKS:**
1. Steve Webb, "The Physics of Medical Imaging", Taylor & Francis, Newyork, 2010.
2. R.Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002.
3. Faiz M. Khan, John P. Gibbons, "The Physics of Radiation Therapy", WoltersKulwer, Philadelphia, 2010.

**REFERENCES:**
1. Stewart C. Bushong, "Radiologic Science for Technologists", Elsevier Mosby, 2004.
2. Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine" Third edition Springer, 2006.
3. David J Dowsett, Patrick A Kenny and R Eugene Johnston, "The physics of Diagnostic Imaging", Chapman & Hall Medical, 1998.
4. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, " Medical physics and Biomedical engineering", Institute of Physics Publishing, Bristol and Philadelphia, 1999.

**e-Resources:**
1. Edx, https://courses.edx.org/courses/UQx/BIOIMG101x, "Introduction to Biomedical Imaging", Prof. Dr. Graham Galloway, The University of Queensland.
2. https://usuhs.libguides.com/c.php?g=154224&p=1012642   [Radiology Resources: eBooks]


**Course Outcomes:** Upon completion of this course, students will be able to:
CO1   Describe the physics principles involved in X ray tube based planar imaging equipment.
CO2   Distinguish the generations of Computed tomography scanner in terms of image acquisition and image reconstruction method.
CO3   Articulate the functioning of Magnetic resonance imaging equipment used for visualizing portions in the body.
CO4   Explain the working of imaging equipment used in nuclear medicine department.
CO5   Discuss radiation safety issues in the operation of Radiotherapy equipment's.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 |   |   | 2 |   |   |   | 2 |   | 2 | 2 |   |
| CO 2 | 2 | 3 | 2 |   | 2 | 2 |   |   |   | 2 |   | 2 | 2 |   |
| CO 3 | 2 | 3 | 2 |   |   | 2 |   |   |   | 2 |   | 2 | 2 |   |
| CO 4 | 2 | 3 | 2 |   |   | 2 |   |   |   | 2 |   | 2 | 2 |   |
| CO 5 | 2 | 3 | 2 |   | 2 | 2 |   |   |   | 2 |   | 2 | 2 |   |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| | **L** | **T** | **P** | **C** |
|---|---|---|---|---|
| **22BME13**    **WEARABLE SYSTEMS** | **3** | **0** | **0** | **3** |

**Pre-requisites: Nil**

**Preamble**
To peruse sensors principles with the technological difficulties and their application in wearable Systems.

**UNIT 1    SENSORS FOR WEARABLE SYSTEMS                                                      9**
Need for wearable systems - Sensors for wearable systems - Inertia movement sensors - Respiration activity sensor - Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor – GSR - Radiant thermal sensor - Wearable motion sensors - CMOS -Based Biosensors- E-Textiles, Bio compatibility

**UNIT 2     ENERGY HARVESTING FOR WEARABLE DEVICES                                     9**
Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation - Hybrid thermoelectric photovoltaic energy harvests - Thermopiles - Portable and wearable energy harvester and hybrid energy harvester - Portable and wearable self-powered harvesting system.

**UNIT 3    WIRELESS COMMUNICATION TECHNOLOGIES FOR WEARABLE
SYSTEMS                                                                                                              9**
Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges – System security and reliability, BAN Architecture – Introduction, Wireless communication techniques - Ultra wideband (UWB) technology for wearables – Real-time location tracking and positioning for wearables.

**UNIT 4    ERGONOMICS FOR WEARABLE BODY SENSOR NETWORKS                       9**
Human factors and ergonomics principles - wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption – Health and safety considerations.

**UNIT 5    APPLICATIONS OF WEARABLE SYSTEMS                                                 9**
Wearable Technology in healthcare - Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural  recording, Gait analysis, Sports Medicine, Smart Fabrics.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**
1.  Annalisa Bonfiglio, Danilo De Rossi ,"Wearable Monitoring Systems", Springer, 2011.
2.  Sandeep K.S. Gupta,Tridib Mukherjee,Krishna Kumar Venkatasubramanian, "Body Area Networks Safety, Security, and Sustainability," Cambridge University Press, 2013.

**REFERENCES:**
1.  Hang,Yuan-Ting,"wearable medical sensors and systems",Springer-2013
2.  Mehmet R. Yuce,Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation and Applications”, Pan Stanford Publishing Pvt.Ltd, Singapore, 2012
3.  Vaibhavi Bhelkar- D.K Shedge, “Different types of wearable sensors and health monitoring systems”

**e-RESOURCES:**
1.  https://www.youtube.com/watch?v=P7YWJuhVM1Q, ”Wearable Electronic Textiles‟, Prof. Volakis, Chair Professor of Electrical Engineering at Ohio State University.
2.  https://www.youtube.com/watch?v=ePEHZyjYtWk, MIT Researchers Create A Wearable Wireless Electronic Skin

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Identify the wearable sensors and its need for wearable systems.
CO2   Interpret the energy requirement for wearable system.
CO3   Manipulate the need for wireless communication techniques.
CO4   Predict the wearability issues related to Body Sensor Networks.
CO5   Illustrate the applications of wearable systems

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| **CO 2** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| **CO 3** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| **CO 4** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| **CO 5** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME14**                    **HUMAN ASSIST DEVICES**                    **L   T   P   C**
                                                                          **3   0   0   3**

**Pre-requisites: 22BMT22- Human Anatomy and Physiology, 22BMT51-MI-I, 22BMT62-MI-II**

**Preamble**
To impart the knowledge on electromechanical units which will assist and restore normal functional ability of particular organ that is defective temporarily or permanently.

**UNIT 1   HEART LUNG MACHINE AND ARTIFICIAL HEART                    9**
Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.

**UNIT 2    CARDIAC ASSIST DEVICES                    9**
Assisted through Respiration, Right and Left Ventricular Bypass Pump, Auxiliary Ventricle, Open Chest and Closed Chest type, Intra Aortic Balloon Pumping, Prosthetic Cardiac Valves, Principles of External Counter Pulsation techniques, Extracorporeal Membrane Oxygenation(ECMO).

**UNIT 3   RESPIRATORY DEVICES                    9**
Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters, Nebulizers, CPAP/ BiPAP machines.

**UNIT 4   AUDITORY AND SPEECH ASSIST DEVICES                    9**
Types of Deafness, Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids. Vestibular implants, Voice synthesizer, speech trainer.

**UNIT 5   VISUAL AIDS                    9**
Ultrasonic and Laser Canes,Intraocular Lens - Monofocal,Multifocal, Toric Lenses. Braille Reader, Tactile Devices for Visually Challenged, Text to Voice Converter, Screen Readers.

**Lecture : 45, Tutorial : 0, Total : 45**
**TEXT BOOKS:**
1.  John G.Webster "Encyclopedia of medical devices and instrumentation" Vol.II, III, IV,V , Wiley – Interscience.
2.  D.S. Sunder, "Rehabilitation Medicine", 3rd Edition, Jaypee Medical Publication, 2010.

**REFERENCES:**
1.  Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006
2.  RORY A.COOPER, HISAICHI, OHNABE, DOUGLAS A HOBSON, "An introduction to Rehabilitation Engineering", CRC Press, 2006.
3.  Paul A. Iaizzo "Hand book of cardiac Anatomy, Physiology and Devices" Second Edition, Springer.

**e-Resources:**
1.  https://www.youtube.com/watch?v=1mu6C288ZQ8, "Mechanical circulatory support" by Dr.Arie Blitz MD – Harrington – McLaughlin heart and vascular institute, University hospitals.
2.  https://www.youtube.com/watch?v=fKlY2SKi_dk," Hemodialysis" Dr.Kevin Nash , Well bound of Evanston in Skokie, Illinois.
**Course Outcomes:** Upon completion of this course, students will be able to:
 CO1   Explain the principles of Heart Lung Machine and Artificial Heart.
 CO2   Interpret the various mechanical techniques that will help in assisting the heart functions.

CO3    Infer the various respiratory devices to overcome the gas exchange phenomena.
CO4    Indicate the devices to be used for speech and hearing loss.
CO5    Discuss the visual sensory impairments and its substitutions.
.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 3 | 3 | - | - | - | 1 | - | - | 1 | - | 2 | 3 | - |
| CO 2 | 3 | 3 | 3 | - | - | - | 1 | - | - | 1 | - | 2 | 3 | - |
| CO 3 | 3 | 3 | 3 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| CO 4 | 3 | 3 | 3 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| CO 5 | 3 | 3 | 3 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME15**          **OPHTHALMOLOGY AND DENTISTRY EQUIPMENTS**          L    T    P    C
                                                                        3    0    0    3

**Pre-requisites: Radiological Equipments, Medical Instrumentation-I, Medical Instrumentation II, Biomaterials and artificial Organs**

**Preamble**
The modern equipments used in dentistry and ophthalmology makes treatment easier. The knowledge helps to support diagnostic and therapeutical purposes.

**UNIT 1    Ophthalmic Instruments                                              9**
Indirect Ophthalmoscope - Direct Ophthalmoscope- Slit Lamp: Haag-Streit. -Photo-slit lamp-Lensometer. Lens gauge –Tonometer - Fundus Camera- External eye photography- Auto-refractometer – Haploscope, Perimetry- Principles of OCT

**UNIT 2    Ophthalmic technique                                               9**
Head posture and its significance-Specular Microscopy- Squint- Keterometer - Retinoscope Exophthalmometer -Dark adaptometer -Paediatric Refraction - eye bank specular-  Rehabilitation of the visually handicapped.

**UNIT 3    Clinical Ophthalmology                                             9**
Congenital Glaucoma - Scleral Buckling- Paralytic Squint- Retinal Hole- Occuloplasty-  Refractive Surgery-  Keratitis-  Non-proliferative Diabetic Retinopathy treatment-  RelexSmile Surgery-Enucleation - Evisceration

**UNIT 4    DENTAL RADIOGRAPHY                                                 9**
Foundation of radiography,-Discovery of X-radiation -Radiation physics -The Dental x-ray machine, Dental chair system- Lighting system -Trolley or delivery system -Tumbler and spittoon system- spare parts.

**UNIT 5    DENTISTRY INSTRUMENTATION                                          9**
Lasers in Dentistry -Dental equipment repair and maintenance- Handpieces,-Burs and rotary attachment-Tooth numbering system -Infection control in dentistry-Instruments used in Periodontal Procedures & Basic Restoration procedures.

                                                                  **Lecture : 45, Total : 45**
**TEXT BOOKS:**
  1.    Abhiyan Kumar , Anita Panda ," Handbook of Opthalmic Instruments "CBS Publishers & Distributors,1st Edition, 2017
  2.     Linda Bartolomucci Boyd," Dental Instruments", Elsevier,Edition 8, 2024.

**REFERENCES:**
  1.    Nikolai V. Tkachenko, "Optical Spectroscopy: Methods and Instrumentations", Elsevier, 5th Edition, 2006..
  2.    Dental equipment repair and technology. University of Michigan library, United States of America
  3.    B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, " Medical physics and Biomedical engineering", Institute of Physics Publishing, Bristol and Philadelphia, 1999.

**e-Resources:**
  1.    https://drive.google.com/file/d/1ZfnUB-lVXudr27-N1oE5OZxD1R2BqynT_/view     Dr. Pranesh Balasubramaniam and Dr. Subhashini Manoharan, ophthalmologists.
  2.    https://www.celegence.com/clinical-evaluation-dental-medical-devices-notified-body-assessments-webinar/ Pratibha Mishra, Medical Device services.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Explain about the Ophthalmic Instruments
CO2    Discuss about he techniques followed in opthalmology
CO3    Explains about the clinical practices under ophthalmology department.
CO4    Deals about the imaging technique of dentistry.
CO5    Explains about the instruments used for dental purposes.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | 2 | | | | | | | 1 | | 1 | 3 | |
| **CO 2** | 2 | 3 | 2 | | | | | | | 1 | | 1 | 3 | |
| **CO 3** | 2 | 3 | 2 | | | | | | | 1 | | 1 | 3 | |
| **CO 4** | 2 | 3 | 2 | | | | | | | 1 | | 1 | 3 | |
| **CO 5** | 2 | 3 | 2 | | | | | | | 1 | | 1 | 3 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME16**                    **SURGICAL ASSIST DEVICES**                    **L    T    P    C**
                                                                              **3    0    0    3**
**Pre-requisites: Nil**

**Preamble**
This course provide the students to acquire an adequate knowledge of the physiological systems of the human body and relate them to the parameters that have clinical importance and to understand the fundamental principle and working of the critical care and operation theatre equipments involved in the measurement.

**UNIT 1    ICU EQUIPMENT                                                               9**
Suction apparatus- Different types- ICU ventilators.-Automated drug delivery systems- Infusion pumps-components of drug infusion system- closed loop control infusion system- implantable infusion system-BMD Measurements.

**UNIT 2    CRITICAL CARE EQUIPMENT                                                     9**
Hemo dialysis Machine – Different types of Dialyzers- Membranes- Machine controls and measurements- Peritoneal Dialysis-Heart Lung Machine – Different types of oxygenators- peristaltic pumps- Incubators.

**UNIT 3    OPERATION THEATRE EQUIPMENT                                                 9**
Craniotomy- Electrosurgical Machines (ESU)- electrosurgical analyzers- surgical aspirator- Instruments for operation-Anesthesia Equipment – Humidification- Sterilization aspects- Sterilizers, Chemical, Radiation- Steam for small and large units- Scavenging system- Cryogenic Equipment - Anesthesia gas-Anesthesia gas monitor- surgical microscope

**UNIT 4    ENDOSCOPY                                                                   9**
Endoscopy Basic Principle –  Imaging Systems –  System components and functions-Types of endoscopes –  Video Endoscopes – Accessories– Maintenance– Endoscopy Processing room requirements– Medical Application.

**UNIT 5    ROBOTICS IN MINIMALLY INVASIVE SURGERY                                      9**
Introduction- Minimally invasive surgery and robotic integration- Development of surgical robotics systems- Perceptual docking for synergistic control-Robotics for neurosurgery, General Surgery, Orthopedics, Gynecology, ENT Surgery and Cardiac Interventions

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.  John G. Webster, "Medical Instrumentation Application and Design", Wiley India Pvt. Ltd, New Delhi, 4th edition, 2015
2.  Khandpur.R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3rd edition, 2014.
3   Abrahim Katzir , "Lasers and Optical Fibers in Medicine",Academic press, 2012.
4   Gerd Keiser, "Optical Communication Essentials", The McGraw-Hill Companies,2003.

**REFERENCES:**
1.  Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice Hall of India, New Delhi, 2nd edition, 2015
2.  Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012
3.  Jerry L. Prince and Jonathan M. Links, "Medical Imaging Signals and Systems", Pearson Education Inc., London, II Edition, 2014.
4.  Paul Suetens, "Fundamentals of Medical Imaging", Cambridge University, 3rd Edition, 2017.

**e-Resources:**
1. https://www.youtube.com/watch?v=1atOc5Jvr-A&t=14s/ " Development of Assistive Technology for persons with Disabilities",Prof.Indumathi Rao,CBR network
2. https://youtu.be/8N7bs3X3ODg?si=m1MOkA3Jope9elaq/ "How to test infusion and syringe pumps using IDA -5", Fluke Biomedical, 2021.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1   Perform continuous monitoring and Identify the need of Infusion pump & syringe pumps.
CO2   Articulate the functions of dialyzer principle and other critical care equipments.
CO3   Express the basics of operation theatre equipment's and special diagnostic devices its application in medicine
CO4   Describe the principles of endoscopy.
CO5   Outline the importance of robotics in minimally invasive surgery.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | 2 | | 1 | 2 | | | | 2 | | 2 | | |
| **CO 2** | 2 | 3 | 2 | | 1 | 2 | | | | 2 | | 2 | | |
| **CO 3** | 2 | 3 | 2 | | 1 | 2 | | | | 2 | | 2 | | |
| **CO 4** | 2 | 3 | 2 | | 1 | 2 | | | | 2 | | 2 | | |
| **CO 5** | 2 | 3 | 2 | | 1 | 2 | | | | 2 | | 2 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME17**                          **MEDICAL DEVICE DESIGN**                    **L    T    P    C**
                                                                                **3    0    0    3**

**Pre-requisites : Electronic Circuits, Biomedical Instrumentation**

**Preamble**
To understand the medical device standards, requirements and design procedure of medical devices and to describe about the design realization, validation and verification of various medical devices

**UNIT 1    NEEDS FINDING AND CONCEPT GENERATION                              9**
Strategic Focus – observation and problem identification – Need statement development. Ideation and Brainstorming – concept screening, concept selection: intellectual property basics – reimbursement basics – business models – prototyping – final concept selection. Safety and Risk Management - Tools, Documents and Deliverables

**UNIT 2    MEDICAL DEVICES STANDARDS AND REQUIREMENTS                        9**
FDA, Medical devices classification, Medical Device regulation, ISO13485, ISO 14971, IEC60601-1, IEC 62304. Reliability, Concept of failure, Product Design and Development Process.

**UNIT 3    TROUBLESHOOTING OF MEDICAL EQUIPMENTS                             9**
Hardware Design, Hardware Risk Analysis, Design and Project Metrics, Design for Six Sigma, Software Design, Software Coding, Software Risk Analysis, Software Metrics.

**UNIT 4    LIFE CYCLE MANAGEMENT OF MEDICAL EQUIPMENT                        9**
Basis and Types of Testing, Hardware Verification and Data Analysis, Software Verification and Data Analysis.

**UNIT 5   RELIABILITY IN MEDICAL DEVICES                                    9**
Transfer to Manufacturing, Hardware Manufacturing, Software Manufacturing, Configuration Management, Intellectual Property-Copy Rights-Trademarks-Trade Secrets. Case Study.

                                                                            **Total : 45**
**TEXT BOOKS:**
1.      Zenios, Makower and Yock, ―Biodesign – The process of innovating medical technologies, Canbridge University Press, 2009
2.      Theodore R. Kucklick , The Medical Device R&amp;D Handbook, Second Edition, CRC Press, 2012
3.      Peter Ogrodnik,Medical Device Design Innovation from Concept to Market, Elsevier, 2013

**REFERENCES:**
1.      Richard C. Fries and Marcel Dekker AG, Handbook of Medical Device Design,2ndedition, 2005.
2.      Gail Baura, Medical Device Technologies: A Systems Based Overview Using Engineering, Elsevier science, 2012.
3.      Matthew Bret Weinger, Michael E. Wiklund, Daryle Jean Gardner-Bonneau'Handbook of Human Factors in Medical Device Design',CRC press,2010.

**e-RESOURCES:**
1.      https://searchworks.stanford.edu/view/13462530
2.      https://www.sciencedirect.com/book/9780123919427/medical-device-design#

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Define the medical devices standards and requirements.
CO2    Summarize the concept of medical device development
CO3    Recall the engineering design and project metrics

CO4    Demonstrate the testing and validation of medical equipment.
CO5    Interpret the various design transfer and manufacturing methods

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |
| CO 2 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |
| CO 3 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |
| CO 4 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |
| CO 5 | 2 | 2 | 2 | 2 | | 2 | | | 1 | 2 | | 1 | 3 | 2 |

**1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).**

**22BME21**                    **SPEECH PROCESSING**                    **L   T   P   C**
                                                                       **3   0   0   3**

**Pre-requisites: 22BMT31-Signals and Systems**

**Preamble**
This course highlights the central role of speech processing in modern speech communication research and applications. It presents a comprehensive overview of digital speech processing that ranges from the basic nature of the speech signal, through a variety of speech analysis, speech modeling and automatic synthesis and recognition of speech signals.

**UNIT 1   BASIC CONCEPTS                                                            9**
Speech Fundamentals – Speech production: Mechanism of speech production – Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – Acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

**UNIT 2   SPEECH ANALYSIS                                                           9**
Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures– mathematical and perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths – Phase Vocoder – Channel Vocoder.

**UNIT 3   SPEECH MODELLING                                                          9**
Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

**UNIT 4   SPEECH RECOGNITION                                                        9**
Large Vocabulary Continuous Speech Recognition: Architecture of large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent sub-word units; Applications and present status.

**UNIT 5   SPEECH SYNTHESIS                                                          9**
Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

                                                    **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
  1.   Lawrence Rabiner, Biing-Hwang Juang and Yegnararayana, "Fundamentals of Speech Recognition", Pearson Education, First Edition, 2008.
  2.   Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, Second Edition 2013.

**REFERENCES:**
  1.   Thomas F Quatieri, "Discrete-Time Speech Signal Processing – Principles and Practice", Pearson Education, 2004.
  2.   Ben Gold and Nelson Morgan, "Speech and audio signal processing, Processing and Perception of Speech and Music", Wiley- India Edition, 2006.
  3.   Lawrence R. Rabiner,, Ronald W. Schafer, "Digital Processing of Speech Signals", Prentice-Hall, 1978.
  4.   Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, 1997.

**e-Resources:**
1. http://freevideolectures.com/Course/2504/ELEC9344-Speech-and-Audio-Processing, "Introduction to speech processing", Prof. E. Ambikairajah, The University of New South Wales.
2. http://www.nptelvideos.in/2012/12/digital-voice-and-picture-communication.html,"Lecture Series on Digital Voice and Picture Communication", Prof.S. Sengupta, Department of lectronics and Electrical Communication Engg ,IIT Kharagpur.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Elaborate the production and classification of speech signal processing using articulatory and acoustic phonetics.

CO2    Analyze the speech signal using feature extracting and pattern comparison techniques.

CO3    Evaluate the speech processing systems using deterministic and stochastic process models.

CO4    Analyze the continuous speech recognition system using its architecture, acoustic and language models.

CO5    Analyze the speech synthesis using Waveform synthesis techniques.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 2 | 1 | 1 | | | | | 1 | 1 | | 1 | | |
| CO 2 | 3 | 2 | 1 | 1 | | | | | 1 | 1 | | 1 | | |
| CO 3 | 3 | 2 | 1 | 1 | | | | | 1 | 1 | | 1 | | |
| CO 4 | 3 | 2 | 1 | 1 | | | | | 1 | 1 | | 1 | | |
| CO 5 | 3 | 2 | 1 | 1 | | | | | 1 | 1 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME22**                          **BIOMETRIC SYSTEMS**                          **L   T   P   C**
                                                                                    **3   0   0   3**

**Pre-requisites: 21BMT32-SENSORS AND MEASUREMENTS**

**Preamble**
To impart the knowledge on design of biometric systems and the underlying trade-offs and to enable the students to understand the technologies in fingerprint, iris, face and hand geometry.

**UNIT 1    INTRODUCTION TO BIOMETRICS                                            9**
Introduction And History - Biometric Characteristics - Types Of Biometric Traits - General Architecture Of Biometric Systems - Accuracy In Biometric Systems- False Match Rate, False Non Match Rate, Failure To Enroll Rate, Derived Metrics – Taxonomy Of Application Environment - Application Of Biometrics.

**UNIT 2    FINGERPRINT TECHNOLOGY                                                9**
History Of Fingerprint Biometrics – Fingerprint Sensors – Features Of Fingerprints – Fingerprint Recognition Systems – Preprocessing, Minutia Extraction, Post Processing – Minutiae Matching – Advantage And Disadvantage Of Fingerprint Biometrics – Application Of Fingerprints.

**UNIT 3    FACE RECOGNITION AND HAND GEOMETRY                                    9**
Introduction And Background -  Design Of Face Recognition System – Neural Network For Face Recognition- Training Of Neural Networks – Face Detection In Video Sequences – Face Recognition Methods – Eigen Images ,Morphological Neural Networks, Contractive Transformation – 3-D Model-Based Method For Face Recognition – Advantage And Disadvantage Of Face Recognition – Basics Of Hand Geometry – Image Capturing, Hand Segmentation, Feature Extraction. Application Of Face Recognition And Hand Geometry.

