
# BIOMEDICAL ENGINEERING

# R2024

# CURRICULUM
# &
# SYLLABI

# GRT INSTITUTE OF ENGINEERING AND TECHNOLOGY, Tiruttani

**(An Autonomous Institution)**

**Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai,**
**Accredited by NAAC with "A++" Grade & An ISO 9001:2015 Certified Institution.**

## B.E - BIOMEDICAL ENGINEERING

## CURRICULUM REGULATIONS - 2024

### CHOICE BASED CREDIT SYSTEM

### CURRICULUM AND SYLLABI (SEMESTER I TO VIII)

**(FOR THE STUDENTS ADMITTED DURING 2024)**

| SEMESTER - I | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS | EXT / INT |
| | | | | L | T | P | | | |
| 1 | IP24101 | Induction Programme | - | - | - | - | - | **0** | - |
| **THEORY COURSES** | | | | | | | | | |
| 2 | HS24101 | Professional English | HS | 3 | - | - | 3 | 3 | 60/40 |
| 3 | MA24101 | Algebra and Calculus | BS | 3 | 1 | - | 4 | 4 | 60/40 |
| 4 | PH24101 | Engineering Physics | BS | 3 | - | - | 3 | 3 | 60/40 |
| 5 | CY24101 | Engineering Chemistry | BS | 3 | - | - | 3 | 3 | 60/40 |
| 6 | GE24101 | Problem Solving and Python Programming | ES | 3 | - | - | 3 | 3 | 60/40 |
| 7 | TA24101 | Heritage of Tamils | HS | 1 | - | - | 1 | 1 | 60/40 |
| **PRACTICAL COURSES** | | | | | | | | | |
| 8 | GE24102 | Problem Solving and Python Programming Laboratory | ES | - | - | 4 | 4 | 2 | 40/60 |
| 9 | PC24101 | Physics and Chemistry Laboratory | BS | - | - | 4 | 4 | 2 | 40/60 |
| 10 | HS24102 | English Laboratory | HS | - | - | 2 | 2 | 1 | 0/100 |
| **TOTAL** | | | | **16** | **1** | **10** | **27** | **22** | |

| SEMESTER - II | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS | EXT / INT |
| | | | | L | T | P | | | |
| **THEORY COURSES** | | | | | | | | | |
| 1 | MA24201 | Statistics and Numerical Techniques | BS | 3 | 1 | - | 4 | 4 | 60/40 |
| 2 | GE24201 | Engineering Graphics | ES | 2 | - | 3 | 5 | 4 | 60/40 |
| 3 | PH24203 | Medical Physics | BS | 3 | - | - | 3 | 3 | 60/40 |
| 4 | TA24201 | Tamils and Technology | HS | 1 | - | - | 1 | 1 | 60/40 |
| **THEORY CUM PRACTICAL COURSES** | | | | | | | | | |
| 5 | BM24201 | Anatomy and Human Physiology | PC | 3 | - | 2 | 5 | 4 | 50/50 |
| 6 | EE24203 | Basic Electrical and Electronics Engineering | ES | 3 | - | 2 | 5 | 4 | 50/50 |
| **PRACTICAL COURSES** | | | | | | | | | |
| 7 | GE24202 | Engineering Practices Laboratory | ES | - | - | 4 | 4 | 2 | 40/60 |
| 8 | HS24201 | English Communication Laboratory | HS | - | - | 4 | 4 | 2 | 40/60 |
| **TOTAL** | | | | **15** | **1** | **16** | **32** | **24** | |