**UNIT 4    IRIS RECOGNITION                                                      9**
Introduction - Anatomical And Physiological Underpinnings – Design Of Iris Recognition System- Image Acquisition, Image Preprocessing – Iris Segmentation Method – Canny Edge Detection, K-Means Clustering Algorithm, Iris Segmentation Algorithm – Determination Of Iris Region – Pupil Removal And Dilation – Advantage And Disadvantage Of Iris Biometrics – Application Of Iris Biometrics.

**UNIT 5    MULTIMODAL BIOMETRICS  AND BIOMETRIC FUTURE SCOPE                     9**
Introduction – Basic Architecture Of Multimodel Biometrics – AADHAAR: An Application Of Multimodel Biometrics – Scope And Future Market Of Biometrics – Role Of Biometrics In Enterprise Security – Role Of Biometrics In Border Security – Smart Card In Biometric Authentication – RFID Biometrics – DNA Biometrics.

                                                    **LECTURE : 45, TUTORIAL : 0, TOTAL : 45**

**TEXT BOOKS:**
1.      G.R.Sinha, SandeepB.Patel, "Biometrics:Concepts and Applications", Wiley Publicatios, 1st edition,2013.
2.      James Wayman, Anil Jain, DavideMaltoni, Dario Maio, "Biometric Systems, Technology Design and Performance Evaluation", Springer, 2005.

**REFERENCES:**
1.      Arun A Ross, KarthikNandakumarand Anil K.Jain, "Handbook of Multibiometics", Springer,2006.
2.      John Vacca, "Biometric Technologies And Verification Systems"  Butterworth Heinemann, 2007.
3.      Chollet G ,"Guide To Biometric Reference Systems And Performance Evaluation", SPRINGER, 2007.

**e-Resources:**
1.  http:// nptel/biometrics- iit-kanpur, "Biometric Systems", Prof. PhalguniGupt , IIT, khanpur.
2.  https://archive.nptel.ac.in/content/syllabus_pdf/106104119.pdf, "Biometrics", Prof. Phalguni Gupta Department of Computer Science and Engineering ,IIT Kanpur.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    **Infer** knowledge on biometric authentication system and applications of biometric systems.

CO2    **Explain** the functional description of fingerprint enhancement, feature extraction, classification and matching technique.

CO3    **Discuss** about various classifiers, algorithm, feature extraction of face and hand geometry recognition.

CO4    **Describe** about iris recognition.

CO5    **Identify** the functions of multimodal biometrics and future scopes of biometrics.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 1 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 3 | - |
| **CO 2** | 1 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 3 | - |
| **CO 3** | 1 | 3 | - | - | 2 | - | - | - | - | - | - | 2 | 3 | - |
| **CO 4** | 2 | 3 | - | - | 2 | - | - | - | - | - | - | 1 | 3 | - |
| **CO 5** | 2 | 3 | - | - | - | - | - | - | - | - | - | 1 | 3 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME23**                    **COMPUTER VISION**                    L   T   P   C
                                                                      3   0   0   3

**Pre-requisites: NIL**

**Preamble**
To learn and understand the concepts of three-dimensional image formation and motion analyses of medical images.

**UNIT 1    IMAGE FORMATION & PROCESSING                            9**
Introduction - Photometric image formation - Point operators - Linear filtering - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization – Application.

**UNIT 2    SEGMENTATION AND FEATURE ALIGNMENT                      9**
Feature detection: Points and patches - Edges – Lines. Segmentation - Active contours: Snakes, Scissors - Split and merge: Region splitting and Merging - Mean shift and mode finding. Feature-based alignment: 2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration

**UNIT 3    STRUCTURE AND MOTION                                    9**
Two-frame structure from motion - Bundle adjustment - Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion.

**UNIT 4    3D RECONSTRUCTION                                       9**
Active range finding - Surface representations - Point-based representations - Volumetric representations - Model-based reconstruction. View interpolation - Layered depth images. Recognition: Object detection - Face recognition - Instance recognition - Category recognition

**UNIT 5    APPLICATIONS OF MEDICAL IMAGE                           9**
Medical image Segmentation - Gesture Recognition, Motion Estimation and Object Tracking. Case study: Computer Vision for Predictive Analytics and Therapy for Dermatology.

**Lecture: 45, Tutorial: 0, Total : 45**

**TEXT BOOKS:**
1.   E. R. Davies, ―Computer & Machine Vision, Fourth Edition, Academic Press, 2012.
2.   David Forsyth and Jean Ponce – Computer Vision – A Modern Approach, Pearson (November 21st 2011) - Copyright © 2012.

**REFERENCES:**
1.   R. Szeliski, - Computer Vision: Algorithms and Applications‖, Springer 2011.
2.   Simon J. D. Prince, - Computer Vision: Models, Learning, and Inference‖, Cambridge University Press, 2012.
3.   E. R. Davies, "Computer Vision Principles, Algorithms, Applications, Learning" Academic Press Inc - 2017

**e-Resources:**
1.   Computer Vision and Image Processing - Fundamentals and Applications - Course (nptel.ac.in), Prof. M. K. Bhuyan, IIT Guwahati.
2.   Modern Computer Vision - Course (nptel.ac.in)  Prof. A.N. Rajagopalan, IIT Madras
3.   Computer Vision - Course (nptel.ac.in) Prof. Jayanta Mukhopadhyay,  IIT Kharagpur

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1   Demonstrate basics of image acquisition and processing.
CO2   Analyze the various segmentation process.
CO3   Interpret the motion of image frames.

CO4    Analyze 3D image reconstruction and recognition.
CO5    Identify the applications of related techniques.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 2 | 3 | - | - | - | - | - | - | 1 | - | 2 | - | - |
| **CO 2** | 2 | 2 | 3 | - | - | - | - | - | - | 1 | - | 2 | - | - |
| **CO 3** | 2 | 2 | 3 | - | - | - | - | - | - | 1 | - | 2 | - | - |
| **CO 4** | 2 | 2 | 3 | - | - | - | - | - | - | 1 | - | 2 | - | - |
| **CO 5** | 2 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME24**                 **VIRTUAL INSTRUMENTATION**               L  T  P  C
                                                                       3  0  0  3

**Pre-requisites:22BMT62- Medical Instrumentation II**

**Preamble:**
This course deals with fundamentals, Lab VIEW programming concepts of virtual instrumentation for configuring data acquisition system and its applications in control and instrumentation ,signal processing and image processing.

**UNIT 1      BASICS OF VIRTUAL INSTRUMENTATION                             9**
Introduction- Virtual Instrument versus Traditional Instrumen – Advantages- Comparison of Graphical Programming and Textual Programming-  LabVIEW environment: Front Panel, Block Diagram, Data Flowtechniques.

**UNIT 2      PROGRAMMING PRINCIPLES                                        9**
Creating simple VI- Data types-Numeric, String, Boolean - Mechanical Operation of Boolean, Arrays, Clusters, Waveforms graphs and waveform charts - Array Functions- Cluster Functions- Debugging Techniques- Documentation- Context Help Window-Sub VI-Creation.

**UNIT 3      LOOPS, STRUCTURES AND OPERATING SYSTEM                        9**
FOR – WHILE loop - Case, Sequence, event structures- Formula nodes- local and global variables- Operating System Requirements-Current Trends on PC based instrumentation – Analog and Digital Interfaces- Modular Instruments.

**UNIT 4      DATA ACQUISITION SYSTEM                                       9**
Instrument control – GPIB – VISA – instrument drivers-serial port communication. Data Acquisition: Review of Transducer and Signal conditioning, DAQ hardware- Analog inputs – Analog outputs- Digital I/O-  DAQassistant and configurations.

**UNIT 5      APPLICATIONS OF VIRTUAL INSTRUMENTATION                       9**
Signal Processing and Analysis- Image acquisition and processing–Biomedical Kit–Motion control– Control Design and Simulation Tools –Simulation Interface Toolkit –Embedded Module –GSD Applications.

                                                        **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.    Jovitha Jerome "Virtual Instrumentation using labview" Prentice Hall of India, NewDelhi, 2010.
2.    Sanjay Gupta and Joseph john " Virtual Instrumentation using labview principles and practices of graphical programming"Tata McGraw Hill Education Private Limited, Second Edition 2017

**REFERENCES:**
1.    Gary W.Johnson and Richard Jennings, "LabVIEW Graphical Programming", McGraw Hill, 4th Edition, New
      York, 2011.
2.    Jeffrey Travis and Jim Kring, "LabVIEW for everyone", 3rd edition, Dorling Kindersley, 2009.
3     John Essick "Hands-On Introduction to LabVIEW for Scientists and Engineers" illustrated, OUP USA, 2021
4     Lisa K. Wells " LabVIEW: User's Guide", Prentice-Hall 1995.

**e-Resources:**
1.    https://youtu.be/O9b7ezt0O5s/ "Introduction to Virtual Reality", Dr Ramesh C Sharma,Dr.B.R Ambedkar UniversityNew Delhi

2. https://www.youtube.com/watch?v=MGdnHQJbPuw " Virtual Education" ,Prof. Maitreyee Dutta and Prof. K G Srinivasa, NITTTR, Chandigarh

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Explain the graphical programming and textural programming in virtual instrumentation using LabVIEW Environment. |
| CO2 | Demonstrate the programming principles in virtual instrumentation using LabVIEW |
| CO3 | Develop the programming in LabVIEW using loops and structures. |
| CO4 | Develop the configuration of data acquisition system using the Analog and digital hardwares. |
| CO5 | Apply virtual instrumentation concept for signal processing, image processing, mechanical and embedded system applications. |

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 3 | 2 | | | | 1 | | | 1 | 2 | 2 | | |
| CO 2 | 2 | 3 | 2 | | | | 1 | | | 1 | 2 | 2 | | |
| CO 3 | 2 | 3 | 2 | | | | 1 | | | 1 | 2 | 2 | | |
| CO 4 | 2 | 3 | 2 | | | | 1 | | | 1 | 2 | 2 | | |
| CO 5 | 2 | 3 | 2 | | | | 1 | | | 1 | 2 | 2 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME25**                    **HEALTHCARE ANALYTICS**                    **L  T  P  C**
                                                                          **3  0  0  3**

**Pre-requisites:**

**Preamble**
Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. This course provides a broad introduction to machine learning and deep learning.

**UNIT 1    INTRODUCTION TO MACHINE LEARNING                                    9**
Machine learning vs Traditional learning, Seven steps of machine learning, Applications of machine learning, Supervised learning, regression, classification, Unsupervised learning, Clustering, Reinforcement learning, Advantages and Disadvantages of Machine learning.

**UNIT 2    SUPERVISED LEARNING ALGORITHMS                                      9**
Introduction to Supervised learning, Naive Bayes Classifier Algorithm, Decision Tree Algorithm, K-Nearest Neighbour Algorithm, SVM Algorithm, Random Forest Algorithm. Case study: Breast cancer detection with SVM and KNN.

**UNIT 3    UNSUPERVISED LEARNING ALGORITHMS                                    9**
Introduction to Unsupervised learning, K-means Clustering, Hierarchical Clustering, Association rule learning, Apriori Algorithm, Frequent Pattern (FP) Growth Algorithm, Gaussian Mixture Models (GMMs). Case study : Diabetes Prediction using K-means Clustering

**UNIT 4    INTRODUCTION TO DEEP LEARNING                                       9**
Machine Learning vs Deep Learning, Representation Learning, Width and Depth of Neural Networks, Learning Algorithms: Capacity - Overfitting - Underfitting - Bayesian Classification - Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted and Deep Boltzmann Machines.

**UNIT 5    CONVOLUTIONAL NEURAL NETWORKS                                       9**
Architectural Overview, Motivation, Layers, dropout, Filters, Parameter sharing, Regularization, Popular CNN Architectures: AlexNet, ResNet and UNet – Applications. Case study: Diabetic Foot Ulcer classification using Alexnet

                                                        **Lecture : 45, Tutorial :0, Total : 45**

**TEXT BOOKS:**
1.  Dr. Ruchi Doshi et al, "Machine Learning- Master Supervised and Unsupervised Learning Algorithms with Real Examples", BPB Publications, 2021.
2.  Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep Learning", MIT Press, First Edition, 2016.

**REFERENCES:**
1.  Nikhil Buduma and Nicholas Lacascio, "Fundamentals of Deep Learning", O.Reilly, First Edition, 2017.
2.  Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.
3.  Tom M Mitchell, ―Machine Learning, First Edition, McGraw Hill Education, 2013.

**e-Resources:**
1.  https://nptel.ac.in/courses/106/105/106105152/, 'Introduction to Machine Learning', Prof.SudeshnaSarkar, Department of computer science and Engineering, IIT Kharagpur
2.  https://nptel.ac.in/courses/106105215, 'Deep Learning', Prof. P.K. Biswas, IIT Kharagpur

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1  Explain the basics of machine learning.
CO2  Apply supervised learning algorithms on the healthcare datasets.
CO3  Analyze and group the unlabeled data items using clustering techniques.
CO4  Elaborate the basics of deep learning.
CO5  Implement the deep learning models in healthcare applications.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | 2 | 2 |   |   |   |   |   |   |   | 1 |   |   |
| **CO 2** | 2 | 3 | 2 | 2 | 2 |   |   |   |   |   |   | 1 | 2 |   |
| **CO 3** | 2 | 3 | 2 | 2 | 2 |   |   |   |   |   |   | 1 | 2 |   |
| **CO 4** | 2 | 3 | 2 | 2 |   |   |   |   |   |   |   | 1 |   |   |
| **CO 5** | 2 | 3 | 2 | 2 | 2 |   |   |   |   |   |   | 1 | 2 |   |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME26**      **PATTERN RECOGNITION AND NEURAL NETWORKS**     L    T    P    C
                                                                                3    0    0    3

**Pre-requisites: Nil**

**Preamble**
The course will introduce the student to the fundamentals of pattern recognition and its application with several supervised and unsupervised algorithms suitable for pattern classification. The course also covers basic neural network architectures and learning algorithms, for applications in pattern recognition and image processing.

**UNIT 1    INTRODUCTION AND SUPERVISED LEARNING                 9**
Introduction to Statistical Pattern Recognition, Overview of Pattern Classifiers, Random Variables, Types of Pattern Recognition, Applications of Pattern Recognition, Statistical Decision making – Bayes theorem –multiple features-Decision Boundaries - estimation of error rates, Nonparametric Decision making – histograms – kernels -window estimators - nearest neighbor classification – Adaptive Decision Boundaries – adaptive and Minimum Squared error Discriminant functions.

**UNIT 2    UNSUPERVISED LEARNING AND CLUSTERING ANALYSIS         9**
Unsupervised learning- Single-linkage Algorithm, Complete – linkage Algorithm, Average-linkage algorithm and Ward's method. Partitional clustering – Forgy's Algorithm – Criterion functions for clustering. Algorithms for clustering: K-Means- Hierarchical. Cluster validation – K-Nearest Neighbour method – Isodata Algorithm.

**UNIT 3    BASICS OF ARTIFICIAL NEURAL NETWORKS                   9**
Introduction – Artificial Neural Networks - Biological neural network- Comparison- Basic Building blocks- Terminologies, Fundamental Model of Artificial Neural Networks, Perceptron, Adaline and Madaline. Multilayer Perceptron - Feedforward Neural Network.

**UNIT 4    BACK PROPAGATION AND ASSOCIATIVE MEMORY             9**
Back propagation network, generalized delta rule, Associative memory Network, Hopfield Network, Bias-variance trade-off – Radial Basis Function Networks.

**UNIT 5    DEEP NEURAL NETWORKS                                      9**
Kohonen Self organizing map, Learning Vector Quantization, Counter Propagation network. A Brief Introduction to Deep Neural Networks, Convolutional Neural Networks, Recurrent Neural Networks.

                                                           **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Earl Gose, Richard Johnsonbaugh and StveJost, "Pattern Recognition and Image analysis", PHI Learning Private Limited, New Delhi, 2009.
2. S.N. Sivanandam, S.Sumathi and S.N. Deepa, "Introduction to Neural Networks using MATLAB 6.0", McGraw Hill Education Private Limited, New Delhi, 2006.

**REFERENCES:**
1. Duda R.O. Hart P.G, "Pattern Classification and scene analysis", Wiley Edition 2000.
2. Hagan, Demuth and Beale, "Neural network design", Vikas Publishing House Pvt Ltd., New Delhi, 2002.
3. Freeman J.A., and Skapura B.M, "Neural Networks, Algorithms, Applications and Programming Techniques", Addison - Wesley, 2003.

4. S.N. Sivanandam and S.N. Deepa, "Principles of Soft computing", John Wiley & Sons, Second Edition, 2011.

**e-Resources:**
1. http://nptel.ac.in/courses/117105101/, "Pattern Recognition and Application", Prof. P. K. Biswas, Indian Institute of Technology, Kharagpur.

2.  http://nptel.ac.in/courses/117108048/,"Pattern Recognition", Prof. P. S. Sastry, Indian Institute of Science, Bangalore.
3.  http://nptel.ac.in/courses/117105084/, "Neural Networks and Applications", Prof.S. Sengupta, IIT Kharagpur.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Explain the types and applications of pattern recognition with error rate estimation.
CO2   Elaborate unsupervised learning and clustering analysis with algorithms.
CO3   Explain the fundamentals of Neural Networks.
CO4   Discuss the function of neural networks of the Back-propagation, Hopfield and RBFN.
CO5   Analyze Deep Neural Network, CNN and RNN.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 3 | 1 | 1 | | | | | 1 | 1 | | 1 | | |
| **CO 2** | 3 | 3 | 1 | 1 | | | | | 1 | 1 | | 1 | | |
| **CO 3** | 3 | 3 | 1 | 1 | | | | | 1 | 1 | | 1 | | |
| **CO 4** | 3 | 3 | 1 | 1 | | | | | 1 | 1 | | 1 | | |
| **CO 5** | 3 | 3 | 1 | 1 | | | | | 1 | 1 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME27**      **BRAIN COMPUTER INTERFACE AND APPLICATIONS**     **L   T   P   C**
                                                                            **3   0   0   3**
**Pre-requisites: 22BMT52- Biosignal Processing**

**Preamble**
Brain-computer interfaces (BCIs) allow their users to communicate or control external devices using brain signals rather than the brain's normal output pathways of peripheral nerves and muscles. The course describes current clinical applications of BCI technology, current limitations of BCI technology, impediments to its widespread clinical use and expectations for the future.

**UNIT 1   INTRODUCTION TO BCI**                                         **9**
Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.

**UNIT 2   BRAIN ACTIVATION**                                                 **9**
Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

**UNIT 3   FEATURE EXTRACTION METHODS**                             **9**
Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artifacts reduction, Feature Extraction - Phase synchronization and coherence.

**UNIT 4   MACHINE LEARNING METHODS FOR BCI**                     **9**
Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis.

**UNIT 5   APPLICATIONS OF BCI**                                          **9**
Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.

**Lecture : 45, Total : 45**

**TEXT BOOKS:**
1. Rajesh.P.N.Rao, "Brain Computer Interfacing: Introduction", Cambridge University Press, 1st Edition, 2013.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, 1st Edition, 2012.

**REFERENCES:**
1. Ella Hassianien, A & Azar.A.T (Editors), "Brain-Computer Interfaces Current Trends and Applications", Springer, 2015.
2. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.
3. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida, 2019.
4. Bishop C.M., "Neural networks for Pattern Recognition", Oxford, Clarendon Press, 1995.

**e-Resources:**
1. https://nptel.ac.in/courses/106103115/," Human Computer Interaction", Prof. Dr. PradeepYammiyavar, Indian Institute of Technology Guwahati.
2. https://sccn.ucsd.edu/wiki/Introduction_To_Modern_BrainComputer_Interface_Design, "Introduction to Modern Brain-Computer Interface Design", Christian A. Kothe Swartz ,Center for Computational Neuroscience, University of California San Diego.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Comprehend and appreciate the significance and role of BCI in the present contemporary world.
CO2    Differentiate the concepts of BCI.
CO3    Allocate functions appropriately to the human and to the machine.
CO4    Select appropriate feature extraction methods.
CO5    Design a system using machine learning algorithms for translation.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 3 | 1 | - | - | - | - | - | - | 1 | - | 1 | 2 | - |
| **CO 2** | 3 | 3 | 1 | - | - | - | - | - | - | 1 | - | 1 | 2 | - |
| **CO 3** | 3 | 3 | 1 | - | 2 | - | - | - | - | 1 | - | 1 | - | - |
| **CO 4** | 3 | 3 | 1 | - | 2 | - | - | - | - | 1 | - | 1 | - | - |
| **CO 5** | 3 | 2 | 3 | - | - | - | - | - | - | 1 | - | 1 | 2 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME31**                    **ANALOG AND DIGITAL COMMUNICATION**          **L   T   P   C**
                                                                            **3   0   0   3**

**Preamble**
This course aims at designing Analog and Digital communication systems that are used for the transmission of information. A detailed quantitative framework for analog and digital transmission techniques is addressed.

**UNIT 1   ANALOG COMMUNICATION**                                                         **9**
Introduction to Communication Systems: Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of AM, DSBCS, SSBSC, VSB Techniques.
Modulators and Demodulators AM Transmitter and Receiver –TRF and Super-heterodyne Receiver- Angle Modulation, FM & PM Modulators and Demodulators, FM Transmitter- Direct method, Indirect method, FM Receiver, Comparison of various Analog Communication System (AM – FM – PM).

**UNIT 2   DIGITAL COMMUNICATION**                                                        **9**
Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) – Phase Shift Keying (PSK)– BPSK – QPSK – 8 PSK - Quadrature Amplitude Modulation (QAM) – 8 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).

**UNIT 3   PULSE MODULATION**                                                             **9**
Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM), DPCM, DM, ADPCM & ADM, Channel Vocoder – TDM, FDM, Data Compression of ECG using Delta Modulation – Comparison of various Pulse Communication System (PAM – PTM – PCM).

**UNIT 4   SOURCE AND ERROR CONTROL CODING**                                             **9**
Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, Mutual information, Channel capacity, Channel coding theorem, Error Control Coding, Linear block codes, Cyclic codes.

**UNIT 5   WIRELESS COMMUNICATION SYSTEM**                                               **9**
Global System for Mobile Communications (GSM) – Code Division Multiple Access (CDMA), Cellular Concept and Frequency Reuse – Channel Assignment and Hand off –Satellite Communication: Kepler‟s Law – satellite orbit – Geostationary Satellite –Satellite link modes – Bluetooth – Wi-Fi, Wireless Patient Monitoring System.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.  Wayne Tomasi, "Electronic Communication Systems", 5th Edition, Pearson Education, 2011.
2.  Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2013.

**REFERENCES:**
1.  Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, 2018.
2.  H.Taub, D L Schilling and G Saha, "Principles of Communication Systems", 4th Edition, Tata McGraw Hill, India, 2018.
3.  George Kennedy, Bernard Davis, S R M Prasanna, "Electronic Communication Systems," 5th nEdition, Tata McGraw Hill Education, India, 2016.

**e-Resources:**
1.   http://nptel.ac.in/courses/ 117101051 /, "Quantization, PCM and Delta Modulation", Prof.Bikash Kumar Dey, IIT, Bombay.
2.  http://nptel.ac.in/courses/ 117101051 /, "Source Coding (Part - 1)", Prof. Bikash Kumar Dey, IIT, Bombay.

3.  http://nptel.ac.in/courses/ 117101051 /, "Introduction to Digital Communication", Prof. Bikash Kumar Dey, III, Bombay.

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Evaluate the AM, FM and PM systems with respect to performance and signal to noise ratio. |
| CO2 | Compare the performance of various shift keying techniques used in digital communication systems. |
| CO3 | Analyze the characteristics of PAM, PTM and PCM modulation techniques and evaluate natural and flat top sampling techniques in digital pulse modulation. |
| CO4 | Compare and contrast of Huffman and Shannon-Fano coding techniques for coding efficiency of lossless data compression. |
| CO5 | Summarize the basic physical and technical settings of mobile communication systems and illustrate the orbital parameters of a satellite. |

**Mapping of COs with POs and PSOs**

| COs/POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|-------|-------|
| CO 1 | 3 | 2 | 2 | 1 | | 2 | | | 2 | 1 | | 1 | | |
| CO 2 | 3 | 2 | 2 | 1 | | 2 | | | 2 | 1 | | 1 | | |
| CO 3 | 3 | 2 | 2 | 1 | | 2 | | | 2 | 1 | | 1 | | |
| CO 4 | 3 | 2 | 2 | | | 2 | | | 2 | 1 | | 1 | | |
| CO 5 | 3 | 2 | 2 | | | 2 | | | 2 | 1 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**Pre-requisites: 22BMT51 Analog and Digital Communication**

**Preamble**
The course aims to provide an understanding of computer networks architecture, various technologies available to build a network and protocols in use at different levels of network layers stack. An overview of global Internet, Internet applications and types of protocols used for mail transfer is also provided.

**UNIT 1    DATA COMMUNICATIONS                                                                  9**
Data Communication– Networks– Protocols and Standards – The OSI Model – Layers in the OSI Model – TCP/IP Protocol Suite – Addressing – Transmission Media

**UNIT 2    DATA LINK LAYER                                                                      9**
Framing – HDLC– Error Detection and Correction – IEEE Standards : 802.3 – Frame Format – Access Method, Categories, 802.5 – Frame Format, 802.11 – Architecture – MAC layers – Frame Format, Bluetooth – Architecture – Bluetooth  layers.

**UNIT 3    NETWORK LAYER                                                                        9**
Connecting Devices – Internetworking: Switching and types – Bridging and types. IPv4 datagram format – Fragmentation – IPv6 –Packet Format – Transition from IPv4 to IPv6. Routing Techniques: Distance vector (RIP) – Link state (OSPF) – Interdomain Routing (BGP).

**UNIT 4    TRANSPORT LAYER                                                                      9**
Connectionless Versus Connection Oriented Service – UDP: User datagram format- Services – Uses, TCP: TCP segment format – Services – A TCP Connection, TCP Congestion Control – Categories. SCTP – Comparison between a TCP segment and an SCTP packet. Quality of Service – Techniques to improve QoS.

**UNIT 5   APPLICATION LAYER                                                                     9**
Electronic Mail: Architecture – MIME, SMTP, POP3, IMAP4 – File Transfer: FTP – WWW: Architecture – HTTP: HTTP Messages – Persistent versus Non persistent Connection.
Domain Name System: Domain Name Space – Distribution of Name Space – DNS in the Internet – DNS Messages – Types of Records. SNMP: Architecture – Role of MIB.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.  Behrouz A. Forouzan, "Data Communications and Networking", Fourth Edition, Tata McGraw - Hill, Reprint 2012.
2.  Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Fifth Edition, Morgan Kaufmann Publishers, 2011.

**REFERENCES:**
1.  William Stallings, "Data Communication and Networks", Pearson Education, Tenth edition, 2014.
2.  James .F. Kurouse & W. Rouse, "Computer Networking: A Topdown Approach Featuring",Sixth edition, Pearson Education, 2013.
3.  William Stallings, "Data Communication and Networks", Pearson Education, Tenth edition, 2014.

**e-RESOURCES:**
1.  http://www.nptel.ac.in/downloads/106105080, Computer Networks, Prof.Sujoy Ghosh, IIT Kharagpur.
2.  https://www.elsevier.com/journals/subjects/computer-science

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Interpret the importance of layering, addressing and annotate the protocol stack of OSI and TCP/IP model.

CO2    Annotate MAC protocols (Ethernet, Token Ring and Wi-Fi) supported by Data Link layer to ensure hop-to-hop reliable communication.

CO3    Use IP addressing and routing protocols to find shortest route to achieve reliable network-layer data transmission.

CO4    Classify the transport layer protocols and explain the congestion control or congestion avoidance techniques to ensure quality of service.

CO5    Analyze the functions and services provided by the application layer protocols (HTTP, SMTP and DNS).

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 3 | 1 | | | | 1 | | | | | 1 | | |
| **CO 2** | 2 | 3 | 2 | | | | 1 | | | | | 1 | | |
| **CO 3** | 2 | 3 | 2 | | | | 1 | | | | | 1 | | |
| **CO 4** | 2 | 3 | 2 | | | | 1 | | | | | 1 | | |
| **CO 5** | 2 | 3 | 1 | | | | 1 | | | | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BME33 | EMBEDDED SYSTEMS AND IOT | L | T | P | C |
|---------|--------------------------|---|---|---|---|
|         |                          | 3 | 0 | 0 | 3 |

**Pre-requisites : 22BMT63 – Microprocessors and Microcontrollers**

**Preamble**
Embedded systems and IOT devices are essential to understand the fundamentals to gain knowledge on telemedicine. IoT design considerations, constraints and interfacing between the physical world and the device will make design trade-offs between hardware and software.

### UNIT 1    INTRODUCTION TO EMBEDDED SYSTEM DESIGN                                    9
Introduction to embedded processors- Application Areas- Categories of embedded processors- Challenges in Embedded System Design, Design Process- Requirements- Specifications- Hardware architecture- Software architecture-Introduction to Harvard & Von Neuman architectures- CISC & RISC Architectures. CPU Bus- Bus Protocols- Bus Organisation, Memory Devices, and their Characteristics- RAM, EEPROM-Flash Memory- DRAM. BIOS, POST, Device Drivers.

### UNIT 2    PERIPHERAL INTERFACING                                                    9
I/O Devices-Timers and Counters- Watchdog Timers, Interrupt Controllers- A/D and D/A, Interfacing-Memory interfacing with a case study- I/O Device Interfacing with case Study- Programmed IO-Memory Mapped IO, Interfacing Protocols-SPI, I2C, USB, CAN.

### UNIT 3    EMBEDDED SYSTEM SOFTWARE DESIGN                                           9
Application Software, System Software, Design techniques – State diagrams, sequence diagrams, flowcharts, etc., Model-based system engineering (MBSE), Use of High-Level Languages- embedded C / C++ Programming, Integrated Development Environment tools- Editor- Compiler- Linker- Automatic Code Generators- Debugger- Board Support Library- Chip Support Library, Analysis and Optimization-Execution Time- Energy & Power.

### UNIT 4    DESIGN AND DEVELOPMENT OF IOT                                             9
Definition and characteristics of IoT, Technical Building blocks of IoT, Communication Technologies, Physical design of IoT - system building blocks - sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino), Benefits and impact of IoMT. Cybersecurity – vulnerability, penetration & encryption technologies.

### UNIT 5    INTERNET OF MEDICAL THINGS                                                9
Case studies – Novel Symmetrical Uncertainty Measure (NSUM) Technique for Diabetes Patients, Healthcare Monitoring system through Cyber-physical system, An loT Model for Neuro sensors, AdaBoost with feature selection using loT for somatic mutations evaluation in Cancer, A Fuzzy- Based expert System to diagnose Alzheimer's Disease, Secured architecture for loT enabled Personalized Healthcare Systems, Healthcare Application Development in Mobile and Cloud Environments.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. James K Peckol, Embedded Systems – A Contemporary Design Tool,  John Weily, 2008.
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for lnternet of Things, Cisco Press, 2017.
3. Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat, Internet of Things and Personalized Healthcare Systems", Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019.

**REFERENCES:**
1. Shibu K V, Introduction to Embedded Systems, Tata McGraw Hill Education Private Limited, 2009.

2. David E.Simon, Embedded Software Primer, Addison Wesley, ISBN-13: 978-0201615692.
3. Barry B.Brey, The Intel Microprocessors, Architecture, Programming and Interfacing" Barry B.Brey, 6th Edition, Pearson Education.

**e-Resources:**

1. https://archive.nptel.ac.in/courses/128/108/128108016/, "IoT and Embedded Systems",Prof.Deberata Das, IIIT Bengaluru.
2. https://archive.nptel.ac.in/courses/108/105/108105057/, "Embedded Systems", Prof. Rajib Mall, IIT Kharagpur.


**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Explain fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.
CO2   Describe the hardware architecture and features of embedded microcontrollers and peripherals.
CO3   Explain software design tools and embedded system design programming phases.
CO4   Describe IoT Architectures and Build simple IoT Systems using embedded target boards.
CO5   Exhibit understanding of IoMT infrastructure for healthcare applications.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 1 | - | - |
| CO 2 | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 1 | - | - |
| CO 3 | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 1 | - | - |
| CO 4 | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 1 | - | - |
| CO 5 | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 1 | 1 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BME34 | **WIRELESS SENSOR NETWORKS** | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisites: Nil**

**Preamble**
This course provides information about architecture and networking sensors of wireless sensor network and also it shows their basic operations in various applications of emerging and exciting domains of wireless sensor network. This course gives an insight of Node-level software platforms and tools utilized for sensor network simulations.

**UNIT 1    OVERVIEW OF WIRELESS SENSOR NETWORKS                                9**
The vision of Ambient Intelligence – Application Examples – Types of Applications – Challenges for Wireless Sensor Networks – Comparison of Mobile ad hoc networks and wireless sensor networks – Enabling Technologies for Wireless Sensor Networks.

**UNIT 2    ARCHITECTURES                                                        9**
Single-Node Architecture – Hardware Components – Energy Consumption of Sensor Nodes – Operating Systems and Execution Environments – Network Architecture – Sensor Network Scenarios – Optimization Goals and Figures of Merit – Gateway Concepts.

**UNIT 3    NETWORKING PROTOCOLS                                               9**
Physical Layer and Transceiver Design Considerations – MAC Protocols for Wireless Sensor Networks – Low Duty Cycle Protocols and Wakeup Concepts – S-MAC – The Mediation Device Protocol – Wakeup Radio Concepts – Address and Name Management – Assignment of MAC Addresses – Routing Protocols – Energy – Efficient Routing, Geographic Routing.

**UNIT 4    INFRASTRUCTURE ESTABLISHMENT ,SENSOR TASKING AND CONTROL          9**
Topology Control – Clustering – Time Synchronization – Localization and Localization services. Task-Driven sensing-Roles of sensor nodes and utilities-Information based sensor tasking –Joint routing and Information Aggregation.

**UNIT 5    SENSOR NETWORK PLATFORMS AND TOOLS                               9**
Sensor Node Hardware – Berkeley Motes – Programming Challenges – Node-level software platforms – Node-level Simulators – State-centric programming.

**Lecture : 45, Total : 45**

**TEXT BOOKS:**
1. Holger Karl & Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", John Wiley, 2005
2. Feng Zhao & Leonidas J. Guibas, "Wireless Sensor Networks-An Information Processing Approach", Elsevier, 2007.

**REFERENCES:**
1. Kazem Sohraby, Daniel Minoli, &TaiebZnati, "Wireless Sensor Networks-Technology, Protocols and Applications", John Wiley, 2007.
2. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 2003.
3. Jun Zheng, Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective", Wiley, 2009.

**e-Resources:**
1. https://www.youtube.com/user/cecedusat, "Wireless Sensor Networks", Dr. Adwitiya Sinha, AP, Eminent University, Delhi.

2. NPTEL Video: https://www.youtube.com/watch?v=GUSrkWJ_Z2g "Introduction: Wireless Sensor Networks- Part- I " Prof.SudipMisra, IIT,Kharagpur.

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Identify the challenges and application areas of Wireless sensor networks with respect to the Physical Environment. |
| CO2 | Summarize the hardware, software components and topologies used in standalone & centrally coordinated wireless network. |
| CO3 | Compare and contrast various routing protocols to find shortest path to reach the destination node with minimum energy consumption. |
| CO4 | Illustrate clustering methods and concepts of Joint routing to obtain maximum energy conservation from each node of the network. |
| CO5 | Compare and contrast ns-2 and TOSSIM simulators to provide substantial support for simulation of different routing protocols over wired and wireless networks. |

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 2 | 3 | | | | | | | 1 | | 1 | | |
| CO 2 | 3 | 2 | 3 | | | | | | | 1 | | 1 | | |
| CO 3 | 3 | 2 | 3 | | | | | | | 1 | | 1 | | |
| CO 4 | 3 | 2 | 3 | | | | | | | 1 | | 1 | | |
| CO 5 | 3 | 2 | 3 | | 3 | | | | | 1 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME35**               **VIRTUAL REALITY IN MEDICINE**               **L   T   P   C**
                                                                        **3   0   0   3**

**Pre-requisites: Nil**

**Preamble:** This course is designed to give historical and modern overviews and perspectives on virtual reality. It describes the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems.

**UNIT 1   INTRODUCTION TO VIRTUAL REALITY**               **9**
Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality,Study the use of Virtual Reality at NASA.

**UNIT 2   REPRESENTING THE VIRTUAL WORLD**               **9**
Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR, GHOST (General Haptics Open Software Toolkit) software development toolkit.

**UNIT 3   THE PHYSIOLOGY OF HUMAN VISION**               **9**
Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation,Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR, Sweeping coverage of eye movements

**UNIT 4   VISUAL PERCEPTION & RENDERING**               **9**
Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates, Automatic stitching of panoramas in Virtual Reality.

**UNIT 5   APPLICATIONS**               **9**
Medical applications-military applications-robotics applications- Advanced Real time Tracking- other applications- games, movies, simulations, therapy.

                                         **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.    Steven M. LaValle, Virtual Reality, Cambridge University Press, Edition 1,2016.
2.    William R Sherman and Alan B Craig, Understanding Virtual Reality: Interface, Application and Design, (The Morgan Kaufmann Series in Computer Graphics)", Morgan Kaufmann Publishers, San Francisco, CA, 2002.
3.    Alan B Craig, William R Sherman and Jeffrey D Will, Developing Virtual Reality Applications: Foundations of Effective Design, Morgan Kaufmann, Edition 1,2009.

**REFERENCES:**
1.    Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
2.    Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", Wiley, 2005.
3.    Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

**e-Resources:**
1.    https://youtu.be/nSLSNVY8zNg, Virtual Reality Engineering, NPTEL Swayam,IIT Madras.
2.    https://nptel.ac.in/courses/106/106/106106138/, Virtual Reality, Prof Steven LaValle, IIT Madras.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Explain basics of VR systems and its application.
CO2 Summarize the design and implementation of the hardware enabled VR systems.
CO3 Explain the system of human vision and its implication on perception and rendering.
CO4 Evaluate the concepts of motion and tracking in VR systems.
CO5 Apply the basic concepts of VR in medical applications.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | 3 | | | | | | | 1 | | 1 | 1 | |
| **CO 2** | 2 | 3 | 3 | | | | | | | 1 | | 1 | | |
| **CO 3** | 2 | 3 | 3 | | | | | | | 1 | | 1 | 1 | |
| **CO 4** | 2 | 3 | 3 | | | | | | | 1 | | 1 | | |
| **CO 5** | 2 | 3 | 3 | | | | | | | 1 | | 1 | 1 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME36**                         **MEDICAL INFORMATICS**                         **L T P C**
**3 0 0 3**

**Pre-requisites:- 22BMT51-MEDICAL INSTRUMENTATION-1 & 22BME31- ANALOG & DIGITAL COMMUNICATION**

**Preamble:**
This course provides sub-discipline of health informatics where skills in both medical and computer sciences come together in an effort to improve healthcare and patient outcomes. It also shares knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

**UNIT 1      INTRODUCTION TO MEDICAL INFORMATICS                         9**
Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital  management and  information system,  Functional capabilities of a computerized HIS,   Distinguish Health Informatics – Medical Informatics and Bioinformatics.

**UNIT 2      AUTOMATION IN CLINICAL LABORATORY AND MEDICAL IMAGING      9**
Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging-      nuclearmedicine,      ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance-DICOM,PACS.

**UNIT 3      COMPUTERISED PATIENT RECORD                         9**
Introduction -   History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology, Clinical information system, Computerized prescriptions for patients.

**UNIT 4      COMPUTER ASSISTED MEDICAL DECISION-MAKING                         9**
Artificial Neural Networks application, Expert system-General model of CMD, Computer–assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

**UNIT 5      RECENT TRENDS IN MEDICAL INFORMATICS                         9**
Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment, Surgical simulation ,  Telemedicine - Tele surgery ,Virtual Hospitals , Smart Medical Homes , Personalized e-health services , Biometrics , GRID and Cloud Computing in Medicine.
**TOTAL :    45  PERIODS**

**TEXT BOOKS:**
1.  Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003.
2.  R.D.Lele, "Computers in medicine progress in medical informatics", Tata Mcgraw Hill, 2005.

**REFERENCES:**
1.  Kathryn J. Hannah, Marion J Ball, "Health Informatics", 3rd Edition, Springer, 2006.
2.  OrpitaBosu and SimminderKaurThukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University press, New Delhi, 2007.
3.  Yi, Ping Phoebe Chen, "Bioinformatics Technologies", Springer International Edition, New Delhi, 2007.

**e-RESOURCES:**

1. Coursera, https://www.coursera.org/learn/health-informatics-professional, "Interprofessional Healthcare Informatics", Prof. Karen Monsen, University of Minnesota.
2. Coursera, https://www.coursera.org/learn/ehealth?, "eHealth: More than just an electronic record", Prof. Tim Shaw, The University of Sydney.

**Course Outcomes: Upon completion of the course, students will be able to:**

1. Explain the structure of informatics and functional capabilities of Hospital Information System.
2. Describe the need of computers in medical imaging and automated clinical laboratory.
3. Articulate the functioning of information storage and retrieval in computerized patient record system in hospitals.
4. Identify the suitable decision support system for automated clinical diagnosis.
5. Discuss the application of virtual reality and telehealth technology in medical industry.

**CO – PO Mapping:**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1 | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - |
| CO2 | - | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| CO3 | - | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| CO4 | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 2 | - |
| CO5 | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - |

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)     "-" No correlation

| | **L** | **T** | **P** | **C** |
|---|---|---|---|---|

**22BME37**  **TELEHEALTH TECHNOLOGY**

| **L** | **T** | **P** | **C** |
|---|---|---|---|
| **3** | **0** | **0** | **3** |

**Pre-requisites :** 22BMT51 - Medical instrumentation I, 22BMT62 - Medical instrumentation II

**Preamble**
Introduces the key principles of telemedical field by understanding various telemedicine technologies with their standards and applications.

**UNIT 1   FUNDAMENTALS OF TELEMEDICINE                                        9**
History of telemedicine, definition of telemedicine, Tele-health, Tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.

**UNIT 2   TELEMEDICAL TECHNOLOGY                                               9**
Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, microwave, Bluetooth technology, Mobile health and ubiquitous healthcare.

**UNIT 3   ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE                  9**
Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues, intellectual property rights.

**UNIT 4   MOBILE HEALTH AND WEB APPLICATIONS                            9**
Mobile Health Today- mHealth Based on Text Messaging, mHealth and Smart phones and History of Smartphone Based mHealth Devices - mHealth and Other Technologies- Emerging Trends and Areas of Interest in mHealth- Health Informatics Standards- Wireless Technologies Used in mHealth- Web Applications - mHealth Challenges and Ethics.

**UNIT 5   TELEMEDICAL APPLICATIONS                                            9**
Telemedicine – health education and self care, Introduction to robotics surgery, Telesurgery, Telecardiology, Teleoncology, Telemedicine in neurosciences, Business aspects - Project planning and costing, Usage of telemedicine.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Norris, A.C. "Essentials of Telemedicine and Telecare", Wiley, 2002.
2. Olga Ferrer Roca, Marcelo Sosa Iudicissa, "Handbook of Telemedicine", IOS Press, Netherland, 3. 2002.
3. Khandpur R S, "TELEMEDICINE – Technology and Applications", PHI Learning Pvt Ltd.,New Delhi, 2017.

**REFERENCES:**
1. Wootton, R., Craig, J., Patterson, V. (Eds.), "Introduction to Telemedicine. Royal Society of Medicine" Press Ltd, Taylor & Francis, 2006.
2. O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), "Public Health Informatics and Information Systems", Springer, 2003.
3. Ferrer-Roca, O., Sosa - Iudicissa, M. (Eds.), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54, 2002.

**e-Resources:**
1. https://t.ly/Mr1IL "Fundamentals of Telehealth and Virtual Care", Mr. Chandramouli – NPTEL.
2. https://t.ly/NuW-p "Introduction to Healthcare – Stakeholders & Key Processes" Ms. Vaishnavi – NPTEL.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Understand the history and advancements in the field of telemedicine and health.
CO2 Describe importance of communication and network in telemedical technology.
CO3 Apply telehealth in healthcare and understand about the concept used in application.
CO4 Explain the role of telecommunication in telehealth technology.
CO5 Discuss the applications of telemedicine in health education and self care.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | 1 | 1 | 2 | - | - | - | - | 1 | - | 1 | 2 | |
| **CO 2** | 2 | 3 | 1 | 1 | 2 | - | - | - | - | 1 | - | 1 | 2 | |
| **CO 3** | 2 | 3 | 1 | 1 | 2 | - | - | - | - | 1 | - | 1 | 2 | |
| **CO 4** | 2 | 3 | 1 | 1 | 2 | - | - | 1 | - | 1 | - | 1 | 2 | |
| **CO 5** | 2 | 3 | 1 | 1 | 2 | - | - | 1 | - | 1 | - | 1 | 2 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BME41 | BIOMECHANICS | L | T | P | C |
|---------|--------------|---|---|---|---|
|         |              | 3 | 0 | 0 | 3 |

**Pre-requisites: Nil**

**Preamble**
Biomechanics is traditionally divided into the areas of kinematics and kinetics. Kinematics is the branch of mechanics that deals with the geometry of the motion of objects; including displacement, velocity, and acceleration, without taking into account the forces that produce the motion. Kinetics is the study of the relationships between the force system acting on a body and the changes it produces in body motion. Based on this, the course describes biomechanics based on skeletal, muscular and neurological considerations.

**UNIT 1  INTRODUCTION TO MECHANICS                                           9**
Principles of Mechanics-Newton's law- Basic concepts related to Kinetics –Mechanical loads on human body- Angular Kinetics of human movement- Resistant to angular acceleration- Angular momentum- Linear Kinematics of human movement-Linear Kinematics quantities- Projectile motion- Factors influencing Projectile trajectory -Angular kinematics of human movement-measuring angles, angular kinematic relationships –relationships between linear and angular motion – Equilibrium and human movement-equilibrium, center of gravity, stability and balance.

**UNIT 2  BIOFLUID MECHANICS                                                      9**
Stress,strain- strain rate– Hooke's-law – Viscosity – Newtonian fluid – Non-Newtonian fluid – Viscoelasticity- rheological properties of blood, laminar flow - turbulent flow – structure and composition of blood vessels-Mechanical properties of blood vessels- Medical applications of blood rheology.

**UNIT 3  BIOMECHANICS OF HUMAN BONE                                          9**
Bone structure & composition- Types of bone - blood circulation in bone - Bone growth and development, viscoelastic properties of bone – Maxwell & Voight models – Bone response to stress - Osteoporosis – causes, diagnosis, and treatment-Common bone injuries.

**UNIT 4  BIOMECHANICS OF HUMAN SKELETAL MUSCLE                              9**
Structural organization of skeletal muscle –muscle fibers, motor units, fiber types, fiber architecture – Skeletal muscle function – Sliding element theory of skeletal muscle- Contraction of skeletal muscle and Hill's three element model – Factors affecting muscular force generation – Muscular strength, power and endurance – Common Muscle injuries.

**UNIT 5  BIOMECHANICS OF SHOULDER,SPINE AND HIP                             9**
Structure of the shoulder – Movements of shoulder complex – Loads on the shoulder – Structure of the spine – Movements of the spine – Muscles and loads on the spine – Structure and movements of the hip – Loads on the hip. Common injuries of shoulder,spine and hip.

**Lecture : 45, Total : 45**

**TEXT BOOKS:**
1. Fung Y C, Biomechanics: "Mechanical Properties of Living Tissues", Springer, 2nd edition, 2008.
2. Susan J Hall, "Basic biomechanics", Tata McGraw hill, 4th edition, 2003.