| SEMESTER - III | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS | EXT / INT |
| | | | | L | T | P | | | |
| **THEORY COURSES** | | | | | | | | | |
| 1 | MA24302 | Transforms and Partial Differential Equations | BS | 3 | 1 | - | 4 | 4 | 60/40 |
| 2 | BM24301 | Signals and Systems | PC | 3 | - | - | 3 | 3 | 60/40 |
| 3 | CS24307 | Fundamentals of Data Structures | ES | 3 | - | - | 3 | 3 | 60/40 |
| **THEORY CUM PRACTICAL COURSES** | | | | | | | | | |
| 4 | BM24302 | Biosciences for Medical Engineering | PC | 3 | - | 2 | 5 | 4 | 50/50 |
| 5 | BM24303 | Bio Sensors and Measurements | PC | 3 | - | 2 | 5 | 4 | 50/50 |
| 6 | BM24304 | Fundamentals of Electronic Devices and Circuits | PC | 3 | - | 2 | 5 | 4 | 50/50 |
| **PRACTICAL COURSES** | | | | | | | | | |
| **7** | CS24308 | Fundamentals of Data Structures Laboratory | **ES** | - | - | 4 | 4 | 2 | 40/60 |
| **TOTAL** | | | | **18** | **1** | **10** | **29** | **24** | |

| SEMESTER - IV | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS | EXT / INT |
| | | | | L | T | P | | | |
| **THEORY COURSES** | | | | | | | | | |
| 1 | MA24402 | Random Processes | BS | 3 | 1 | - | 4 | 4 | 60/40 |
| 2 | BM24401 | Analog and Digital Integrated Circuits | PC | 3 | - | - | 3 | 3 | 60/40 |
| 3 | EC24407 | Microprocessors and Microcontrollers | PC | 3 | - | - | 3 | 3 | 60/40 |
| 4 | GE24402 | Environmental Science and Sustainability | BS | 2 | - | - | 2 | 2 | 60/40 |
| **THEORY CUM PRACTICAL COURSES** | | | | | | | | | |
| 5 | BM24402 | Biosignal Processing | PC | 3 | - | 2 | 5 | 4 | 50/50 |
| 6 | BM24403 | Biomedical Instrumentation | PC | 3 | - | 2 | 5 | 4 | 50/50 |
| **PRACTICAL COURSES** | | | | | | | | | |
| 7 | BM24404 | Analog and Digital Integrated Circuits Laboratory | PC | - | - | 4 | 4 | 2 | 40/60 |
| 8 | GE24S03 | Soft Skills and Aptitude | EEC | 2 | - | - | 2 | 0 | 0/100 |
| **TOTAL** | | | | **20** | **1** | **7** | **27** | **22** | |

| SEMESTER - V | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS | EXT / INT |
| | | | | L | T | P | | | |
| **THEORY COURSES** | | | | | | | | | |
| 1 | BM24501 | Diagnostic and Therapeutic Equipment | PC | 3 | - | - | 3 | 3 | 60/40 |
| 2 | BM24502 | Biocontrol Systems | PC | 3 | - | - | 3 | 3 | 60/40 |
| 3 | | Open Elective I | OE | 3 | - | - | 3 | 3 | 60/40 |
| 4 | | Professional Elective I | PE | 3 | - | - | 3 | 3 | 60/40 |
| 5 | | Professional Elective II | PE | 3 | - | - | 3 | 3 | 60/40 |
| 6 | | Non-Credit Mandatory course I | EEC | 3 | - | - | 3 | - | 0/100 |
| **THEORY CUM PRACTICAL COURSES** | | | | | | | | | |
| 7 | BM24503 | Medical Image Processing | PC | 3 | - | 2 | 5 | 4 | 50/50 |
| **PRACTICAL COURSES** | | | | | | | | | |
| 8 | BM24504 | Diagnostic and Therapeutic Equipment Laboratory | PC | - | - | 4 | 4 | 2 | 40/60 |
| 9 | BM24S01 | Design Thinking and Innovation Laboratory | ES | - | - | 2 | 2 | 1 | 0/100 |
| **TOTAL** | | | | **21** | **-** | **8** | **29** | **22** | |