**REFERENCES:**
1. Joseph Hamill, Kathleen M Knutzen, Timothy R Derrick, "Biomechanical Basis of Human Movement", Wolters Kluwer,5th Edition, 2021.
2. Duane Knudson, "Fundamentals of Biomechanics", Springer Science plus Business Media,2nd Edition, 2007.
3. Cees Oomens, Marcel Brekelmans,Sandra Loerakker,Frank Baaijens, "Biomechanics- concepts and computation", Cambridge University Press,2nd Edition,2018.

**e-Resources:**
1. http://nptel.kmeacollege.ac.in/syllabus/112106059/, "Biomechanics" Dr. C. Lakshmana Rao Professor, Department of Applied Mechanics, Indian Institute of Technology, Chennai, Dr. M. Manivannan, Dept. of. Applied Mechanics, IIT Madras.
2. https://onlinecourses.nptel.ac.in/noc23_bt04/, "Biomechanics" ,Prof.Varadhan, Department of Biomedical Engineering, IIT Madras.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Discuss the basics of kinetics, Kinematics of linear and angular momentum.
CO2    Explain the rheological properties of blood and its medical applications.
CO3    Describe the biomechanics of human bone.
CO4    Elucidate the structure and functions of muscle fibers.
CO5    Describe the structure, movements, and loads applied to spine, shoulder and hip.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| **CO 2** | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| **CO 3** | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| **CO 4** | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| **CO 5** | 2 | 3 | - | - | - | - | - | - | - | 1 | - | 1 | 3 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME42**          **BIOFLUIDS AND DYNAMICS**      **L   T   P   C**
                                                             **3   0   0   3**

**Pre-requisites: 22PHT11 Engineering Physics, 22BMT22 Human Anatomy And Physiology,**

**Preamble**
Biofluids and dynamics is the application of physics and engineering principles to the study of complex biological processes that involve fluid motion, both inside and outside an organism. The course aims to develop understanding of biofluids from the movement of individual cells, the flow of blood through the cardiovascular system, to animal locomotion in the air or water, there are many biological scenarios that require a quantitative understanding of the mechanical processes surrounding the flow of fluids.

**UNIT 1   FLUID FLOW**                                        **9**
Different types of fluid flows, laminar and turbulent flow, transition from laminar to turbulent flow, laminar flow through a round pipe-laminar flow through an annulus, laminar flow between parallel plates, laminar flow between co-axial rotating cylinders, measurement of viscosity- capillary tube viscometer, co-axial cylinder viscometer.

**UNIT 2   BOUNDARY LAYER FLOW**                       **9**
Development of boundary layer- over a flat plate, within a pipe, estimates of boundary layer region, boundary layer equations, drag on a flat plate, nature of turbulence, smooth and rough surface, boundary layer separation, control of separation, mechanism of transition.

**UNIT 3   CIRCULATORY BIOFLUID MECHANICS**             **9**
Nature of blood, blood flow in systemic and pulmonary circulations, pressure gradient in the blood vessels, pressure variation throughout the systemic circulation, models of blood flow- Poiseuille's flow, pulsatile flow, applications in the cardiovascular system – cardiac mechanics in heart valves.

**UNIT 4   PRESSURE AND FLOW IN BLOOD VESSELS**         **9**
Friction loss in flow in a tube, velocity distribution of aortic system, waveform of pressure and velocity in aorta, wave reflections and impedance in arterial segments, blood flow in veins and blood flow in capillaries, quasi unidirectional flow in large vessels.

**UNIT 5   ANALYSIS OF CARDIOVASCULAR DYNAMICS**        **9**
Control theory and system analysis, mechanical analysis of circulatory systems, basic concept of myocardial mechanics, index of contractibility, fluid dynamics of aortic and mitral valves, fluid dynamics in the cardiac chamber.

                                                     **Lecture : 45, Total : 45**

**TEXT BOOKS:**
1. K.L.Kumar, "Engineering fluid mechanics", Eurasia Publishing House (P) Ltd., New Delhi, Reprint 2014.
2. Gianni Pedrizetti, "Fluid Mechanics for Cardiovascular Engineering"- 1st Edition, Springer Cham,2021.

**REFERENCES:**
1. Ali ostadar, "Biofluid Mechanics: Principles and applications" Academic press, 2016.
2. Krishnan B. Chandran ,Stanley, E.Rittgers and Ajit P. Yoganathan , Biofluid mechanics: The human circulation , 2nd Edition , CRC PRESS , 2012.
3. Jagan N Mazumdar , "Biofluid Mechanics", World scientific publishing , 2004.

**e-Resources:**
1. http://nptel.ac.in/courses/112105171/1, "Fluid Mechanics" Prof. S.K. Som, Department of Mechanical Engineering, Indian Institute of Technology, Kharagpur.

2.  https://www.youtube.com/watch?v=AdhWBb7j55c, "Introduction to fluid mechanics",Prof.Dr.Subashisa Dutta.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1  Comprehend the types of flow and measurement of viscosity.
CO2  Discuss the boundary layer formation and flow.
CO3  Analyze the mechanics of systemic and pulmonary circulations.
CO4  Describe the flow of blood and identify the pressure measurement in various blood vessels, valves.
CO5  Analyze the dynamics of the cardiovascular systems.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| CO 2 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| CO 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| CO 4 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| CO 5 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME43**                    **REHABILITATION ENGINEERING**            **L   T   P   C**
                                                                        **3   0   0   3**

**Pre-requisites:** Human Assist Devices, Wearable systems

**Preamble**
Rehabilitation science and engineering to emphasize the importance of both science and engineering in advancing rehabilitation efforts and addressing the needs of people with disabling conditions. It provides the standard methods to regain functions lost due to congenital disorders, disease and injuries like limb loss to restore the function.

**UNIT 1   INTRODUCTION                                                       9**
Rehabilitation concepts- impairment, disability, handicap, Epidemiology of rehabilitation, Preventive rehabilitation , Diagnosis of Disability, Socio- vocational rehabilitation, therapeutic exercise – coordination exercises, balance training, gait training, relaxation exercises, strengthening exercises, mobilization exercises, endurance exercises, postural correction, ergonomic exercises, hydrotherapy, suspension therapy.

**UNIT 2   SENSORY REHABILITATION                                             9**
Visual system, visual augmentation, tactual vision substitution, auditory vision substitution, auditory system – auditory augmentation, visual auditory substitution, tactual auditory substitution, tactual augmentation, tactual substitution. Electronics travel appliances.

**UNIT 3   MOTOR REHABILITATION                                               9**
Orthopedics- prosthetics and orthotics in rehabilitation – fundamentals, applications and computer aided engineering in customized component design, intelligent prosthetic knee, hierarchically controlled prosthetic hand, self-aligning knee joint. Externally powered and controlled orthotics. Restoration of hand functions, standing and walking, hybrid assistive systems. Knee prostheses, myoelectric hand and arm prosthesis.

**UNIT 4   WHEELED MOBILITY AIDS                                              9**
Categories of wheel chairs, wheel chair structure and component design – materials, frame design, wheels and casters. Ergonomics- wheel chair propulsion- power wheel chair electrical systems- user interface, integrated control, power systems. Electromagnetic compatibility, Personal transportation-vehicle selection -lift mechanisms, wheel chair restraint mechanisms, hands controls.

**UNIT 5   COMPUTER ACCESS AND APPLICATIONS OF REHABILITATION               9**
Computer access- user interface, outputs, acceleration techniques, cost effectiveness- intervention- environmental – next generation information systems. Rehabilitation applications- conceptual frame work- provision process-education and quality assurance- specific impairment.

**Lecture : 45, Total : 45**

**TEXT BOOKS:**
1. Dr. S.Sunder , Textbook of Rehabilitation, 4rd Edition , Jaypee Medical Publications, New Delhi, 2012.
2. Joseph D.Bronzino, "The Biomedical Engineering Handbook" Fourth Edition: Three volume set, CRC Press, 2010.
3. Rory A Cooper, An Introduction to Rehabilitation Engineering, CRC Press, 2 st Edition, 2012.

**REFERENCES:**
1. Horia Nicolai .L, Teodorescu , Lakhmi .C. Jain " Intelligent systems and technologies in rehabilitation engineering "1st Edition , CRC press, 2013.
2. Dario farina ,winne Jensen& metinakay " Introduction to  neural engineering for motor rehabilitation" Wiley, IEEE, 2013.

3. Randall L.Braddom, Hand book of physical medicine and rehabilitation, W.B. Saunders Publications.

**e-Resources:**
1. https://www.youtube.com/watch?v=qw_m-gteuSY "Design considerations: prosthesis and orthosis"Prof. SujathaSrinivasan , Department of mechanical engineering . IIT Madras.
2. **https://sms.hest.ethz.ch/education/lectures/rehabilitation-engineering-i.html** Prof. Robert Riener & Dr. Elisabeth Wilhelm, **Sensory-Motor Systems Lab**,

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1   Discuss the insights of rehabilitation and different exercises for the betterment of healthcare
CO2   Interpret the different the visual aids for the augmentation of blind people.
CO3   Describe the sensory and motor functions of hand and the artificial devices used for improvement of lost function
CO4   Analyze the design, power and fabrication of wheel chair models
CO5   Illustrate the principles of computer technologies and its application in rehabilitation engineering.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | | | 2 | | | | 1 | | | 3 | |
| CO 2 | 2 | 3 | 2 | | 1 | | | | | | | | 3 | 1 |
| CO 3 | 2 | 3 | 2 | | | | | | | | | | 3 | |
| CO 4 | 2 | 3 | 2 | | | | | | | | | | 3 | |
| CO 5 | 2 | 3 | 2 | | | | | | | | | | 3 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High). & Dr. Elisabeth Wilhelm

**Pre-requisites: Nil**

**Preamble**

Physiological systems modeling, simulation and control is a research area integrating science and engineering and contributes to a continuous refinement of knowledge on how the body works. This course provides the concepts on developing of differential equations to describe the dynamic models, simulate and visualize the dynamic responses of physiological models using software.

**UNIT 1   SYSTEM CONCEPT**                                               **9**

Review of physiological system modeling - system properties - different configurations of tracheal network, static and dynamic resistance, Thermal resistance in human systems, System with volume storage capacity and its electrical analog, Simplified model of respiratory system, Simulation of aortic segments, Comparison of muscle model isotonic response, Step response of resistant / compliant systems –Dye dilution study of circulation, pulse response of first order system.

**UNIT 2   TRANSFER FUNCTION**                                           **9**

System as an operator and use of Transfer function, Bio Engineering of coupled systems, Examples of transformed signals and circuits for transfer function with impedance concept - Development of lung model, Impedance of a two stage ladder network, Measurement of airway resistance.

**UNIT 3   PERIODIC SIGNALS**                                                 **9**

Sinusoidal Functions, Analysis of Instrumentation to measure air flow system, second order system – representation of a respiratory system, Evaluation of Transfer function from frequency response for muscle response modes, Relationship between Phase lag and Time Delay-closed loop aspects of papillary control system, Transient Response of an Undamped Second order system, General Description of Natural Frequency Damping, Physical Significance of under damped responses of post systolic operations in aortic arch.

**UNIT 4   TRANSIENT OSCILLATIONS AND RESONANCE**                       **9**

Transient response of underdamped second order system and its physical significance-Underdamped response of physiological system-Signal consonance of underdamped second order response-Resonance.

**UNIT 5   PHYSIOLOGICAL FEEDBACK SYSTEMS AND SIMULATIONS**        **9**

Characterization of Physiological Feedback systems- Hypophysis adrenal systems, pupillary hippus, Uses and Testing of System Stability, Simulation of physiological systems using Open CV / MATLAB software.

                                           **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Willian B. Blesser, "A System Approach to Biomedicine", McGraw Hill, New York, 1969.
2. Marmarelis, "Nonlinear Dynamic Modeling of Physiological Systems", Wiley-IEEE Press,2004.

**REFERENCES:**
1. Micheal C.K.Khoo,"Physiological Control System Analysis, Simulation and Estimation".-Prentice Hall of India, New Delhi, 2001.
2. John Enderle Susan Blanchard, Joseph Bronzino "Introduction to Biomedical Engineering", second edition, Academic Press, 2005.

**e-Resources:**
1. https://www.edx.org/course/system-dynamics-health-sciences-witsx-hsd101x#!,"System Dynamics for Health Sciences", David Rubin Adjunct Professor, Biomedical Engineering University of the Witwatersrand.

2. http://serious-science.org/mathematical-modelling-of-physiological-systems-820, "Mathematical Modelling of Physiological Systems", Thomas Heldt, Asst. Prof. of Electrical and Biomedical Engineering, EECS.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Explain the application of Physiological models.
CO2   Develop the lung model using transfer function with impedance concept.
CO3   Discuss the transient response and frequency response of physiological systems.
CO4   Develop differential equations to describe the dynamic models, simulate and visualize the dynamic responses of physiological models.
CO5   Implement physiological models using MATLAB software to get dynamic responses of feedback systems.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 1 | 1 | | | | | | | | | 2 | 2 | |
| **CO 2** | 3 | 2 | 1 | | | | | | | | | 1 | 1 | |
| **CO 3** | 3 | 2 | 1 | | | | | | | | | 1 | 1 | |
| **CO 4** | 3 | 2 | 1 | | | | | | | | | 1 | 1 | |
| **CO 5** | 3 | 2 | 1 | | 2 | | | | | | | 1 | 2 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME45**                    **ROBOTICS IN MEDICINE**          **L   T   P   C**
                                                                  **3   0   0   3**

**Pre-requisites: Nil**

**Preamble**
This course aims to introduce the basics of Robotics, Kinematics, Inverse Kinematics to explore various kinematic motion planning solutions for different Robotic configurations.

**UNIT 1   INTRODUCTION                                                          9**
Introduction Automation and Robots, Classification, Application, Specification, Notations, Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation – Five-axis robot, Four-axis robot, Six-axis robot-Regulatory requirements and safety considerations.

**UNIT 2    KINEMATICS                                                           9**
Inverse Kinematics – General properties of solutions tool configuration, Five axis robots, Three- Four axis, Six axis Robot, Workspace analysis and trajectory planning work envelope and examples, work space fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion - Direct and inverse kinematics for various robot configurations.

**UNIT 3   ROBOT VISION                                                          9**
Robot Vision Image Processing and Perception: Representation, segmentation, feature extraction, object recognition, and depth estimation for robotic tasks. – Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration.

**UNIT 4   PLANNING                                                             9**
Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.

**UNIT 5   APPLICATIONS                                                         9**
Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynaecology, Orthopaedics, Neurosurgery- Other emerging applications: drug delivery, microsurgery, telemedicine.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.    1.   Robert Schilling, "Fundamentals of Robotics-Analysis and control", Prentice Hall, 2003.
2.    1.   J.J.Craig, "Introduction to Robotics", Pearson Education,7th Edition, 2016.

**REFERENCES:**
1.    Staugaard, Andrew C,"Robotics and Artificial Intelligence: An Introduction to Applied   Machine Learning", Prentice Hall Of India, 2006.
2.    Grover, Wiess, Nagel, Oderey, "Industrial Robotics: Technology, Programming and Applications", McGraw Hill, 2012.
3.    Wolfram Stadler, "Analytical Robotics and Mechatronics", McGraw Hill, 1995.
4.    Saeed B. Niku, "Introduction to Robotics: Analysis, Systems, Applications", Prentice Hall, 2001.
5.    K. S. Fu, R. C. Gonzales and C. S. G. Lee, "Robotics", McGraw Hill, 2008.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Understand the basics of robotic systems.
CO2    Design basic Robotics system and formulate Kinematics.
CO3    Construct Inverse Kinematic motion planning solutions for various Robotic configurations.
CO4    Design Robotic systems for Medical application.

CO5    Explore various applications of Robots in Medicine.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|------|------|
| **CO 1** | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **CO 2** | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **CO 3** | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **CO 4** | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |
| **CO 5** | 3 | 2 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME46**                                    **BIOMIMETICS**                              **L  T  P  C**
                                                                                           **3  0  0  3**
**Pre-requisites: 22BMT32 - Biochemistry**

**Preamble:**
Biomimetics is the field of science and engineering that seeks to understand and to use nature as a model for copying, adapting, and inspiring concepts and designs The students will learn essential concepts of biomimicry using multiple perspectives including biology, design, business and engineering. Biomimicry is the process of learning about and from nature in order to transfer that knowledge and propose innovative solutions to human-related problems.That same process also helps advance knowledge creation in Biomedical Engineering.

**UNIT 1      BIOLOGICALLY INSPIRED TECHNOLOGIES AND MECHANISMS                  9**
Artificial Intelligence, Artificial and Biomimetic Materials, Vision and Colors, Artificial Muscles, Inchworm Motors. Robotics as a Beneficiary of Biomimetic Technologies, Nature as a Source of Innovation for Operation in Water, Birds and Insects as the Source of Inspiring Flight: Birdman Flying Sport, A Bird like Flying Device with Flapping Wings, Morphing Aircraft Wings, Anti-G Fluid-Pressurized Pilot Suit Inspired by the Dragonfly.

**UNIT 2      EVOLUTIONARY ROBOTICS AND OPEN-ENDED DESIGN AUTOMATION      9**
Model of Evolutionary Adaptation, Machine Bodies and Brains: Evolving Controllers, Evolving Bodies and Brains. Morphology Representations: Tree Representations. Developmental Representations, Regulatory Network Representations. Evolving Machines in Physical Reality: Evolving Controllers for Physical Morphologies, Making Morphological Changes in Hardware. The Economy of Design Automation

**UNIT 3      GENETIC ALGORITHMS: MIMICKING EVOLUTION AND NATURAL              9**
             **SELECTION IN OPTIMIZATION MODELS**
Common Metaheuristic Methods, The Framework of Genetic Algorithms, Modifications of the Genetic Algorithm Framework: Parallel Genetic Algorithms, Compounded Genetic Algorithms, Hybrid Genetic Algorithms, Mutations, Invasions,  Gender, Distance-Based Parent Selection , Removal of Population Members,  The Genetic Algorithm Process,    Steepest Descent Algorithm, Mutation, Calculating Diversity , Application: Balancing a Turbine Engine, Turbine Balancing

**UNIT 4      BIO-NANOROBOTICS: A FIELD INSPIRED BY NATURE                      9**
Biomolecular Machine:  The ATPase Motor, Kinesin and Myosin, The Flagella Motors, DNA-Based Molecular Nanomachines, Joints, and Actuators, nanosensors , Design and Control Philosophies for Nanorobotic Systems,  Bio-Nano Components, Assembled Bio-Nanorobots,  Distributive Intelligence, Programming and Control, Automatic Fabrication and Information Processing Machines, Design Architecture for the Bio-Nanorobotic Systems, Self-Replication — Mimetics: A Novel Property of Living Systems

**UNIT 5      DEFENSE AND ATTACK STRATEGIES AND MECHANISMS IN BIOLOGY      9**
Acoustics: Blast Wave Projector, Infrasound, Squawk Box, Anti lethal devices, Body Armor,  Passive Camouflage, Warning Coloration, Active Camouflage,  Translucent Camouflage,  Reflecting Camouflage, Motion Camouflage, False Target Generation, Barriers, Slick Coating, Sticky Coating, Sticky,  Rope, Smoke, Stakes Bio-technicals Hypodermic Syringe or Dart Neuro-Implant, Pheromones, Elastic Mechanisms, Electrical Stun Gun, Entanglers: Bola, Cloggers, Projectile, Water Stream, Riot Control Agent, Chemical Mace, Operational,  Long-Term Disablement Passive Deterrents,  Physiological: Neurochemical Diversion . Surveillance  Electrosensing
                                                                     **TOTAL:  45 PERIODS**

**TEXT BOOKS:**
1    Yoseph Bar-Cohen, Biomimetics- Biologically Inspired Technologies, CRC Press, 2005.

2    Yoseph Bar-Cohen,  Biomimetics Nature - Based Innovation,  , CRC Press, 2012

**REFERENCES:**
1    SabariGhosal, A.K. Srivastava, Fundamentals of Bioanalytical Techniques and Instrumentation, PHI Learning Private limited, 2013.
2    G.W. Ewing, Instrumental Methods of Chemical Analysis, 5$^{th}$Edition, 1985, McGraw HillBooks Co., NewYork.
3    Romana Santos, "Biological And Biomimetic Adhesives Challenges And Opportunities" RSC Publicing,, 2013.

**e-RESOURCES:**
1    NPTEL,http://nptel.ac.in/courses/103108100/#, "Modern Instrumental Methods of Analysis", Prof. Dr. J.R. Mudakavi, IISc, Bangalore.
2    NPTEL,  http://nptel.ac.in/courses/104104066/,"Advance  Analytical  Course",  Prof.  Dr.  Padma  S Vankar,IIT, Kanpur.
3    https://www.mdpi.com/journal/biomimetics,  " Journal of Biomimetics"

**Course outcomes: Upon completion of the course, students will be able to:**
1    Explain the principle and working of spectrophotometer used in medical diagnosis.
2    Choose the correct chromatography technique to separate the constituents from a complex mixture.
3    Suggest a suitable thermos and electrochemical instrument to measure the biochemicals.
4    Discuss the principles of operation of instruments that measure the products of combustion.
5    Compare the working principles of NMR and mass spectrophotometers.

**CO – PO Mapping:**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO1 | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| CO2 | 2 | 3 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| CO3 | 2 | 1 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| CO4 | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| CO5 | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)      "-" No correlation

| 22BME47 | **FORENSIC SCIENCE IN HEALTHCARE** | **L T P C** |
|---|---|---|
| | | **3 0 0 3** |

**Pre-requisites:** 22BM31- Biochemistry

**Preamble:** To understand the nature, meaning and significance of forensic science and its relation to health care.

**UNIT1 INTRODUCTION TO FORENSIC SCIENCE 9**

History of Forensic Science- Branches of Forensic Science-Forensic Experts -An Expert's Role- Daubert and Fryes principle- Scientific Methods of Crime Investigation-Principles of Forensic science - Forensic Laboratories Setup in India.The Forensic ScienceLaboratory- Organization- Role of the Forensic Scientist and Investigator– Laboratory Section-Analytical Instruments-Specialized Equipment-Evidence: Biological, Trace, Fingerprint,Impression, Firearm and Tool Mark, Chemical Photographic and Questioned Documents

**UNIT2 IDENTIFICATION AND EXAMINATION OFFINGERPRINTS 9**

Fingerprint-History-Fingerprints as Evidence - Fingerprints as means of Identification –Description of Fingerprints-Fingerprint Patterns – Fingerprint Classification-Computerization of Fingerprints- Development of Latent Fingerprints- Recognition, Collection and Preservation of Fingerprint Evidence- palm prints, lip prints, ear prints and nail prints

**UNIT3 DIGITAL FORENSICS 9**

Applications of Computers in ForensicScience / Environmental Science -Use of Computers in Forensic Science – Forensic Databases –Image Databases-DNA Databases –Paint Databases-Forensic Archiving of X-Ray Spectra –Video Image Processing and Animation Software – Use of Network in Forensic Science.

**UNIT4 HEALTHCARE ROLE IN EVIDENCE COLLECTION 9**

Healthcare Providers, Categories of Evidence, Types of Evidence Physical Evidence, Trace Evidence, Verbal Evidence, Demonstrative Evidence, Testimonial Evidence, Digital or Electronic Evidence, Behavioral Evidence, Basic Principles of Evidence Collection, General Procedures, Personal Protective Equipment

**UNIT5 BIOMETRICS IN PERSONAL IDENTIFICATION 9**

Concepts of Biometric Authentication,Role in person Identification, Techniques and Technologies (Finger Print Technology, Face Recognition,IRIS, Retina Geometry, Hand Geometry, Speaker Recognition, Signature Verification and other forensicrelated techniques). Bioterrorism: Definition, Concepts of Biosecurity and microbial forensics

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**
1. James, S.H and Nordby, J.J. Forensic Science: An introduction to scientific and investigative techniques, Second edition, CRC Press, (2005)
2. Connie Darnell, "Forensic Science in Healthcare: Caring for Patients, Preserving the Evidence"CRC Press, 2012

**REFERENCES:**
1. Kiland by Stuart H. JamesJon 1. NordbySuzanne Bell "Forensic ScienceAn Introduction to Scientific and Investigative Techniques" Fourth Edition, CRC Press, 2014.
2. Max M. Houck 1 Jay. A. Siegel "Foundamentals of forensic science", Third edition, Academic Press imprint of Elsevier, 2015.
3. Saferstein R.: "Criminalistics – An Introduction to Forensic Science", 10thedition, Prentice Hall , 1998

**e-RESOURCES:**
1. NPTEL https://nptel.ac.in/courses/109106408,"Forensic Linguistics",Prof. Deepak Mashru, National Forensic Sciences Universtiy (INI).

2    NPTELhttps://onlinecourses.swayam2.ac.in/cec20_ge10/preview "Introduction of Forensic Science Services & Police Organization"By Prof. Devasish Bose.
3    NPTELhttps://onlinecourses.swayam2.ac.in/cec19_cs03/preview. "Criminalistics", By Prof. Devasish Bose.

**Course outcomes: Upon completion of the course, students will be able to:**
1. Explain the concept of forensic science.
2. Describe the identification methods of finger prints.
3. Discuss the principles and applications of digital forensics
4. Choose the suitable techniques for evidence collection
5. Apply appropriate biometric method for personal identification.

**CO – PO Mapping:**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO1** | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO2** | 2 | 3 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO3** | 2 | 1 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO4** | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO5** | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)     "-" No correlation

| 22BME51 | BIOMEMS AND NEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisites: 22BMT34 – SENSORS AND MEASUREMENTS**

**Preamble**
BioMEMS is the application of MEMS (Microelectromechanical Systems) technology in the fields of biomedical and health sciences. Various bio-MEMS products have been developed, such as microfluidic devices, neural interface devices, µTAS (micro total analysis systems), lab-on-a-chip, DNA chips, micro drug delivery system, microsurgical tools, bio-sensors. This course introduces to students about the fundamentals of bio-MEMS technology, typical BioMEMS devices and their applications.

**UNIT 1   MEMS IN HEALTHCARE                                                                                    9**
MEMS and Microsystems- Introduction - Typical MEMS and Microsystem Products - Application of Microsystem in Healthcare Industry – Working Principles of Microsystems Micro-sensors – Micro-actuation - MEMS with Micro actuation– Micro accelerators.

**UNIT 2     FUNDAMENTALS OF MOEMS                                                                          9**
Micro-Opto Electromechanical Systems: Fundamental principle of MOEMS Technology, Advantages - Light Modulators, Beam splitter – Micro-lens, Micro-mirrors - Digital Micro-mirror Device, Grating Light Valve, Optical Switch, Waveguide and Tuning.

**UNIT 3   MICROFLUIDIC SYSTEMS                                                                                 9**
Microfluidics- Introduction and Fluid Properties, Applications of MFS- Fluid Actuation Methods Electrophoresis, Dielectrophoresis, Electrowetting, Optoelectrowetting, Electroosmosis Flow, Electrothermal Flow, Thermocapillary Effect- Microfluidic Channel- Microdispenser- Microneedle-Microfilter.

**UNIT 4   MICRO SENSORS                                                                                               9**
BioMEMS for Clinical Monitoring, Lab on a chip, DNA Sensors, E-Nose, E-Tongue. Microsystem approaches to PCR, MEMS based Implantable Drug Delivery System, Emerging BioMEMS Technology.

**UNIT 5   NANOSYSTEMS AND QUANTUM MECHANICS                                            9**
Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrodinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Tai-Ran Hsu, "MEMS & Microsystems- Design, Manufacture and Nanoscale Engineering", John Wiley & Sons, 2nd Edition 2008
2. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2002

**REFERENCES:**
1. Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill, 2 nd Reprint 2008
2. Albert Folch, "Introduction to Bio mems, " CRC Press, First Edition, 2012.
3. A.M. Dirac," Principles of Quantum Mechanics", Oxford University Press, Oxford, 1978

**e-Resources:**
1. https://link.springer.com/chapter/10.1007/978-3-642-02525-9_47, Bharat Bhushan, Springer Handbook of Nanotechnology.
2. https://researchconnect.press/JNNN-Articles/Advancements-in-MEMs-and-NEMs-from-Bio-tribological-Perspective.pdf?_t=1633963499, Jay Molino, Journal of Nanomedicine, Nanotechnology and Nanomaterials
3. https://www.sciencedirect.com/science/article/pii/S0020768324000428, C. Mandriota, Springer

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1   Describe the principle, components and regulatory consideration of BioMEMS.
CO2   Explain the various Microfabrication techniques.
CO3   Develop an appropriate method for identifying biomarkers using Microfluidic principles.
CO4   Design and implementation of Microsensors and Microactuators for biomedical applications.
CO5   Describe the fabrication and applications of NEMS technology.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 1 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 2** | 1 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 3** | 1 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 4** | 1 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 5** | 1 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME52**          **PRINCIPLES OF TISSUE ENGINEERING**      L   T   P   C
                                                                           3   0   0   3

**Pre-requisites:**

**Preamble**
Tissue engineering combines the principles of materials and <u>cell transplantation</u> to develop substitute tissues and promote endogenous regeneration. It combines the principles and technologies from the life, material and engineering sciences to develop functional substitutes for damaged or diseased organs.

**UNIT 1 INTRODUCTION TO CELL BIOLOGY**                                    **9**
Cell types – Progenitor cells – Cell growth and differentiation – Cell culture: Expansion – Transfer - Storage and Characterization – Cell signalling molecules – Growth factors – Cell attachment: Differential cell adhesion, Receptor-ligand binding – Cell surface markers.

**UNIT 2 INTRODUCTION TO TISSUE ENGINEERING**                          **9**
Fundamentals Of Stem Cell Tissue Engineering; Growth Factors; Extracellular Matrix: Structure, Function And Tissue Engineering Application; Mechanical Forces On Cells; Cell Adhesion; Cell Migration.

**UNIT 3 TISSUE ENGINEERED DEVICES**                                          **9**
Polymer Scaffold For Tissue Engineering Applications; Biomimetic Materials; Nanocomposite Scaffolds Tissue Engineering; Bioreactors; Regulatory Issues In Tissue Engineering..

**UNIT 4 TISSUE ENGINEERING MODELS**                                        **9**
Bioengineering Of Human Skin Substitute; Nerve Tissue Engineering; Musculoskeletal Tissue Engineering; Bone Tissue Engineering; Cartilage Tissue Engineering; Temporomandibular Tissue Engineering; Smooth Muscle Tissue Engineering; Esophagus Tissue Engineering.

**UNIT 5 TISSUE ENGINEERING APPLICATIONS**                                **9**
Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenrative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy, orthopedic applications, Stem cells and Gene therapy Physiological models, issue engineered therapies, product characterization, components, safety, efficacy. Preservation –freezing and drying. Patent protection and regulation of of tissue-engineered products, ethical issues.

                                             **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Joseph D.Bronzino "Tissue Engineering and Artificial Organs" Third Edition, Taylor and Francis, 2006.
2. Lanza, R., Langer, R., Vacanti, J. P., & Atala, A. (Eds.). (2020). Principles of tissue engineering. Academic press

**REFERENCES:**
1. Ulrich Meyer, Thomas Meyer, JorgHandschel, Hans peter Wiesmann "Fundamentals of tissue engineering and regenerative medicine" Springer ,First Edition , 2009.
2. Aldo R. Boccaccini , Julie E.Gough "Tissue engineering using ceramics and polymers" CRC PRESS, 2007
3. Angela K.Dillow, Anthony Lowman "Biomimetic materials and design" CRC PRESS, 2002.
4. Sophie Bottcher –Haberzeth and Thomas Biedermann" Skin tissue engineering methods and protocols" First edition, Springer network, 2019

**e-Resources:**
1. https://www.youtube.com/watch?v=bgRjFW5agvA, "Introduction to tissue engineering" Prof. Vignesh Muthuvijayan Department of Biotechnology, IIT MADRAS.

2.  https://www.youtube.com/watch?v=AEWqAcSeQm4 "Nano–Biomimicry" Prof Dr.P.Gopinath, Department of Biotechnology, IIT Roorkee.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Elucidate the principle of cell lines and interpret the types of growth factors, cellular matrix.

CO2   Evaluate the functions of cellular tension, adhesion and migrations.

CO3   Analyze the different material for scaffold fabrication and correlate the design with the immune responses.

CO4   Illustrate the interaction of bio, nanomaterial with supporting materials and analyze the mobility, preservation.

CO5   Describe the biomolecules for drug delivery and identify the substitute material for artificial organs.

**Mapping of COs with POs and PSOs**

| Cos/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 3 | | | 2 | 2 | 2 | 2 | | 1 | | 1 | | |
| **CO 2** | 3 | 3 | | | 2 | 2 | 2 | 2 | | 1 | | 1 | | |
| **CO 3** | 3 | 3 | | | 2 | 2 | 2 | 2 | | 1 | | 1 | | |
| **CO 4** | 3 | 3 | | | 2 | 2 | 2 | 2 | | 1 | | 1 | | |
| **CO 5** | 3 | 3 | | | 2 | 2 | 2 | 2 | | 1 | | 1 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME53**              **PRINCIPLES OF GENETIC ENGINEERING**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Pre-requisites:** 22BM31 Biochemistry

**Preamble:** This course is designed to develop an understanding of fundamental and applied aspects of genetics and molecular biology which includes classical Mendalian genetics, Chromosome structure and organization DNA sequencing and Gene cloning.

### UNIT 1    FUNDAMENTALS OF GENETICS                                   9
Classical genetics, Mendelian Laws- Mendel's experiment-monohybrid cross-phenotype, genotype, Dihybrid inheritance, Interaction of genes, Fine structure of Genes

### UNIT 2    CHROMOSOMES                                                9
Chromosome structure and organization in prokaryotes and eukaryotes, unusual chromosomes- chromosome banding, chromosome abnormalities- genetic disorders

### UNIT 3    RECOMBINANT DNA TECHNIQUES                                 9
Enzymes used in DNA technology, Isolation and purification of DNA (genomic and plasmid) and RNA, Electrophoresis: Agarose, PAGE, Pulse-field electrophoresis, capillary electrophoresis, 2D electrophoresis.

### UNIT 4    DNA SEQUENCING                                            9
Polymerase chain reaction and its applications, RTPCR, DNA sequencing, Oligonucleotide synthesis, Blotting techniques- Southern, northern and western.

### UNIT 5    GENE CLONING                                              9
Restriction enzymes: Recognition site and types, Cloning vectors: Plasmid, Bacteriophage, Cosmid, Human artificial chromosome, Cloning techniques, Genetic Engineering applications with examples.

**TOTAL:  45 PERIODS**

**TEXT BOOKS:**
1  P.S. Verma and V.K.Agarwal, "Genetics", 1st Edition, S.Chand and Company, Newdelhi, 2014
2  R.W.Old and S.P.Primrose, "Principles of Gene manipulation: An Introduction to Genetic Engineering" 6th edition, blackwell scientific publications, New Jersey, 2003.

**REFERENCES:**
1  Benjamin A. Pierce,  Genetics: A Conceptual Approach, 6th edition,W. H. Freeman publication, 2016.
2  Desmond S. T. Nicholl, An Introduction to Genetic Engineering, Cambridge University Press, 4th edition, 2023.
3  **Tariq Ahmad Bhat, PhD Jameel M. Al-Khayri, PhD,**  Genetic Engineering, Volume 1 Principles, Mechanism, and Expression, CRC Press.

**e-RESOURCES:**
1  NPTEL, https://nptel.ac.in/courses/102103013 , "Genetic Engineering & Applications ", Dr. Utpal Bora IIT Guwahati
2  https://www.sciencedirect.com/topics/neuroscience/genetic-engineering, "International Journal of Genetic Engineering"
3  https://www.britannica.com/science/genetic-engineering, Britannica, The Editors of Encyclopaedia.

**Course outcomes: Upon completion of the course, students will be able to:**
1  Explain the concept of Gene and gene inheritance.
2  Describe the chromosome structure and organization in prokaryotes and eukaryotes**.**
3  Choose the suitable techniques for isolation of DNA.
4  Discuss the principles of DNA sequencing and amplification techniques.
5  Apply appropriate enzyme, vector and techniques for gene cloning.

**CO – PO Mapping:**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO1** | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO2** | 2 | 3 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO3** | 2 | 1 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO4** | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO5** | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)      "-" No correlation

**22BME54**            **PHARMACEUTICAL ENGINEERING**            L    T    P    C
                                                                3    0    0    3

**Pre-requisites: Nil**

**Preamble**
This course is designed to impart a fundamental knowledge on the art and science of various unit operations used in pharmaceutical industry.

**UNIT 1    SIZE REDUCTION AND SEPARATION                                        9**
Size Reduction: Objectives, Mechanisms & Laws governing size reduction, factors affecting size reduction, principles, construction, working, uses, merits and demerits of Hammer mill, ball mill, fluid energy mill, Edge runner mill & end runner mill.
Size Separation: Objectives, applications & mechanism of size separation, official standards of powders, sieves, size separation Principles, construction, working, uses, merits and demerits of Sieve shaker, cyclone separator, Air separator, Bag filter & elutriation tank.

**UNIT 2    EVAPORATION AND DISTILLATION TECHNOLOGY                            10**
Heat Transfer: Objectives, applications & Heat transfer mechanisms. Fourier's law, Heat transfer by conduction, convection & radiation. Heat interchangers & heat exchangers.
Evaporation: Objectives, applications and factors influencing evaporation, differences between evaporation and other heat process. principles, construction, working, uses, merits and demerits of Steam jacketed kettle, horizontal tube evaporator, climbing film evaporator, forced circulation evaporator, multiple effect evaporator& Economy of multiple effect evaporator.
Distillation: Basic Principles and methodology of simple distillation, flash distillation, fractional distillation, distillation under reduced pressure, steam distillation & molecular distillation

**UNIT 3    MIXING AND DRYING TECHNOLOGY                                        9**
Drying: Objectives, applications & mechanism of drying process, measurements & applications of Equilibrium Moisture content, rate of drying curve. principles, construction, working, uses, merits and demerits of Tray dryer, drum dryer spray dryer, fluidized bed dryer, vacuum dryer, freeze dryer.
Mixing: Objectives, applications & factors affecting mixing, Difference between solid and liquid mixing, mechanism of solid mixing, liquids mixing and semisolids mixing. Principles, Construction, Working, uses, Merits and Demerits of Double cone blender, twin shell blender, ribbon blender, Sigma blade mixer, planetary mixers, Propellers, Turbines, Paddles & Silverson Emulsifier.

**UNIT 4    FILTRATION AND CENTRIFUGATION                                       9**
Filtration: Objectives, applications, Theories & Factors influencing filtration, filter aids, filter medias. Principle, Construction, Working, Uses, Merits and demerits of plate & frame filter, filter leaf, rotary drum filter, Meta filter & Cartridge filter, membrane filters and Seidtz filter.
Centrifugation: Objectives, principle & applications of Centrifugation, principles, construction, working, uses, merits and demerits of Perforated basket centrifuge, Non-perforated basket centrifuge, semi continuous centrifuge & super centrifuge.

**UNIT 5    MATERIALS OF PHARMACEUTICAL PLANT CONSTRUCTION, CORROSION AND ITS PREVENTION                                    8**
Factors affecting during materials selected for Pharmaceutical plant construction, Theories of corrosion, types of corrosion and there prevention. Ferrous and nonferrous metals, inorganic and organic non metals, basic of material handling systems.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1.  C.V.S. Subrahmanyam, "Pharmaceutical engineering Unit operations principles and practices", Vallabh Prakashan, 2019.
2.  K Sambamurthy, "Pharmaceutical Engineering", New Age International (P) Limited, 2007.

**REFERENCES:**
1. Y. Sultana, "Unit Operations in Pharmaceutical Engineering", CBS Publishers & Distributors, 2018.
2. McCabe WL, Smith J.C and Harriott, "Unit operations of Chemical Engineering", McGraw Hill International Book Co. London, 2004
3. Girish K.Jani, "Pharmaceutical Engineering I, Unit Operation I", B.S.Shah Prakashan, India, 2006.

**e-Resources:**
1. https://www.iit.edu/academics/programs/pharmaceutical-engineering-certificate, Pharmaceutical Engineering.
2. https://in.coursera.org/learn/pharma-medical-device-innovations, Prof. Stephen T Parente, Pharmaceutical and Medical Device Innovations.

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Explain appropriate size reduction technology in drug manufacturing. |
| CO2 | Discuss the fundamental concepts of evaporation and distillation of materials in Pharmaceutical industry |
| CO3 | Use the modern tools for mixing and drying of drug materials. |
| CO4 | Differentiate filtration and centrifugation techniques. |
| CO5 | Recognize the various categories of materials used in pharmaceutical industry. |

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 3 | 2 | | 1 | | | | | 2 | | 2 | 2 | |
| CO 2 | 2 | 3 | 2 | | 1 | | | | | 2 | | 2 | 2 | |
| CO 3 | 2 | 3 | 2 | | 1 | | | | | 2 | | 2 | 2 | |
| CO 4 | 2 | 3 | 2 | | 1 | | | | | 2 | | 2 | 2 | |
| CO 5 | 2 | 3 | 2 | | 1 | | | | | 2 | | 2 | 2 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BME55 | BIOPHOTONICS | L | T | P | C |
|---------|--------------|---|---|---|---|
|         |              | 3 | 0 | 0 | 3 |

**Pre-requisites: Nil**

**Preamble**

Biophotonics deals with interactions between light and biological matter. It is an exciting frontier which involves a fusion of photonics and biology. It offers great hope for the early detection of diseases and for new modalities of light guided and light activated therapies.

**UNIT 1     PHOTONIC DETECTION AND IMAGING TECHNIQUES                    9**

Introduction to photonics. Physical phenomenon in tissue optics. Confocal microscopy, Two - photon excitation fluorescence microscopy, Near - field Imaging in biological and biomedical applications, Optical coherence tomography imaging,Speckle correlometry, Laser Doppler perfusion monitoring and imaging, Light scatter spectroscopy and imaging of cellular and sub cellular events, Thermal imaging for biological and medical diagnostics, Optical wave guide biosensors.

**UNIT 2     BIOMEDICAL DIAGNOSTICS                                        9**

Functional imaging with diffusing light, Photon migration spectroscopy frequency -domain techniques, Atomic spectrometry in biological and clinical analysis, Fluorescence spectroscopy, Elastic - scattering spectroscopy and diffuse reflectance, Raman spectroscopy, Quantitative characterization of biological tissue using optical spectroscopy, Near – infraredfluorescence Imaging and Spectroscopy, Optoacoustic Tomography, Ultrasonically modulated optical imaging.

**UNIT 3     INTERVENTION AND TREATMENT TECHNIQUES                        9**

Mechanistic principles of photo dynamic therapy, Synthetic strategies in designing porphyrin - based photo sensitizers for photodynamic therapy, Light Irradiation for photodynamic therapy-source-Light Dosimetry-Light delivery, Two photon Photodynamic therapy (PDT), Case study and clinical applications.

**UNIT 4     PRODUCTION AND APPLICATIONS OF LASER                         9**

Tissue engineering with Laser, Laser tissue welding, Lasers in interventional pulmonology, Lasers in urosurgery, Low - power laser therapy, Image - guided surgery, Optical methods for caries detection, Laser tweezers and scissors, diagnosis and therapeutic intervention.

**UNIT 5     ADVANCED BIOPHOTONICS FOR GENOMICS, PROTEOMICS, AND          9
             MEDICINE**

Recent developments in Fourier Transform Infrared (FTIR) Micro spectroscopic methods for biomedical analyses, Living- cells analysis using optical methods, Amplification techniques for optical detection, nanosensors for single – cell analyses. Advanced photonics: Optical trapping techniques in bio analysis, in vivo bioluminescence imaging as a tool for drug development.

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Tuan Vo Dinh ,"Biomedical Photonics Handbook", 2nd edition, Volume 3, CRC Press, 2014.
2. David L. Andrews, Photonics, Volume 4, "Biomedical Photonics, Spectroscopy, and Microscopy", Wiley & Sons, 2015.

**REFERENCES:**
1. David A. Boas, ConstantinosPitris, and NimmiRamanujam, "Handbook of Biomedical Optics", 1st Edition, CRC Press, 2011.
2. P. N. Prasad,"Introduction to biophotonics", John Wiley & Sons, Inc, 2003.
3. Markolf H. Niemz,"Laser-Tissue Interactions", Springer, 2007.

**e-Resources:**
1. https://nptel.ac.in/courses/117/108/117108037, "Biophotonics", Dr.ManojVarma, IISc Bangalore.
2. https://www.classcentral.com/course/swayam-biophotonics-22923, "Biophotonics", Prof. Basudev Lahiri, IIT Kanpur.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Describe Photonic detection and imaging techniques for medical diagnostics using optical imaging methods.

CO2   Characterize biological tissues using various spectroscopy techniques.

CO3   Depict the principles of photodynamic therapy in treatment of skin disorders.

CO4   Explain the production and applications of LASER in medicine for diagnostic and therapeutic intervention.

CO5   Examine living cells using advanced photonic techniques for drug development.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | | 2 | | | | | 2 | | 2 | 3 | |
| CO 2 | 2 | 3 | 2 | | 2 | | | | | 2 | | 2 | 3 | |
| CO 3 | 2 | 3 | 2 | | 2 | | | | | 2 | | 2 | 3 | |
| CO 4 | 2 | 3 | 2 | | 2 | | | | | 2 | | 2 | 3 | |
| CO 5 | 2 | 3 | 2 | | 2 | | | | | 2 | | 2 | 3 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**Pre-requisites: 22BMT32 BIOCHEMISTRY**
**Preamble:**
Analytical instrumentation plays a dominant role in the estimation of bio chemical components in different chemical environment. This course familiarizes the fundamental principles, instrumentation and application of conventional and modern analytical techniques used in medical diagnosis.

### UNIT 1        FUNDAMENTALS OF SPECTROPHOTOMETER                                9
Electromagnetic spectrum, Interaction of radiation with matter, Laws relating to Absorption of radiation - Beer-Lambert"s Law, Absorption instruments, Colorimeter, Types of Spectrophotometers – single and Double Beam Instruments, Infrared spectrophotometer. Flame Photometer

### UNIT 2        PRINCIPLES OF CHROMATOGRAPHY TECHNIQUES                          9
Definition - Chromatography, Types of chromatography - Gas Chromatography, Liquid Chromatography and its types - Paper Chromatography, Thin Layer Chromatography, Column, Chromatography – Ion exchange chromatography, Gel permeation Chromatography, High Pressure Liquid Chromatography.

### UNIT 3        THERMO AND ELECTROCHEMICAL INSTRUMENTS                           9
Thermo analytical methods- Thermo Gravimetric Analysis, Differential thermal analysis, Differential scanning colorimetry, Electrochemical method and its types – Electrochemical cell, Types of electrode, Potentiometers, conductivity meters, voltammetry, polarographs, coulometer, Amperometers.

### UNIT 4        BLOOD GAS ANALYZER                                               9
Principles of pH measurements, pH Electrode – Hydrogen, glass, calomel, Ag-Agcl electrode. pH meters, Ion Analyzer, Measurement of Blood pH, $pO_2$, $pCO_2$. Infrared and thermal gas analyzer.

### UNIT 5        NUCLEAR MAGNETIC RESONANCE AND MASS SPECTROMETERS                9
NMR – Basic principles, Types of NMR spectrometer. Electron spin Resonancespectroscopy – Basic principles, Instrumentation and applications. Electron spectrometer – Basic principles, Instrumentation, Ion Spectroscopy –Instrumentation. Mass spectrometers – Different types and Applications.