| SEMESTER - VI | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS | EXT / INT |
| | | | | L | T | P | | | |
| **THEORY COURSES** | | | | | | | | | |
| 1 | BM24601 | Biomechanics and Rehabilitation Engineering | PC | 3 | - | - | 3 | 3 | 60/40 |
| 2 | BM24602 | Virtual Instrumentation | PC | 3 | - | - | 3 | 3 | 60/40 |
| 3 | AD24604 | Artificial Intelligence and Machine Learning | ES | 3 | - | - | 3 | 3 | 60/40 |
| 4 | | Professional Elective III | PE | 3 | - | - | 3 | 3 | 60/40 |
| 5 | | Professional Elective IV | PE | 3 | - | - | 3 | 3 | 60/40 |
| 6 | | Open Elective II | OE | 3 | - | - | 3 | 3 | 60/40 |
| 7 | | Non-Credit Mandatory course II | EEC | 3 | - | - | 3 | - | 0/100 |
| **PRACTICAL COURSES** | | | | | | | | | |
| 8 | BM24603 | Biomechanics and Virtual Instrumentation laboratory | PC | - | - | 4 | 4 | 2 | 40/60 |
| 9 | BM24604 | Mini Project | EEC | - | - | 4 | 4 | 2 | 40/60 |
| **TOTAL** | | | | **21** | **-** | **8** | **29** | **22** | |

| SEMESTER - VII | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS | EXT / INT |
| | | | | L | T | P | | | |
| **THEORY COURSES** | | | | | | | | | |
| 1 | BM24701 | Healthcare Management Systems | PC | 3 | - | - | 3 | 3 | 60/40 |
| 2 | GE24701 | Human Values and Ethics | HS | 2 | - | - | 2 | 2 | 60/40 |
| 3 | | Management Elective | HS | 3 | - | - | 3 | 3 | 60/40 |
| 4 | | Professional Elective V | PE | 3 | - | - | 3 | 3 | 60/40 |
| 5 | | Professional Elective VI | PE | 3 | - | - | 3 | 3 | 60/40 |
| 6 | | Open Elective III | OE | 3 | - | - | 3 | 3 | 60/40 |
| **PRACTICAL COURSES** | | | | | | | | | |
| 8 | BM24702 | Hospital Internship with Training | EEC | - | - | 4 | 4 | 2 | 40/60 |
| **TOTAL** | | | | **17** | **-** | **4** | **21** | **19** | |

| SEMESTER - VIII | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATEGORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS | EXT / INT |
| | | | | L | T | P | | | |
| **PRACTICAL COURSES** | | | | | | | | | |
| 1 | BM24801 | Project Work/ Internship | EEC | - | - | 20 | 20 | 10 | 40/60 |
| **TOTAL** | | | | **-** | **-** | **20** | **20** | **10** | |

| TOTAL CREDITS | 165 |
|---|---|

**SUMMARY**

| Name of the Programme: Biomedical Engineering | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| S.No | Subject Area | Credits per Semester | | | | | | | | Total Credits |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| 1 | HS | 5 | 3 | | | | | 5 | | 13 |
| 2 | BS | 12 | 7 | 4 | 6 | | | | | 29 |
| 3 | ES | 5 | 10 | 5 | | 1 | 3 | | | 24 |
| 4 | PC | | 4 | 15 | 16 | 12 | 8 | 3 | | 58 |
| 5 | PE | | | | | 6 | 6 | 6 | | 18 |
| 6 | OE | | | | | 3 | 3 | 3 | | 09 |
| 7 | EEC | | | | | | 2 | 2 | 10 | 14 |
| 8 | Non-Credit Mandatory | | | | | ✓ | ✓ | | | |
| TOTAL | | 22 | 24 | 24 | 22 | 22 | 22 | 19 | 10 | 165 |