**TOTAL:  45 PERIODS**

**TEXT BOOKS:**
1  R.S. Khandpur, Handbook of Analytical Instrumentation, 3rd Edition, McGraw Hill Education, Newdelhi,
   2015
2  Braun, R.D., Introduction to Instrumental Analysis, McGraw – Hill, Singapore, 2nd Edision 2012

**REFERENCES:**
1  SabariGhosal, A.K. Srivastava, Fundamentals of Bioanalytical Techniques and Instrumentation, PHI
   Learning Private limited, 2013.
2  G.W. Ewing, Instrumental Methods of Chemical Analysis, 5[th]Edition, May 2013, McGraw HillBooks Co., NewYork.
3  Bela G. Liptak,  Analytical Instrumentation,  CRC Press 1994

**e-RESOURCES:**
1     NPTEL,http://nptel.ac.in/courses/103108100/#, "Modern Instrumental Methods of Analysis", Prof. Dr. J.R. Mudakavi, IISc, Bangalore.
2     NPTEL, http://nptel.ac.in/courses/104104066/,"Advance Analytical Course", Prof. Dr. Padma S Vankar,IIT, Kanpur.
3     https://dfsl.maharashtra.gov.in/en/general-analytical-and-instrumentation# "**General Analytical and Instrumentation"**  Directorate of Forensic Science Laboratories.

**Course outcomes: Upon completion of the course, students will be able to:**

1 Explain the principle and working of spectrophotometer used in medical diagnosis.
2 Choose the correct chromatography technique to separate the constituents from a complex mixture.
3 Suggest a suitable thermos and electrochemical instrument to measure the biochemicals.
4 Discuss the principles of operation of instruments that measure the products of combustion.
5 Compare the working principles of NMR and mass spectrophotometers.

**CO – PO Mapping:**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO1** | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO2** | 2 | 3 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO3** | 2 | 1 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO4** | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |
| **CO5** | 2 | 2 | 2 | 1 | 1 | | | | | 2 | | 2 | 2 | |

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)      "-" No correlation

**Pre-requisites: 22MAT41 Probability and Random Processes**

**Preamble:**
Biostatistics is a statistical science including methods of collecting, organizing and analyzing data in such a system that meaningful conclusions can be drawn from them. The data are obtainable in the form of tables and graphs. Statistics also deals with the processing of data devoid of attempting draw any Interfaces from it. The characteristics of the data are described in simple terms. It is a scientific restraint that uses mathematical tools to make forecasts and projections by analyzing the given data. This is for use to inhabitants employed in Biomedical engineering.

### UNIT 1      CLASSIFICATION AND TABULATION OF DATA           9
Introduction, Meaning and Objectives of Classification, Objectives of Classification, Types of Classification, Geographical Classification, Chronological Classification, Qualitative Classification, Quantitative Classification, Formation of a Discrete Frequency Distribution, Formation of Continuous Frequency Distribution, Class Limits, Class Intervals, Class Frequency, Class Mid-Point or Class Mark, Considerations in the Construction of Frequency Distributions, Relative Frequency Distribution, Bivariate or Two-Way Frequency Distribution, Tabulation of Data, Difference Between Classification and Tabulation, Role of Tabulation, Parts of a Table, General Rules of Tabulation, Review of the Table, Types of Tables, Simple and Complex Tables, General and Special Purpose Tables.

### UNIT 2      DIAGRAMMATIC AND GRAPHIC PRESENTATION           9
Introduction, Significance of Diagrams and Graphs, Comparison of Tabular and Diagrammatic Presentation, Difference Between Diagrams and Graphs, General Rules for Constructing Diagrams: Title, Proportion Between Width and Height, Selection of Scale, Footnotes, Index, Neatness and Cleanliness, Simplicity. Types of Diagrams: One-Dimensional or Bar Diagrams, Two-Dimensional Diagrams, Squares, Circles, Pictograms and Cartograms, Choice of a Suitable Diagram. Graphs: Technique of Constructing Graphs, Graphs of Time Series or Line Graphs, Rules for Constructing the Line Graphs on Natural Scale, Graphs of One Variable, Graph of Two or More Variables, Graphs Having Two Scales, Range Chart, Band Graph, Semi-Logarithmic Line Graphs or Ratio Charts, Interpretation of Logarithmic Curves. Graphs of Frequency Distributions: Histogram, Frequency Polygon, Smoothed Frequency Curve, Cumulative Frequency Curves or Ogives

### UNIT 3      MEASURES OF CENTRAL VALUE           9
Introduction, Average Defined, Objectives of Averaging, Requisites of a Good Average. Types of Averages: Arithmetic Mean, Calculation of Arithmetic Mean—Continuous Series. Median: Calculation of Median—Continuous Series. Computation of Quartiles, Decides, Percentiles. Geometric Mean: Properties of Geometric Mean, Calculation of Geometric Mean—Individual Observations, Calculation of Geometric Mean—Discrete Series, Calculation of Geometric Mean—Continuous Series, Uses of Geometric Mean, Weighted Geometric Mean. Harmonic Mean: Calculation of Harmonic Mean—Individual Observations, Calculation of Harmonic Mean—Discrete Series, Calculation of Harmonic Mean—Continuous Series, Uses of Harmonic Mean, Weighted Harmonic Mean, Merits and Limitations of Harmonic Mean

### UNIT 4      MEASURES OF DISPERSION, SKEWNESS, MOMENTS AND KURTOSIS      9
Introduction, Significance of Measuring Variation, Range, The Interquartile Range or the Quartile Deviation, The Mean Deviation: Calculation of Mean Deviation—Continuous Series, Merits and Limitations. The Standard Deviation: Calculation of Standard Deviation. Difference Between Dispersion and Skewness. Tests of Skewness, Measures of Skewness, Absolute Measures of Skewness, Relative Measures of Skewness, Bowley's Coefficient of Skewness, Kelly's Coefficient of Skewness, Measure of Skewness Based on the Third Moment. Moments: Moments About Arbitrary Origin, Conversion of Moments About an Arbitrary Origin Into Moments About Mean or Central Moments, Moments About Zero, Sheppard's Correction for

Grouping Errors, Conditions for Applying Sheppard's Corrections, Measure of Skewness Based on Moments, Kurtosis, Measures of Kurtosis

### UNIT 5     CORRELATION ANALYSIS                                                       9
Introduction, Significance of the Study of Correlation, Types of Correlation:  Positive and Negative Correlation, Simple, Partial and Multiple Correlation, Linear and No-Linear (Curvilinear) Correlation. Methods of Studying Correlation: Scatter Diagram Method, Merits and Limitations of the Method, Graphic Method, Karl Pearson's Coefficient of Correlation, Calculation of Correlation in Grouped Data, Assumption of the Pearsonian Coefficient, Merits and Limitations of the Pearsonian Coefficient, Interpreting Coefficient of Correlation. Rank Correlation Coefficient,  Features of Spearman's Correlation Coefficient,  Where Ranks are Not Given , Merits and Limitations of the Rank Method .

**TOTAL:  45 PERIODS**

**TEXT BOOKS:**
1    Gupta S.P (2021), Statistical Methods, 46$^{th}$ Edition, Sultan Chand & Sons, Educational Publishers, New Delhi
2    Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.

**REFERENCES:**
1     Miller, Irwin and Miller, Marylees (2006): John E. Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
2     Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co. Ltd.
3     Bernard Rosner "Fundamentals of Biostatistics" Seventh Edoition,  Cengage Learning, Inc. 2010

**e-RESOURCES:**
1     https://onlinecourses.nptel.ac.in/noc19_bt19/preview **Introduction to Biostatistics,** By Prof. Shamik , IIT Bombay.
2     https://www.cartercenter.org › ln-biostat-hss-final,  "Biostatistics",  G Degu
3     https://www.sciencedirect.com/book/9780123694928/biostatistics,  " **Biostatistics"** Ronald N. Forthofer, Eun Sul Lee and Mike Hernandez

**Course outcomes: Upon completion of the course, students will be able to:**
  1  Apply basic statistical concepts commonly used in health Sciences
  2  Demonstrate the basic methods in Diagrammatic and Graphic Presentation of data.
  3  Determine best measure of central tendency in a given circumstance.
  4  Calculate the Dispersion, Skewness, Moments And Kurtosis for the given data
  5  Apply statistical knowledge to design, conduct and interpret  research studies

**CO – PO Mapping:**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 1 | | | | | | 2 | | 2 | | |
| **CO2** | 2 | 3 | 2 | 1 | | | | | | 2 | | 2 | | |
| **CO3** | 2 | 1 | 2 | 1 | | | | | | 2 | | 2 | | |
| **CO4** | 2 | 2 | 2 | 1 | | | | | | 2 | | 2 | | |
| **CO5** | 2 | 2 | 2 | 1 | | | | | | 2 | | 2 | | |

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)     "-" No correlation

**22BME61    MODERN TRENDS IN PLANNING AND DESIGNING OF HOSPITALS    L    T    P    C**
**3    0    0    3**

**Pre-requisites : Hospital Management**

**Preamble**
To understand the medical device standards, requirements, and design procedure of medical devices and to describe about the design realization, validation and verification of various medical devices

**UNIT 1    HOSPITAL PLANNING                                                                                9**
Principles of planning, regionalization, hospital planning team, planning process, size of the hospital, site selection, hospital architect, architect report, equipping a hospital, interiors & graphics, construction & commissioning, planning for preventing injuries, electrical safety.

**UNIT 2    TECHNICAL ANALYSIS                                                                           9**
Assessment of the demand and need for hospital services factors influencing hospital utilization-bed planning-land requirements-project cost-space requirements-hospital drawings and documents-preparing project report

**UNIT 3    PLANNING & DESIGNING OF DIFFERENT SERVICES IN HOSPITALS          9**
Planning and designing of administrative services, medical and ancillary services, nursing services, supportive services, public areas and staff services, hospital services

**UNIT 4    HOSPITAL STANDARDS AND DESIGN                                                  9**
Building requirement-entrance and ambulatory zone-diagnostic zone-intermediate zone-critical zone-service zone-administrative zone-list of utilities-communication facility-biomedical equipment voluntary and mandatory standards-general standards-medical standards-electrical standards-standard for centralized medical gas system-standards for biomedical waste

**UNIT 5    FACILITIES PLANNING                                                                          9**
Transport, Information system, Communication, Food services, Mortuary, Heating Ventilation and Air Conditioning, Medical gases, House Keeping, Laundry.

**Total : 45**

**TEXT BOOKS:**
1.    S.K.Gupta, S.kant, R.Chandrashekhar, S.Satpathy, Modern trends in planning and designing of hospitals: Principles and practice', Jaypee Brothers-Medical publishers, New Delhi, 2007.
2.    G.Kunders, Hospitals- Facilities Planning & Management, Tata Mcgraw - Hill education-2004.

**REFERENCES:**
1.    Purnima Sharma, Sangeet Sharma, Nerendra Malhotra, Jaideep Malhotra. Step by Step Hospital Designing and Planning, 2nd Edition, Jaypee Brothers-Medical publishers, New Delhi, 2010.
2.    SA Tabish, Hospital and Nursing Homes planning, Organisation and Management, Jaypee Brothers-Medical publishers, New Delhi, 2003

**e-RESOURCES:**
1.    https://youtu.be/utF-cRGNiJ8?si=u6OGGuIQo3RNb46R
2.    https://www.who.int/docs/default-source/wpro---documents/regional-committee/session-69/working-documents/wpr-rc69-9-improving-hospital-planning-management-annex.pdf?sfvrsn=ae45d622_4

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Define the medical devices standards and requirements.
CO2    Summarize the concept of medical device development

CO3    Recall the engineering design and project metrics
CO4    Demonstrate the testing and validation of medical equipment.
CO5    Interpret the various design transfer and manufacturing methods

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 1 | | 2 | | | 2 | | | 2 | | | 2 | |
| **CO 2** | 3 | 1 | | 2 | | | 2 | | | 2 | | | 2 | |
| **CO 3** | 3 | 1 | | 3 | | | 2 | | | 2 | | | 2 | |
| **CO 4** | 3 | 1 | | 3 | | | 3 | | | 2 | | | 2 | |
| **CO 5** | 3 | 1 | | 2 | | | 2 | | | 2 | | | 2 | |

**1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).**

| | | L | T | P | C |
|---|---|---|---|---|---|
| **22BME62** | **ELECTRICAL SAFETY AND QUALITY ASSURANCE** | 3 | 0 | 0 | 3 |

**Pre-requisites: Nil**

**Preamble**
The Electrical Safety is to make an aware of the role of biomedical engineer in hospitals, especially in the management of electrical supply and maintenance of electrical safety. The quality assurance is to provide basic knowledge on the concept of Healthcare Quality management towards continuous improvement of patient care.

**UNIT 1    INTRODUCTION TO ELECTRICAL SAFETY AND SAFETY MANAGEMENT**                                                                           9

Fundamentals of electricity and electrical systems – Relevant legislation, standards, and regulations – OSHA  regulation and standards – Electrical Hazards and risk – Types of Electrical Hazards – Effect of Electrical Current on the Human Body – Principles of Electrical Safety –Approaches to Prevent Accidents – Fire Prevention and Fire Fighting – Safety training and education.

**UNIT 2   ELECTRICAL SHOCKS AND FIRST AID**                                                                           9

Electric Shocks and its types – Occurrence and Possibility of Electric Shock - Severity of Electric Shock– Medical Analysis of Electric Shock and Its Effects– AC Shocks Versus DC Shocks– Effect of Impulse Discharge through Human Body – Shocks Due to Flashovers/Sparkovers – Prevention of Shocks– Installation of Earthing System–Functional Requirements of Earthing System – Neutral Grounding – First AID– First Principles of Actions After Electric Shock– Cardiac Pulmonary Resuscitation

**UNIT 3    SAFETY DURING INSTALLATION, TESTING AND COMMISSIONING, OPERATION AND MAINTENANCE**                                                                           9

Preliminary preparations – Safe Sequence During Installation – Selection, Inspection and maintenance of electrical equipments – Quality control and quality assurance in electrical installations –personal protective equipment – Steps in Commissioning - Zone wise Testing and Commissioning- safety clearance notice – safety precautions – Safeguards for Operators Safety – Types of Maintenance and Safety Process-Safety Precautions.

**UNIT 4   QUALITY MEDICAL CARE IN HOSPITALS**                                                                           9

Quality – Dimensions of Quality in Healthcare – Standards and codes compliance in healthcare settings – Present International and Indian scenario – Essentials of quality improvement in healthcare – Quality control and quality assurance in electrical equipment for medical use - implementation of quality management program- Inspection and testing of electrical systems and equipment for medical applications

**UNIT 5   REGULATORY REQUIREMENT FOR HEALTH CARE**                                                                           9

CE and FDA regulations, Accreditation for hospitals –ISO, JCI, NABH, NABL, GMP and BRC - Other regulatory Codes.

                                                                                                    **TOTAL :      45 PERIODS**

**TEXT BOOKS:**
1.    S. Rao, R.K. Jain, H.L. Saluja,"Electrical Safety, Fire Safety Engineering And Safety Management", Khanna Publishers, Second Edition, 2012.
2.    Joshi S. K., "Quality Management in Hospitals", Jaypee Brothers Medical Publishers, 2008.

**REFERENCES:**
1.   Joseph F.Dyro, "Clinical Engineering Handbook", Elsevier Publishers, 2004.

2.   Sharon Myers,"Patient Safety & Hospital Accreditation - A Model for Ensuring Success", SpringerPublishers, 2012.

**e-RESOURCES:**
1.   https://nptel.ac.in/courses/103/106/103106071/#Lecture-5-Electrical-Safety-Hazard.html.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Acquire the knowledge of electrical safety and hazards in a commercial building and hospitals.

CO2   Realize the effect of electrical shock in the human body and implement the first AID for the affected person.

CO3   Acquire the knowledge of electrical safety during the installation, testing and commissioning of electricalequipments.

CO4   Discuss the need and significance of quality practices and improvement of quality in the health care.

CO5   Identify the basic requirements of regulations and accreditation process for the CE, FDA, ISO, JCI andNABH.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 3 | 1 | 2 | - | - | - | - | - | 1 | 1 | - | 2 | - | - |
| CO 2 | 3 | 1 | 2 | - | - | - | - | - | 1 | 1 | - | 2 | - | - |
| CO 3 | 3 | 1 | 2 | - | - | - | - | - | 1 | 1 | - | 2 | - | - |
| CO 4 | 3 | 1 | 2 | - | - | - | - | - | 1 | 1 | - | 2 | - | - |
| CO 5 | 3 | 1 | 2 | - | - | - | - | - | 1 | 1 | - | 2 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BME63 | **MEDICAL ETHICS AND STANDARDS** | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**Pre-requisites:**

**Preamble**
This course is to achieve familiarity with some basic ethical framework& understand how these ethical frameworks can help us to think through contemporary questions in medical ethics. The course gives knowledge about the legal and ethical principles and application of these principles in health care settings. It helps the students gain knowledge about the medical standards that to be followed in hospitals.

**UNIT 1   INTRODUCTION TO MEDICAL ETHICS                              9**
Definition of Medical ethics, Scope of ethics in medicine, American medical Association code ofethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and the Patient, The Doctorand the Profession, Professional Independence, The Doctor and Society.

**UNIT 2   ETHICAL THEORIES AND MORAL THEORIES                       9**
Theories-Deontology &Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles Non Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research, Bioethical issues in Human Genetics & Reproductive Medicine.

**UNIT 3   MEDICAL STANDARDS                                           9**
Evolution of Medical Standards – IEEE 11073 - HL7 – DICOM – IRMA - LOINC – HIPPA –Electronics Patient Records – Healthcare Standard Organizations – JCAHO (Join Commission on Accreditation of Healthcare Organization) - JCIA (Joint Commission International Accreditation) - Evidence Based Medicine - Bioethics.

**UNIT 4   HOSPITAL ACCREDITATION AND SAFETY STANDARDS            9**
Accreditation - JCI Accreditation & its Policies. Patient centered standards, Healthcare Organization management standards -Indian Perspective. Life Safety Standards- Protecting Occupants, Protecting the Hospital From Fire, Smoke, and Heat, Protecting Individuals From Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards-Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.

**UNIT 5   MEDICAL EQUIPMENT SAFETY STANDARDS                       9**
General requirements for basic safety & essential performance of medical equipment. IEC 60601standardsBase Standard-general requirement of electrical medical devices, Collateral Standards EMC radiation protection &programmable medical device system, Particular Standards-type of medical device.

**Lecture : 45, Total : 45**

**TEXT BOOKS:**
1.   Daniel A Vallero, "Biomedical ethics for Engineers", Elsevier publication, 1st edition, 2007.
2.   Johnna Fisher, "Biomedical Ethics: A Canadian Focus." Oxford University Press Canada, 2009.

**REFERENCES:**
1.   Nils Hoppe and Jose Miola, "Medical law and Medical Ethics", Cambridge University Press,2014
2.   Robert M Veatch," Basics of Bio Ethics", Second Edition. Prentice- Hall,Inc, 2003.

**e-Resources:**
1.   https://nptel.ac.in/courses/109106092/, "Issues in Bioethics", Dr. Sreekumar Nellickappilly, IIT, Madras .

2. https://onlinecourses.nptel.ac.in/noc22_mg95/, "Ethics In Engineering Practice",Prof. Susmita Mukhopadhyay , IIT, Kharagpur .

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1 Identify the scope of medical ethics
CO2 Illustrate the concepts of ethical theories and moral principles for the health professions
CO3 Explain the purpose of medical standards
CO4 Acquire knowledge about hospital accreditation standards and Summarize the importance of hospital safety standards
CO5 Recommend the suitable principles of medical equipment safety standards in hospitals

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 1 | 1 | - | - | - | 2 | - | 3 | - | 1 | - | 1 | 1 | - |
| CO 2 | 1 | 1 | - | - | - | 2 | - | 3 | - | 1 | - | 1 | 1 | - |
| CO 3 | 1 | 1 | - | - | - | 2 | - | 3 | - | 1 | - | 1 | 1 | - |
| CO 4 | 1 | 1 | - | - | - | 2 | - | 3 | - | 1 | - | 1 | 1 | - |
| CO 5 | 1 | 1 | - | - | - | 2 | - | 3 | - | 1 | - | 1 | 1 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME64**      **PRODUCTIVITY MANAGEMENT AND ENGINEERING**      **L**   **T**   **P**   **C**
                                                                                  **3**   **0**   **0**   **3**

**Pre-requisites: Nil**

**Preamble**
To introduce the basic principles of Productivity models and the applications of Engineering concepts required for various organizations and society. Apply analytical skills and problem-solving tools to the analysis of the re-engineering process improvement models.

**UNIT 1    PRODUCTIVITY**                                                               9**
Productivity Concepts – Macro and Micro factors of productivity – Dynamics of Productivity - Productivity Cycle – Productivity Measurement at International, National and Organisation level - Productivity measurement models

**UNIT 2     SYSTEMS APPROACH TO PRODUCTIVITY MEASUREMENT**           **9**
Conceptual frame work-Management by Objectives (MBO)- Performance Objectivated Productivity (POP) – Methodology and application to manufacturing and service sector.

**UNIT 3    ORGANISATIONAL TRANSFORMATION**                               **9**
Elements of Organisational Transformation and Reengineering-Principles of organizational transformation and re-engineering-fundamentals of process re-engineering- preparing the workforce for transformation and re-engineering, methodology, guidelines- LMI CIP Model – DSMC Q & PMP model.

**UNIT 4    RE-ENGINEERING PROCESS IMPROVEMENT MODELS**                 **9**
PMI models- PASIM Model- Moen and Nolan Strategy for process improvement- LMICIP Model-NPRDC Model.

**UNIT 5    RE-ENGINEERING TOOLS AND IMPLEMENTATION**                     **9**
Analytical and process tools and techniques – Information and Communication Technology – Implementation of Reengineering Projects – Success Factors and common implementation Problem – Cases.

                                                         **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Edosomwan, J.A., "Organisational Transformation and Process Re-engineering", Library Cataloging in Pub. Data, 1996.
2. Premvrat, Sardana, G.D. and Sahay, B.S., "Productivity Management – A Systems Approach", Narosa Publishing House. New Delhi, 1998.

**REFERENCES:**
1. Rastogi, P.N., "Re-engineering and Re-inventing the Enterprise", Wheeler Pub. New Delhi, 1995.
2. Sumanth, D.J., 'Productivity Engineering and Management', TMH, New Delhi, 1990.
3. Chand, S., "Industrial Engineering and Production Management",Martand T Telsang,Third Edition.

**e-Resources:**
1. https://nptel.ac.in/courses/112107143, "Production Planning and Control", Dr.D.K.Dwivedi, Dr.Inderdeep Singh, Dr.Pradeep Kumar, Prof.P.K.Jain, Industrial Engineering, IIT Roorkie.
2. http://www.toknowpress.net/ISBN/978-961-6914-05-5.pdf, "Productivity Management in an Organization:Measurement and Analysis", Dr.Kongkiti Phusavat,Kasetsart University, Thailand.

**Course Outcomes:** Upon completion of this course, students will be able to:
 CO1    Explain Productivity of an organization, evaluate it, and  find ways to improve it

**CO2**    Design the systems for measuring total productivity/total factor productivity/partial productivity in manufacturing and service sectors

**CO3**    Set the targets for meeting productivity levels and in turn improve the performance in different functional areas.

**CO4**    Implement BPR tools for improving the productivity.

**CO5**    Re-Engineer the process for improving the productivity with the help of models.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 2 | 2 | | 2 | 1 | | | | 1 | | 2 | 1 | |
| **CO 2** | 3 | 2 | 2 | | 2 | 1 | | | | 1 | | 2 | 1 | |
| **CO 3** | 3 | 2 | 2 | | 2 | 1 | | | | 1 | | 2 | 1 | |
| **CO 4** | 3 | 2 | 2 | | 2 | 1 | | | | 1 | | 2 | 1 | |
| **CO 5** | 3 | 2 | 2 | | 2 | 1 | | | | 1 | | 2 | 1 | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME65**  **BIOMEDICAL WASTE MANAGEMENT**  **L  T  P  C**

**3  0  0  3**

**Pre-requisites: 21BMT44 – HOSPITAL MANAGEMENT**
**Preamble**
This course helps the students to understand the significance of infections, biomedical waste and its proper handling, storage and disposal. Also this course gives the knowledge about the technologies, safety and risk factors involved in treatment and disposal of biomedical wastes.