## MANDATORY COURSE

| NON-CREDIT MANDATORY COURSE I: SEMESTER V | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | MX24C71 | Introduction to Women and Gender Studies | MC | 3 | - | - | 3 | - |
| 2 | MX24C72 | Elements of Literature | MC | 3 | - | - | 3 | - |
| 3 | MX24C73 | Disaster Risk Reduction and Management | MC | 3 | - | - | 3 | - |
| 4 | MX24C74 | Film Appreciation | MC | 3 | - | - | 3 | - |

| NON-CREDIT MANDATORY COURSE II: SEMESTER VI | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | MX24C75 | Well Being with Traditional Practices - Yoga, Ayurveda and Siddha | MC | 3 | - | - | 3 | - |
| 2 | MX24C76 | History of Science and Technology in India | MC | 3 | - | - | 3 | - |
| 3 | MX24C77 | Industrial Safety | MC | 3 | - | - | 3 | - |
| 4 | MX24C78 | Political and Economic Thought for a Human Society | MC | 3 | - | - | 3 | - |
| 5 | MX24C79 | State, Nation Building and Politics in India | MC | 3 | - | - | 3 | - |

## MANAGEMENT ELECTIVE

| MANAGEMENT ELECTIVE: SEMESTER VII | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | GE24M01 | Principles of Management | HS | 3 | - | - | 3 | 3 |
| 2 | GE24M02 | Total Quality Management | HS | 3 | - | - | 3 | 3 |
| 3 | GE24M03 | Engineering Economics and Financial Accounting | HS | 3 | - | - | 3 | 3 |
| 4 | GE24M04 | Human Resource Management | HS | 3 | - | - | 3 | 3 |
| 5 | GE24M05 | Knowledge Management | HS | 3 | - | - | 3 | 3 |
| 6 | GE24M06 | Industrial Management | HS | 3 | - | - | 3 | 3 |

# PROFESSIONAL ELECTIVE COURSES: VERTICALS

| Vertical I Management (Healthcare) | Vertical II Sensor System Technology | Vertical III Advanced Signal Processing | Vertical IV Image Processing and Bio Engineering | Vertical V Mechanics | Verticals VI Advanced Healthcare Devices | Verticals VII Medical Device Innovation and Development |
|---|---|---|---|---|---|---|
| Clinical Engineering | Communication Systems | Bio Signal Analysis | Embedded Systems and IoMT | Biomechanics | Bio MEMS | Foundation Skills in Integrated Product Development |
| Hospital Planning and Management | Wearable Devices | Computer Vision | Telehealth Technology | Genetic Engineering | Critical Care and Operation Theatre Equipment | Patient safety, Standards and Ethics |
| Medical Waste Management | Body Area Networks | Speech and Audio Signal Processing | Medical Device Design | Physiological Modeling | Human Assist Devices | Principles of Tissue Engineering |
| Economics and Management for Engineers | Virtual Reality and Augmented Reality in Healthcare | Rapid Prototyping | Medical Imaging Systems | Assistive Technology | Advancements in Healthcare Technology | Medical Innovation and Entrepreneurship |
| Biostatistics | Medical Device Regulations | Brain Computer Interface and Applications | Artificial Organs and Implants | Ergonomics | Robotics in Medicine | Biomaterials |
| Forensic Science in Healthcare | Medical Informatics | Biometric Systems | Neural Engineering | Haptics | Medical Device Troubleshooting | Biomedical Optics and Photonics |

## PROFESSIONAL ELECTIVE COURSES: VERTICALS

| VERTICAL I: MANAGEMENT (HEALTHCARE) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | BM24P01 | Clinical Engineering | PE | 3 | - | - | 3 | 3 |
| 2 | BM24P02 | Hospital Planning and Management | PE | 3 | - | - | 3 | 3 |
| 3 | BM24P03 | Medical Waste Management | PE | 3 | - | - | 3 | 3 |
| 4 | BM24P04 | Economics and Management for Engineers | PE | 3 | - | - | 3 | 3 |
| 5 | BM24P05 | Biostatistics | PE | 3 | - | - | 3 | 3 |
| 6 | BM24P06 | Forensic Science in Healthcare | PE | 3 | - | - | 3 | 3 |