**UNIT 1   BIOMEDICAL WASTE MANAGEMENT**                                        **9**
Introduction – biomedical waste – hazardous, non-hazardous – classification of biomedical waste – source of biomedical waste – major source, minor source – classifications of biomedical waste – need of biomedical waste management in hospitals – waste management hierarchy – color coding and label for biomedical waste segregation.

**UNIT 2     IDENTIFICATION, HANDLING AND STORAGE OF MEDICAL WASTE**        **9**
Identifying infectious waste - types of infectious waste- containers and packaging-Containment of Sharps, Containment of Solid Wastes, Containment of Liquids-waste handling practices-Waste Collection, Waste Storage – treatment consideration- Onsite Treatment of Infectious Waste, Offsite Treatment of Infectious Waste.

**UNIT 3   HAZARDOUS MATERIALS**                                              **9**
Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Respiratory Protection.

**UNIT 4   DISPOSAL AND MINIMIZATION OF TREATED WASTE**                       **9**
Landfill disposal - incinerator ash, sharps, pathological wastes, red bags - discharge to the sanitary sewer system – minimizing infectious waste- source separation, volume and weight reduction techniques.

**UNIT 5   SAFETY AND RISK ANALYSIS**                                         **9**
Occupational Safety for Waste Management-Preparing for Hazardous Material Emergencies - Training Staff and Waste Handlers- Essential Components of Effective Waste Management.

**Lecture : 45, Tutorial : 0, Total : 45**
**TEXT BOOKS:**
1.    Gordon, Judith G. Reinhardt, Peter A , "Infectious and medical waste management",CRC press,2016.
2.    Madhuri Sharma, "Hospital Waste Management And Its Monitoring", Jaypee Brothers Medical Publishers, 2nd Edition,2017.

**REFERENCES:**
1.    Jorge Emmanuel, Charles J. Puccia, Robert A. Spurgin, "Non-incineration medical waste treatment technologies", health care without harm,2011.
2.    C.R.BRUNNER, "Medical Waste Disposable Handbook", Incentrated, Consultant in Corporated, Virginia, 2000.
3.    Dr. G. Latha, Dr. M. Rajasekhar, "Biomedical Waste Management in Hospitals", Lulu Publication,2021.

**e-Resources:**
1.    https://dth.ac.in/medical/courses/Microbiology/block-9/3/index.php, "Biomedical waste and its management",Nptelcourse,IIT Madras.
2.    https://gmch.gov.in/estudy/e%20lectures/Community%20Medicine/Biomedical%20Waste%20Management.pdf, "Biomedical waste management", Dr. NAVPREET,Govt. Medical College & Hospital, Chandigarh.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Explain the basic concepts involved in the waste management for effective disposal of medical waste.

CO2    Describe the handling and storage methods involved in hospital for disposal of infectious medical waste.

CO3    Summarizing the technologies used in the treatment of hospital medical waste for the hazardous free environment.

CO4    Explain the methods involved in the disposal of biomedical waste to create infection free zone around the hospital.

CO5    Describe the challenges and safety measures involved in managing the hazardous waste for effective operation of the hospital.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | - |
| **CO 2** | 1 | 3 | - | 2 | - | 1 | 2 | - | - | - | - | 1 | - | - |
| **CO 3** | 2 | - | 2 | - | 1 | - | 3 | - | - | - | - | - | 2 | - |
| **CO 4** | - | - | 1 | 3 | 2 | - | 2 | - | - | - | - | - | 1 | - |
| **CO 5** | - | 1 | 3 | - | 1 | - | 2 | - | - | - | - | 2 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BME66     TROUBLESHOOTING AND MAINTENANCE OF MEDICAL       L   T   P   C**
**                   EQUIPMENT                                                                      3   0   0   3**

**Pre-requisites : Electronic Circuits, Medical Instrumentation, Radiological Instrument**

**Preamble**

To understand the troubleshooting of electrical and electronic and medical equipment and is to apply the tools in design, testing and developing medical equipment**.**

**UNIT 1     TESTING OF ELECTRICAL EQUIPMENT                                            9**

AC, DC power supply, Grounding, shielding, Guarding, insulation testing, insulation resistance measurement, Types of Circuit Breakers, Rating – Testing of circuit breakers –Transformer testing- Earthing –Earth wires - Earthing of appliances –contactor, relay testing–CT and PT, Panel wiring- Megger-Testing equipment and instruments.

**UNIT 2     TESTING OF ELECTRONIC COMPONENTS                                     9**

Troubleshooting of PCB, Calibration of analog and digital sensor probe, Display interface, DC Power supply design, testing, Safe electrical practice, Cables and standard, Fuse.

**UNIT 3     TROUBLESHOOTING OF MEDICAL EQUIPMENTS                         9**

Functions and operating procedure-Testing and maintenance of Heart lung machine, surgical lights, ventilator, patient monitor, anesthesia machine, dialyzer, surgical tools. Troubleshooting of X-ray machines, ECG recorders, incubator, baby warmer, infusion pumps, annual maintenance, contract requirements, vendor services, quality and safety standards.

**UNIT 4     LIFE CYCLE MANAGEMENT OF MEDICAL EQUIPMENT                 9**

Cost of the medical equipment, maintenance cost, replacement analysis, managing equipment service, decision making, extracting optimal benefit from medical equipment over its life cycle. Case study.

**UNIT 5     RELIABILITY IN MEDICAL DEVICES                                              9**

Need for reliability, Tools for reliability assurance, MTBF, MTTR, FMEA, Fault tree analysis, Markov method, cause failure analysis. Human errors in healthcare systems, human factors approach to reduce error, Quality assurance through regulatory compliance: ISO: 9000, FDA, IEEE, ASTM, UL, CE. Computerized Maintenance management system for medical equipment.

**Total : 45**

**TEXT BOOKS:**
1.     David Herres, "Troubleshooting and Repairing Commercial Electrical Equipment", McGraw Hill Professional edition, 2013.
2.     R. S. Khandpur, "Troubleshooting Electronic Equipment" 1st Edition, McGraw Hill, 2007.
3.     Keith Willson, Keith Ison, Slavik Tabakov, "Medical equipment management", CRC Press, UK, 2014

**REFERENCES:**
1.     Joseph. J Carr, John M Brown, Introduction to Biomedical Equipment Technology, John Wiley& Sons, New York,4thedition, 2008.
2.     David Herres, "Troubleshooting and Repairing Commercial Electrical Equipment", McGraw Hill Professional edition, 2013.

**e-RESOURCES:**
1.     https://www.biomedics.com.au/resources/medical-equipment-testing-maintenance-guide/
2.     https://main.mohfw.gov.in/sites/default/files/BMMP_Technical%20Manual_0.pdf

**Course Outcomes:** Upon completion of this course, students will be able to:
 CO1     Apply testing techniques to diagnose and troubleshoot the electric circuits.

CO2 Apply testing techniques to diagnose and troubleshoot electronic components.
CO3 Demonstrate the ability to troubleshoot and maintain medical equipment.
CO4 Analyze life cycle management principles in the context of medical equipment.
CO5 Evaluate reliability tools and quality assurance in medical devices.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 3 | 2 | 1 | | | 2 | | | 1 | 2 | | | 2 | 3 |
| **CO 2** | 3 | 2 | 1 | | | 2 | | | 1 | 2 | | | 2 | 3 |
| **CO 3** | 3 | 3 | 2 | | | 2 | | | 2 | 3 | | | 3 | 3 |
| **CO 4** | 2 | 1 | 3 | | | 2 | | | 2 | 1 | | | 3 | 2 |
| **CO 5** | 3 | 2 | 2 | | | 3 | | | 3 | 2 | | | 3 | 3 |

**1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).**

**22BME67**                    **MEDICAL DEVICE REGULATION & SAFETY**          **L   T   P   C**
                                                                              **3   0   0   3**

**Pre-requisites: Nil**

**Preamble**
The course showcases the Quality management system, Standardization and safety for medical devices. The students are able to enumerate the compatibility standards for medical devices and describe the medical device regulations. Also the Students are able to list the steps taken for usability testing.

**UNIT 1    STANDARDS AND SAFETY**                                            **9**
Quality management system for medical devices -ISO 9001 and ISO13485, Safety and Standardization for Risk management -ISO 14971, European standard conformity (CE marking), FDA guidelines for medical devices approval and classification based on risk assessment.

**UNIT 2    COMPATIBILITY STANDARDS  FOR  MEDICAL DEVICES**                   **9**
Evaluation of biocompatibility of medical devices-ISO 10993 Series, Electromagnetic compatibility standards of medical equipment -IEC 60601 series, Medical device software -IEC 62104.

**UNIT 3    MEDICAL DEVICE REGULATION**                                       **9**
Medical device and in vitro diagnostics: Introduction & types of devices including combination devices. Medical Device Rules, 2017: Implications on medical devices. Classification of medical devices. Labeling of medical devices and in vitro diagnostics.

**UNIT 4    CLASSIFICATION OF MEDICAL DEVICES**                               **9**
Classification of In-vitro diagnostic medical devices-Classification of medical devices in United States - Class I, Class II, Class III. Classification of medical devices in Canada - Class I, Class II, Class III, Class IV. Classification of medical devices in United Kingdom: class I, Class IIa, Class IIb and Class III. Classification of medical devices in India-Class A, Class B, Class C and Class D.

**UNIT 5    USABILITY TESTING**                                               **9**
Introduction –Usability testing and Risk management -common elements of usability test-types of test - conducting, documenting and analyzing the test. Design validation.

                                                                   **Lecture : 45, Total : 45**

**TEXT BOOKS:**
1.  Seeram Ramakrishna, Lingling Tian, Charlene Wang, Susan Liao, Wee Eong Teo,   Medical Devices Regulations, Standards and Practice, Wood head Publishing, 1ˢᵗ Edition, 2015.
2.  MDR17, Regulation of Medical Devices, MINISTRY OF HEALTH AND FAMILY WELFARE, New Delhi, 2017.
3.  Michael E. Wiklund P.E., Jonathan   Kendler, Allison Y. Strochlic, Usability Testing of Medical Devices, CRC Press, 2010.

**REFERENCES:**
1.  Joseph D. Nally (ed.), Good Manufacturing Practices for Pharmaceuticals, CRC Press, sixth edition, 2007.
2.  Joint Commission International Accreditation Standards for Hospitals, Joint Commission International, 6ᵗʰ Edition, 2017.
3.  Use of International Standard ISO 10993-1, "Biological evaluation of medical devices - Part 1: Evaluation and testing within a risk, U.S. Department of Health and Human Services Food and Drug Administration, September 4, 2020.

**e-Resources:**
1.  https://cdsco.gov.in/opencms/export/sites/CDSCO_WEB/Pdf-documents/medicaldevice/Classificationg1.pdf, Classification of medical devices and in vitro diagnostic medical devices under the provisions of the Medical Devices Rules, Directorate General of Health Services, New Delhi , 2017.

2. https://www.iso.org/obp/ui/#iso:std:iec:62366:-1:ed-1:v1:en, Application of usability engineering to medical devices, ISO - International Organization for Standardization.
3. https://nptel.ac.in/courses/127106136, Regulatory requirements for medical devices including in vitro diagnostics in India (Version 2.0), Prof.   Arun B.Ramteke, Prof. Aseem Sahu, Prof. Malay Mitra.  IIT Madras.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1   Discuss the safety and standardization of medical devices.
CO2   Acquire the knowledge of compatibility standards for medical devices.
CO3   Describe the medical device regulation and its implications on medical Equipment.
CO4   Extend the classification of medical devices for different countries.
CO5   Explain the procedure about Usability Testing.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 1 | 1 | | | | 2 | 2 | 2 | | | | 1 | 2 | 2 |
| CO 2 | 1 | 1 | | | | 2 | 2 | 2 | | | | 1 | 2 | 2 |
| CO 3 | 1 | 1 | | | | 2 | 2 | 2 | | | | 1 | 2 | 2 |
| CO 4 | 1 | 1 | | | | 2 | 2 | 2 | | | | 1 | 2 | 2 |
| CO 5 | 1 | 1 | | | | 2 | 2 | 2 | | | | 1 | 2 | 2 |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMO01**        **BIOMETRIC SYSTEMS AND THEIR APPLICATIONS**     **L   T   P   C**
                                                                                 **3   0   0   3**

**Pre-requisites: Nil**

**Preamble**

Biometric system helps to impart the knowledge on design of biometric systems and the underlying trade-offs. It enables the students to understand the technologies in fingerprint, iris, face recognition and hand geometry.

**UNIT 1    BIOMETRICS SYSTEM**                                            **9**

History of Biometrics – Types of Biometric Traits – General Architecture of Biometric Systems – Basic working of Biometric matching – Biometric system error and performance measure.

**UNIT 2     FINGERPRINT BIOMETRICS**                                 **9**

Finger print using vein pattern of palm – Fingerprint Biometrics – Fingerprint recognition system – minutiae extraction – advantage and disadvantages of fingerprint biometrics.

**UNIT 3    FACE RECOGNITION**                                            **9**

Background of face recognition – design of face recognition system - neural network for face recognition - face detection in video sequences - face recognition methods.

**UNIT 4    IRIS RECOGNITION & HAND GEOMETRY**                         **9**

Design of iris recognition system – iris segmentation method – application of iris biometrics – basics of hand geometry – image capturing, hand segmentation, feature extraction.

**UNIT 5    PRIVACY CONCERNS & MULTIMODAL BIOMETRICS**               **9**

Privacy concerns with Biometric Deployments – Privacy Enhancement and comparison with other biometrics. Basic architecture of multi model biometrics – multi model biometrics using face and ear – case study of biometric application.

                                                  **Lecture: 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**

1. G.R.Sinha, SandeepB.Patel, "Biometrics:Concepts and Applications", Wiley Publicatios, 1st edition,2013.
2. James Wayman, Anil Jain, DavideMaltoni, Dario Maio, "Biometric Systems, Technology Design and Performance Evaluation", Springer, 2005.

**REFERENCES:**

1. David Zhang, "3D Biometrics: Systems and Applications", Springer- 2013
2. Arun A Ross, KarthikNandakumarand Anil K.Jain, "Handbook of Multibiometics", Springer,2006
3. Anil K. Jain, "Introduction to Biometrics" Springer, - 2011

**e-Resources:**

1. http:// NPTEL/biometrics- IIT-kanpur, "Biometric Systems", Prof. PhalguniGupt , IIT, khanpur.
2. 100.pdf (ijsr.net), Shilpa Shrivastava, International Journal of Science and Research (IJSR)
3. DT2014_SlovakiaREVIEWED2.pdf, K. Lai, S. Samoil, Research gate.

**Course Outcomes:** Upon completion of this course, students will be able to:

| | |
|---|---|
| CO1 | Demonstrate knowledge on biometric authentication system using biometric applications. |
| CO2 | Explain the fingerprint technology using fingerprint enhancement, feature extraction, classification and matching technique used for criminal application. |
| CO3 | Design face recognition system using neural network, video sequences used for various biometric applications |
| CO4 | Describe about iris recognition and hand geometry using segmentation and feature extraction technique used for commercial application |

| CO5 | Identify issues biometric privacy concern and multimodal biometrics using face and ear used for biometric application. |

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1 | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| CO 2 | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| CO 3 | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| CO 4 | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| CO 5 | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMO02**                    **HEALTHCARE MANAGEMENT SYSTEMS**              L   T   P   C
                                                                            3   0   0   3

**Pre-requisites:**

**Preamble**
The course covers the need and significance of Clinical Engineering and Health Policies in a healthcare management system. The course familiarizes the training strategies, quality management policies and information technology used in health care and the needs of managerial training to hospital staffs.

**UNIT 1**  **SCOPE OF CLINICAL ENGINEERING AND NATIONAL HEALTH POLICIES**                                                                              **9**
Clinical engineering program, Educational responsibilities, Role to be performed by them in hospital, Staff structure in hospital,Need for evolving health policy, Health organization in state, Health financing system, Health education, Health insurance, Health legislation.

**UNIT 2**  **MANAGEMENT OF TECHNICAL STAFF IN A HEALTHCARE SYSTEM**        **9**
Difference between hospital and industrial organization, Levels of training, Steps of training, Developing Training program, Evaluation of training, Wages and salary, Employee appraisal method.

**UNIT 3**  **CODES AND QUALITY MANAGEMENT IN HEALTHCARE**                  **9**
Quality management in hospitals and clinical laboratories, Necessity for standardization and Quality management, NABH and NABL standards, FDA, Joint Commission of Accreditation of hospitals.

**UNIT 4**  **STANDARDS IN HEALTHCARE**                                    **9**
ICRP and other standard organization, Methods to monitor the standards, Overview of Medical Device regulation and regulatory agencies.

**UNIT 5**  **COMPUTERS AND INFORMATION TECHNOLOGY IN HEALTHCARE**         **9**
Computer application in ICU, Picture Archival System (PACS) for Radiological images department, Clinical laboratory administration, Patient data and medical records, Communication, Simulation.

**Lecture : 45, Total : 45**

**TEXT BOOKS:**
1. R.C. Goyal, "Handbook of Hospital Personal Management", Prentice Hall of India, 2008.
2. Joseph. F. Dyro, "Clinical Engineering Management", Academic Press Series in Biomedical Engineering, 2004.

**REFERENCES:**
1. Antony Kelly, "Strategic Maintenance planning", Butterworths London, 2006.
2. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006.
3. B.M. Sakharkar, "Principles of hospital administration and planning", Jaypee Brothers Medical Publishers Pvt Limited, 2$^{nd}$ edition, 2009.
4. Norman Metzger, "Handbook of Health Care Human Resources Management", 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.

**e-Resources:**
1. https://www.youtube.com/watch?v=ZZS8-ySBNFM, "Organisation and Management of Hospital", Prof. S.B.Aroara, Professor, School of Health Sciences,
   Indira Gandhi National Open University (IGNOU), MaidanGarhi, New Delhi.
2. http://www.nptelvideos.in/2012/11/human-resource-management-i.html, "Lecture Series on Human Resource Management-I", Prof.Kalyan Chakravarti, Vinod Gupta School of Management, IIT Kharagpur.

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Identify the need for clinical engineering in healthcare system and evaluate the use of various health policies.

CO2    Describe how high quality training is delivered for technical staff.

CO3    Demonstrate the quality management concept in health care.

CO4    Debate the concepts of quality and safety.

CO5    Apply the concept of information technology in medicine.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | - | - | - | - | - | - | 2 | - | - | - | 3 | 1 | - | - |
| CO 2 | - | - | - | - | - | - | - | - | - | - | 3 | 1 | - | - |
| CO 3 | - | - | - | - | - | 2 | - | - | - | - | 3 | 1 | - | - |
| CO 4 | - | - | - | - | - | 3 | - | - | - | - | 2 | 1 | - | - |
| CO 5 | - | - | - | - | 3 | 2 | - | - | - | - | - | 1 | - | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMO03**                    **BASICS OF BIOINFORMATICS**

**L  T  P  C**
**3  0  0  3**

**Pre-requisites : Nil**

**Preamble:**
This course covers the application of computer science, statistics, and engineering to research and interpret biological data. It also focuses on extracting new information from massive quantities of biological data and familiarize with the modeling techniques and tools for capturingprocessing and analyzing large data sets.

**UNIT I      BIOLOGICAL DATA ACQUISITION                                      9**
The form of biological information. Retrieval methods for DNA sequence, protein sequence and protein structure information

**UNIT 2     BIOLOGICAL DATABASES                                              9**
Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence and structure databases, Organism specific databases

**UNIT 3     RETRIEVAL AND DATA PROCESSING                                     9**
Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches: Localversus global. Distance metrics. Similarity and homology. Scoring matrices

**UNIT 4     METHODS OF ANALYSIS                                               9**
Dynamic programming algorithms, Needleman-wunsch and Smith-waterman. Heuristic Methods of sequence alignment, FASTA and PSI BLAST. Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment.

**UNIT 5    APPLICATIONS                                                       9**
Genome Annotation and Gene Prediction; ORF finding; Phylogenetic Analysis : Comparative genomics, orthologs, paralogs. Genome analysis – Genome annotation.

**TOTAL :    45  PERIODS**

**TEXT BOOKS:**
1.   Arthur K. Lesk, "Introduction to Bioinformatics", Oxford University, Fifth Edition, 2019.
2.   David W. Mount, "Bioinformatics: Sequence and Genome Analysis", Cold Spring Harbor Laboratory Press,  2nd edition,2004
3.   Durbin, S.Eddy, A.Krogh, G.Mitchison, "Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids "Cambridge University, 7th edition,2002.

**REFERENCES:**
1.   Bryan Bergeron, "Bio Informatics Computing", Second Edition, Pearson Education, 2003.
2.   Yi-Ping Phoebe Chen Edition, "Bio Informatics Technologies", First Indian Reprint, Springer Verlag, 2007

**e-RESOURCES:**
1.   https://academic.oup.com/books/searchresults?q=bioinformatics&fl_SiteID=6283&SearchSource Type=1&allJournals=1&access_openaccess=true
2.   https://in.coursera.org/lecture/bioinformatics-pku/overview-of-resources-WlYAG.

**Course Outcomes: Upon completion of the course, students will be able to:**
1.   Explain the structure and information derived from living organisms and their products.
2.   Classify the biological databases assequence and structure databases.
3.   Infer an approach to build search query and sequence alignment.
4.   Identify sequence structure, alignment and search queryfor automated clinical diagnosis.
5.   Discuss the application of Genome analysis used in biological data classification.

**CO – PO Mapping:**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO1** | 1 | 2 | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - |
| **CO2** | 2 | 1 | - | - | 1 | - | - | - | - | 1 | - | 1 | 3 | - |
| **CO3** | 3 | 1 | - | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| **CO4** | 2 | 2 | - | - | 2 | - | - | - | - | 1 | - | 1 | 2 | - |
| **CO5** | 2 | 1 | - | - | - | - | - | - | - | 1 | - | 1 | 1 | - |

1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)     "-" No correlation

**Pre-requisites: Nil**

**Preamble**
The purpose of this course is to provide a basic understanding of biological mechanisms of living organisms.. In addition, the course is expected to encourage engineering students to think about solving biological problems with engineering tools.

**UNIT 1    BASIC CELL BIOLOGY**                                               **9**
Cell Structure and organelles - Functions of each component in the cell. Cell membrane –transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions.

**UNIT 2    INTRODUCTION TO BIO-MOLECULES**                               **9**
Classification of carbohydrates - mono, di, oligo and polysaccharides, physical and chemical properties of carbohydrates. Classification of lipids- simple, compound, and derived lipids. Classification and properties of proteins, structural organization of proteins, Nucleic acid: – Components of DNA and RNA, Double helical structure of DNA (Watson-Crick model),

**UNIT 3    HUMAN PHYSIOLOGY**                                                   **9**
Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle, Digestive system: Organs of Digestive system – Digestion and Absorption. Respiratory system: Parts of respiratory system – Lung volumes and capacities – Gaseous exchange, Excretary system: Structure of Kidney and Nephron – Mechanisms of Urine formation.Nervous system– Brain and spinal cord

**UNIT 4    GENES, REPLICATION OF DNA, AND INTRODUCTION TO RECOMBINANT DNA TECHNOLOGY**       **9**
Prokaryotic gene and Eukaryotic gene structure, gene replication, Transcription and Translation in Prokaryote and Eukaryote cell. Recombinant DNA technology and Introduction to cloning.

**UNIT 5    APPLICATION OF BIOLOGY**                                               **9**
Brief introduction to Production of vaccines, Enzymes, antibodies. Basics of biosensors, biochips, Bio fuels. Tissue engineering and its application.

                                                            **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. S. ThyagaRajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," Tata McGraw-Hill, New Delhi, 2012.
2. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2018.
3. T Johnson, Biology for Engineers, CRC press, 2011 Molecular Biology and Biotechnology 2nd ed. J.M. Walker and E.B. Gingold. Panima Publications. PP 434.

**REFERENCES:**
1. Jeremy M. Berg, John L. Tymoczko and LubertStryer, "Biochemistry," W.H. Freeman and Co. Ltd., 6th Ed., 2006.
2. Robert Weaver, "Molecular Biology," MCGraw-Hill, 5th Edition, 2012.
3. Jon Cooper, "Biosensors A Practical Approach" Bellwether Books, 2004.

**e-Resources:**
1. https://nptel.ac.in/courses/121/106/121106008/, ' Biology For Engineers and Othernon-Biologists ' Prof. Suraishkumar & Prof. Madhulika Dixit, IIT Madras.
2. https://freevideolectures.com/course/4877/nptel-biology-engineers-other-non-biologists

3.    https://ocw.mit.edu/courses/20-020-introduction-to-biological-engineering-design-spring-2009
4.    https://ocw.mit.edu/courses/20-010j-introduction-to-bioengineering-be-010j-spring-2006

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Explain the cells, its structure and function, and Different types of cells and basis for Classification of living organisms.

CO2    Explain about bio molecules its structure and function and their role in a living organism.

CO3    Express the concept of biology and its uses in combination with different technologies for production of medicines and production of transgenic plants and animals.

CO4    Illustrate about genes and genetic materials (DNA & RNA) present in living organisms and how they replicate, transfer & preserve vital information in living organisms.

CO5    Discuss the importance of vaccines, biosensors in bio engineering and applications of tissue engineering.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | 3 | 3 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 2** | 3 | 3 | 3 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 3** | 3 | 3 | 3 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 4** | 3 | 3 | 3 | - | - | - | - | - | - | 2 | - | 2 | 3 | - |
| **CO 5** | 3 | 3 | 3 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

| 22BMO05 | REGULATORY REQUIREMENTS IN PHARMACEUTICAL INDUSTRIES | L | T | P | C |
|---------|------------------------------------------------------|---|---|---|---|
|         |                                                      | 3 | 0 | 0 | 3 |

**Pre-requisites: Nil**

**Preamble**

To impart fundamental knowledge on various Good Regulatory Practices for Pharmaceuticals, and to impart fundamental knowledge on documentation and general principles involved in regulatory writing and submission to agencies.

| UNIT 1 | REGULATORY CONCEPTS | 9 |
|--------|---------------------|---|

Quality assurance – Quality control – Practice of cGMP – Schedule M – USFDA.

| UNIT 2 | REGULATORY ASPECTS | 9 |
|--------|---------------------|---|

Pharmaceuticals: Bulk drug manufacture; Personnel, Buildings and Facilities, Process Equipment, Documentation and Records, Materials Management, Production and In-Process Controls, Packaging and Identification Labelling of API's and Intermediates, Storage and distribution, – Biotechnology derived products; Principles, Personnel, Premises and equipments, Animal quarters and care, production, labelling, Lot processing records and distribution records, quality assurance and quality control.

| UNIT 3 | INTELLECTUAL PROPERTY RIGHTS | 9 |
|--------|------------------------------|---|

Patent system – Different types of patents – Filing process of application for patent – Infringement of patents – The patent rules 2003 as amended by the patents (amendment) rules 2016.

| UNIT 4 | ICH GUIDELINES | 9 |
|--------|----------------|---|

Quality guidelines – Impurities in new drug substances (Q3A(R2)) – Impurities in newdrug products(Q3B(R2)) – Validation of analytical procedures text and methodology (Q2 (R1)).

| UNIT 5 | QUALITY AUDIT AND SELF INSPECTIONS | 9 |
|--------|-------------------------------------|---|

SOPs – Documentation – Loan license auditing – Common technical documentation (CTD) – Drug master file (DMF).

**Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**

| 1. | C.V.SSubbrahmanyam & J.Thimmasetty, Pharmaceutical regulatory affairs, 1st Edition., vallabh Prakashan, New Delhi, 2012 |
| 2. | Willig, H., Tuckeman, M.M. and Hitchings, W.S., "Good Manufacturing Practices for Pharmaceuticals", 5th Edition, Marcel Dekker Drugs and the Pharmaceutical Sciences, by CRC Press, New York, 2000. |

**REFERENCES:**

| 1. | Ira R. Berry,The Pharmaceutical Regulatory Process, marcel dekker Series: Drugs and the 73 Pharmaceutical Sciences, by CRC Press, Newyork, 2004. |
| 2. | Mindy J. Allport-Settle, Current Good Manufacturing Practices: Pharmaceutical, Biologics, and Medical Device Regulations and Guidance Documents Concise Reference, Pharmalogika Inc., USA, 2009. |
| 3. | Sharma, P.P., "How to Practice GMPs", 3rd Edition, Vandana Publications, 2006 |

**e-Resources:**

| 1. | http://www.fda.gov/regulatoryinformation/legislation/FederalFoodDrugandCosmeticActFDCAct/FDCActChapterVDrugsandDevices/ucm108125.htm |
| 2. | https://youtu.be/DauygxZJ4EQ,Current regulatory requirements for conducting clinical trials in India for investigational new drugs/new drug (Version 3.0),NPTEL Swayam. |

| Course Outcomes: Upon completion of this course, students will be able to: | |
|---|---|
| CO1 | To be familiarise with the pharmaceutical industry manufacturing practices and regulatory aspects of pharmacy products. |
| CO2 | The key regulatory and compliance elements with respect to Good Manufacturing Practices, Good Laboratory Practices, Good Automated Laboratory Practices and Good Documentation Practices. |
| CO3 | To know the process of patenting activities. |
| CO4 | To know the quality guidelines followed for pharmaceutical products and few of the aspects involved in document preparation for pharmaceutical product registration. |
| CO5 | Prepare for the readiness and conduct of audits and inspections. |

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| CO 1    | 2    | 3    | 3    |      |      | 1    |      | 1    |      |       |       | 1     |       |       |
| CO 2    | 2    | 3    | 3    |      |      | 1    |      | 1    |      |       |       | 1     |       |       |
| CO 3    | 2    | 3    | 3    |      |      | 1    |      | 1    |      |       |       | 1     |       |       |
| CO 4    | 2    | 3    | 3    |      |      | 1    |      | 1    |      |       |       | 1     |       |       |
| CO 5    | 2    | 3    | 3    |      |      | 1    |      | 1    |      |       |       | 1     |       |       |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMO06**                           **RAPID PROTOTYING**                    **L    T    P    C**
                                                                            **3    0    0    3**

**Pre-requisites: Nil**

**Preamble**
The course aims to provide an understanding of all the expected requirement of product are addressed and if required, its performance is also assessed from the prototype. Rapid prototyping offers a convenient option for manufacturing of product or its prototype from the CAD model.

**UNIT 1    INTRODUCTION TO PROTOTYPE                                            9**
Prototype Fundamentals – Historical Development – Three Phases of Development Leading to Rapid Prototyping – Fundamentals of Rapid Prototyping – Advantages of Rapid Prototyping – Classification of Rapid Prototyping Systems

**UNIT 2    PROCESS CHAIN & LIQUID-BASED RAPID PROTOTYPING SYSTEMS        9**
Fundamental Automated Processes – Process Chain –3D Systems' Stereolithography Apparatus (SLA) – Process – Principle, Applications – Cubital's Solid Ground Curing (SGC) – Process – Principle, Applications – D-Mec's Solid Creation System (SCS) – Process – Principle, Applications – Cmet's Solid Object Ultraviolet-Laser Printer (SOUP) – Process – Principle, Applications.

**UNIT 3    SOLID-BASED RAPID PROTOTYPING SYSTEMS                               9**
Cubic Technologies' Laminated Object Manufacturing (LOM) – Process – Principle, Applications Stratasys' Fused Deposition Modeling (FDM) – Process – Principle, Applications – Kira's Paper Lamination Technology (PLT) – Process – Principle, Applications –3D Systems' Multi-Jet Modeling System (MJM) — Process – Principle, Applications Solidscape's Modelmaker And Patternmaster – Process – Principle, Applications – The Shape Deposition Manufacturing Process– Process – Principle, Applications

**UNIT 4    POWDER-BASED RAPID PROTOTYPING SYSTEMS                             9**
3D Systems' Selective Laser Sintering (SLS) – Process – Principle, Applications – EOS's Eosint Systems– Process – Principle, Applications – Soligen's Direct Shell Production Casting (DSPC) – Process – Principle, Applications – Fraunhofer's Multiphase Jet Solidification (MJS) – Process – Principle, Applications – Therics Inc.'s Theriform Technology– Process – Principle, Applications – Extrude Hone's Prometal 3D Printing Process– Process – Principle, Applications

**UNIT 5    RAPID PROTOTYPING DATA FORMATS                                     9**
STL Format – STL File Problems – Consequences of Building a Valid and Invalid Tessellated Model – STL File Repair- Generic Solution – Special Algorithms – Performance Evaluation – Other Translators – Standard for Representing Layered Manufacturing Objects

                                                      **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Chua C.K., Leong K.F. and Lim C.S., "Rapid Prototyping: Principles and Applications", Second Edition, World scientific publications, 2003.
2. Chua C.K., Leong K.F. and Lim C.S., "Rapid Prototyping: Principles and Applications", Third Edition, World scientific publications, 2010.

**REFERENCES:**
1. Pham,D.T. and Dimov.S.S., "Rapid manufacturing" , Springer, London, 2001.
2. Roger Narayan, "Rapid prototyping of biomaterials: Principles and applications", First Edition, Woodhead Publishing , 2014

**e-RESOURCES:**
1. https://archive.nptel.ac.in/courses/112/104/112104265/ Rapid Prototyping, Prof. J.Ramkumar,IIT

Kanpur
2. https://nptel.ac.in/courses/112104204/47, Prof. Shantanu Battacharya, IIT Kanpur.

**Course Outcomes:** Upon completion of this course, students will be able to:
CO1    Describe the basics of Rapid Prototyping and its systems.
CO2    Explain the concept of process chain & liquid-based rapid prototyping systems.
CO3    Explicate the working principle of solid-based rapid prototyping systems with its applications.
CO4    Enumerate the process, principle and application of powder based rapid prototyping systems.
CO5    Discuss the rapid prototyping data formats and standard for representing layered manufacturing objects.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 1 | 3 | 1 | | 1 | | | | | 1 | | 2 | | |
| **CO 2** | 1 | 3 | 1 | | 1 | | | | | 1 | | 2 | | |
| **CO 3** | 1 | 3 | 1 | | 1 | | | | | 1 | | 2 | | |
| **CO 4** | 1 | 3 | 1 | | 1 | | | | | 1 | | 2 | | |
| **CO 5** | 1 | 3 | 1 | | 1 | | | | | 1 | | 2 | | |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMO07**          **RADIOTHERAPY BASICS AND APPLICATIONS**          **L   T   P   C**
                                                                        **3   0   0   3**

**Pre-requisites: Nil**

**Preamble**
This course aims to provide a broad view of interaction of radiation and source of radiotherapy and to measure the physical parameters.

**UNIT 1    NUCLEAR TRANSFORMATION                                                    9**
Natural and artificial radioactivity, Decay constant    Activity,    Physical and Biological Effective half-lives, Mean life, Decay processes, Radioactive series, Radioactive equilibrium.

**UNIT 2    INTERACTION OF RADIATION WITH MATTER                                      9**
Attenuation, scattering, absorption, Transmission, Attenuation coefficient, Half Value (HVL), Energy transfer, Absorption and their coefficients, Photoelectric effect, Compton effect.
Electron interactions with matter: Energy loss mechanism - Collision losses, radioactive losses, Ionisation, Excitation, Heat production, Delta rays, Polarization effects. Scattering, stopping power, absorbed dose, secondary electrons.

**UNIT 3    BASIC RADIATION THERAPY                                                   9**
Physical components of telecobalt Unit - Linear Accelerator   Unit - loading   Brachytherapy   Unit - Gamma   Knife   Unit   - Physics of Photons, electrons, protons and neutrons in radiotherapy, Physical parameters of dosimetry - percentage depth dose, Tissue - Air Ratio, Tissue maximum Ratio, Compensators,   Wedges, Shielding Blocks, Patient immobilization devices, Port film, Special techniques in Radiotherapy - SRS, SRT, IMRT, IGRT and Tomotherapy.

**UNIT 4    BEAM THERAPY                                                              9**
Various   sources   used   in   Radiotherapy   and   their   properties-   Physics   of   Photons, Electrons, Protons and Neutrons in Radiotherapy. Physical Parameters of dosimetry - Phantoms – percentage depth dose – Factors affecting percentage depth dose – Tissue air ratio- Back scatter factor, Tissue maximum Ratio – Factors affecting TAR & BSF, TMR.

**UNIT 5    CLINICAL APPLICATIONS                                                     9**
Skin   reaction   to   radiotherapy   –   Radiotherapy   of   Brain   -   Radiation   of   Abdomen   and   Pelvis   - Brachytherapy – Stereotactic radiosurgery.

**Lecture: 45, Tutorial: 0, Total : 45**

**TEXT BOOKS:**
1.  Faiz M. Khan,   "The physics of radiation therapy" 4th edition (2010), Lippincott,   Williams   and Wilkins, USA.
2.  David S. Chang "Basic Radiotherapy Physics and Biology" Springer - 2021

**REFERENCES:**
1.  Joseph Selman - The Fundamentals of X-Ray and Radium Physics, Charles C Thomas Pub Ltd; 8th edition.
2.  Basic Medical Radiation Physics – Stanton.
3.  S. Vijayakumar "Technical Basis Of Radiation Therapy Practical Clinical Applications" Springer 2006

**e-Resources:**
1.  27 - Basics of Radiation Therapy (d2ogjlfjkptkow.cloudfront.net) , Elaine M. Zeman, Science of Clinical Oncology.
2.  IJCMAAS_MAY_2015_VOL6_ISS3_11.pdf, S. Mohan Kumar, International Journal of Current Medical And Applied Sciences.

3. [Tissue-air ratio, backscatter factor and definition of field size | British Journal of Radiology | Oxford Academic (oup.com)](#), Paul M. Pfalzner, British Journal of Radiology

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1    Demonstrate the basics behind radioactivity and half- life period.
CO2    Analyze the interactions of matter with electrons and charged particles.
CO3    Identify the various types of source and techniques in radiotherapy.
CO4    Interpret the various factors physical parameters of dosimetry.
CO5    Describe the application of radiation in oncology field.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| **CO 2** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| **CO 3** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| **CO 4** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |
| **CO 5** | 2 | 3 | 2 | - | - | - | - | - | - | 1 | - | 2 | 2 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMO08**       **NANOTECHNOLOGY AND APPLICATIONS**       **L   T   P   C**
                                                                                **3   0   0   3**

**Pre-requisites: 22BMT34 – SENSORS AND MEASUREMENTS**
                            **22BMT42 – ANALOG AND DIGITAL INTEGRATED CIRCUITS**

**Preamble**
This course aims to provide a broad view of the nascent field of nanoscience and nanotechnology to Undergraduates to explore the basics of nanomaterial synthesis and characterization.

**UNIT 1    INTRODUCTION TO NANOTECHNOLOGY**                 **9**
General definition and size effects–important nano structured materials and nano particles- importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

**UNIT 2     SYNTHESIS OF NANOMATERIALS**                       **9**
Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

**UNIT 3    NANO COMPOSITES**                                  **9**
Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications

**UNIT 4    NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES**    **9**
Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method

**UNIT 5    APPLICATIONS OF NANOTECHNOLOGY**                    **9**
Nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

                                                    **Lecture : 45, Tutorial : 0, Total : 45**

**TEXT BOOKS:**
1. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 2005, Overseas Press.
2. G. Cao, "Nanostructures & Nanomaterials: Synthesis, Properties & Applications" Imperial College Press, 2004

**REFERENCES:**
1. William A Goddard "Handbook of Nanoscience, Engineering and Technology", 3rd Edition, CRC Taylor and Francis group 2012
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gibtl & Co
3. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge, 2006.

**e-Resources:**
1. [Nanotechnology: Applications, techniques, approaches, & the advancement in toxicology and environmental impact of engineered nanomaterials (meddocsonline.org)](#), Sumera Zaib, MedDocs eBooks

2.   [study-of-nanotechnology-and-its-application.pdf (onlinescientificresearch.com)](), Dr.Sumit Kumar Gupta, Journal of Physics & Optics Sciences
3.   [Nanotechnology and its Applications in Medicine (hilarispublisher.com)](), Anna Pratima Nikalje, Medicinal chemistry

**Course Outcomes:** Upon completion of this course, students will be able to:

CO1   Describe the basic science behind the properties of materials.
CO2   Interpret the creation, characterization, and manipulation of nanoscale materials.
CO3   Comprehend the exciting applications of nanotechnology at the leading edge of scientific Research.
CO4   Apply their knowledge of nanotechnology to identify how they can be exploited for new applications.
CO5   Describe the applications of nanotechnology.

**Mapping of COs with POs and PSOs**

| COs/POs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 |
|---------|------|------|------|------|------|------|------|------|------|-------|-------|-------|-------|-------|
| **CO 1** | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 2** | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 3** | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 4** | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |
| **CO 5** | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 2 | 3 | - |

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

**22BMV01**                         **INDUSTRIAL INTERNET OF THINGS**          **L  T  P  C**
                                                                               **0  0  2  1**

**Prerequisite:**
 Knowledge of Communication network and Programming Languages.
**Preamble:**
Industrial Internet of things is the network of physical objects that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.This course aims to impart knowledge about the implementation of IOT among the studentcommunity.

**Module 1 – Introduction to IOT and Python Programming**                                        **10**
- Introduction to IoT
- Enabling technologies
- Open Architecture
- Communication protocols
- HTTP - 6LowPAN – CoAP - MQTT
- PYTHON Programming
- Linux on Raspberry Pi
- Accessing Internet
- SMTP mail server
- Creating a project on security using cryptography
- HTML Programming

**Module 2 – Application Using Raspberry PI and ESP Processors**                                 **20**
- Interfacing of Analog Sensors
- IoT based Location Finder with Map Integration
- IoT based Electrical Applications (Demo)
- Working with MQTT and Fire base
- Linking MATLAB and Raspberry Pi
- Data logging techniques using SQL
- Working with IFTTT
- Google Assistant Interface for Appliances Control
- Interfacing with Alexa
- Working with Firebase Cloud services
- Working with Adafruit and Thingsboard servers

                                                                        **TOTAL : 30 PERIODS**
**REFERENCES:**
1. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-On Approach"2014.
2. Waltenegus Dargie,Christian Poellabauer, "Fundamentals of Wireless Sensor
   Networks:Theory and Practice", Wiley Publications, 1st edition,2020.

**e-RESOURCES:**
1. https://nptel.ac.in › courses, "Internet of Things" – Prof.Sudip Misra, IIT Kharagpur.
2. https://www.khanacademy.org/computing/computer-science/internet-intro/internet-works-
   intro/v/the-internet-packet-routers-and-reliability.

**Course Outcomes: Upon completion of the course, students will be able to:**
1. Understand the basics of IoT architecture and its communication protocols
2. Develop python programming in IoT applications using Raspberry Pi and ESP

| 22BMV02 | **BIOMEDICAL SIGNAL AND IMAGE PROCESSING USING NIVISION AND BIOMEDICAL TOOLKIT** | **L T P C**<br>**0 0 2 1** |

**Prerequisite:**
Knowledge of Signals, Systems and Processing methods of Images.

**Preamble:**
Biomedical Signal and Image Processing provides an introduction to the basic concepts of signal and Image processing methods and to acquire knowledge of analysis of systems using various transformation techniques. It provides students to realize and develop an algorithm using LabVIEW. This course gives an in-depth analysis of the origin and processing of bioelectrical signals and Images of humans. The analysis is related to differentiate healthy and pathological conditions and emerges from clinical situations and issues.

**Module 1 – Graphical System Design - Data Acquisition & Signal processing**    **20**
- Introduction to Graphical Systems Design using NI Technology
- Hands on LabVIEW Programming concepts
- Decision making Structures – Loops – Arrays – Clusters – Variables
- File I/O Operations.
- Introduction to Data Acquisition System
- Signal Conditioning for Data Acquisition
- Acquisition of Analog and Digital signals
- Introduction to Sensors & Signals
- Interfacing Biomedical Vernier Sensors
- Data Logging
- Biomedical Signal processing
- Analyzing Blood Pressure and ECG Feature Extraction.

**Module 2 – Image processing using Graphical System Design**    **10**
- Introduction to Image processing
- Introduction to Images & types of Images
- Memory Allocation & Memory Management of Image
- Introduction to offline Gray scale Image Processing
- Thresholding Images - Cropping Images
- Pixel Processing - Morphology Process for Binary Images
- Pattern Recognition - Color Recognition - Size Identification
- Particle Classification - Particle Analysis
- Application development using Biomedical images

**TOTAL : 30 PERIODS**

**REFERENCES:**
1. Sanjit K.Mitra,"Digital Signal Processing–A Computer Based Approach",Mc GrawHill,4$^{th}$edition 2013.
2. Rafael C, Gonzalez and Richard E Woods, "Digital Image Processing*"*, Pearson Education Asia,Fourth Edition, 2018.
3. Jovitha Jerome "Virtual Instrumentation using labview" Prentice Hall of India, NewDelhi, 2010.

**e-RESOURCES:**
1. http://www.ni.com/academic/students/learn-labview/

**Course Outcomes: Upon completion of the course, students will be able to:**
1. Understand the concepts of Data Acquisition, Interfacing of Biomedical Sensors.
2. Cultivate the conceptual learning of analysis and processing of signals and images for IndustrialApplications.

**22BMV03**  TRAINING ON MACHINE  **L  T  P C**
LEARNING  **0  0  2  1**

**Prerequisite:**
Knowledge on Fundamentals of Images processing techniques and Python Programming Languages.

**Preamble:**
Training on Machine Learning is a complete practical approach for designing the smart devices using machine learning methodology. This course aims to Integration of Data Analytics along with the Machine Learning Algorithms.

**Module 1 –  Introduction to Machine Learning**  **20**

- Machine learning Approaches
- Design smart devices Mathematical Expressions/ Concepts/ Different types of Supervisory and Un-supervisory Concepts.
- Introduction about the Python to machine learning- Introduction of Numpy/Pandas/Scikit
- Data extraction Phases-Working on Data for the different field domains such as Cloud, WSN, Medical(Using raspberry pi 3)
- Programming in Python is employed Working on the different Supervisory Machine learning algorithms based on above stated data.
- Validation of machine learning algorithms with following parameters such as Confusion Matrix, n-Cross Validated Matrix, RoC validations, Matrix (Hands-on Working with RPI3+Python along with the datas)

**Module 2 –  Applications of Machine Learning**  **10**

- Hands -on With the following projects:
- WSN/Cloud Security, Smart Home Automation Product,
- Medical Image Processing,
- Project Demo of AI Learned Sticks on RPI-3,
- Introduction of deep learning -Pytorch mechanism.

**TOTAL : 30 PERIODS**

**REFERENCES:**
1. Reema Thareja, "Python Programming using Problem Solving Approach", Oxford University Press, 2017.
2.  Miroslav Kubat , " An Introduction to Machine Learning ", SPRINGER, Second Edition, 2017.

**e-RESOURCES:**
1.  https://swayam.gov.in/course/4178-spoken-tutorial-python-english, "Introduction to Python", Prof. Prabhu Ramachandran, IIT Bombay.
2. https://onlinecourses.nptel.ac.in/noc18_cs21, "Programming, Data Structures and Algorithms Using Python", Prof.Madhavan Mukund, IIT-Bombay.

**Course Outcomes: Upon completion of the course, students will be able to:**

1. Implement machine learning algorithms on hardware's.
2. Develop Bio-inspired evolutionary algorithms on Data Analytical Part