| VERTICAL II: SENSOR SYSTEM TECHNOLOGY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | BM24P07 | Communication Systems | PE | 3 | - | - | 3 | 3 |
| 2 | BM24P08 | Wearable Devices | PE | 3 | - | - | 3 | 3 |
| 3 | EC24P38 | Body Area Networks | PE | 3 | - | - | 3 | 3 |
| 4 | BM24P09 | Virtual Reality and Augmented Reality in Healthcare | PE | 3 | - | - | 3 | 3 |
| 5 | BM24P10 | Medical Device Regulations | PE | 3 | - | - | 3 | 3 |
| 6 | BM24P11 | Medical Informatics | PE | 3 | - | - | 3 | 3 |

| VERTICAL III: ADVANCED SIGNAL PROCESSING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | BM24P12 | Bio Signal Analysis | PE | 3 | - | - | 3 | 3 |
| 2 | AD24P04 | Computer Vision | PE | 3 | - | - | 3 | 3 |
| 3 | BM24P14 | Speech and Audio Signal Processing | PE | 3 | - | - | 3 | 3 |
| 4 | BM24P15 | Rapid Prototyping | PE | 3 | - | - | 3 | 3 |
| 5 | BM24P16 | Brain Computer Interface and Applications | PE | 3 | - | - | 3 | 3 |
| 6 | BM24P17 | Biometric Systems | PE | 3 | - | - | 3 | 3 |

| VERTICAL IV: IMAGE PROCESSING AND BIO ENGINEERING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | BM24P18 | Embedded Systems and IoMT | PE | 2 | - | 2 | 4 | 3 |
| 2 | BM24P19 | Telehealth Technology | PE | 2 | - | 2 | 4 | 3 |
| 3 | BM24P20 | Medical Device Design | PE | 3 | - | - | 3 | 3 |
| 4 | BM24P21 | Medical Imaging Systems | PE | 3 | - | - | 3 | 3 |
| 5 | BM24P22 | Artificial Organs and Implants | PE | 3 | - | - | 3 | 3 |
| 6 | BM24P23 | Neural Engineering | PE | 3 | - | - | 3 | 3 |

| VERTICAL V: MECHANICS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | BM24P24 | Biomechanics | PE | 3 | - | - | 3 | 3 |
| 2 | BM24P25 | Genetic Engineering | PE | 3 | - | - | 3 | 3 |
| 3 | BM24P26 | Physiological Modeling | PE | 3 | - | - | 3 | 3 |
| 4 | BM24P27 | Assistive Technology | PE | 3 | - | - | 3 | 3 |
| 5 | BM24P28 | Ergonomics | PE | 3 | - | - | 3 | 3 |
| 6 | BM24P29 | Haptics | PE | 3 | - | - | 3 | 3 |

| VERTICAL VI: ADVANCED HEALTHCARE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | BM24P30 | Bio MEMS | PE | 3 | - | - | 3 | 3 |
| 2 | BM24P31 | Critical Care and Operation Theatre Equipment | PE | 3 | - | - | 3 | 3 |
| 3 | BM24P32 | Human Assist Devices | PE | 3 | - | - | 3 | 3 |
| 4 | BM24P33 | Advancements in Healthcare Technology | PE | 3 | - | - | 3 | 3 |
| 5 | BM24P34 | Robotics in Medicine | PE | 3 | - | - | 3 | 3 |
| 6 | BM24P35 | Medical Device Troubleshooting | PE | 3 | - | - | 3 | 3 |

| VERTICAL VII: MEDICAL DEVICE INNOVATION AND DEVELOPMENT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | BM24P36 | Foundation Skills in Integrated Product Development | PE | 3 | - | - | 3 | 3 |
| 2 | BM24P40 | Patient safety, Standards and Ethics | PE | 3 | - | - | 3 | 3 |
| 3 | BM24P41 | Principles of Tissue Engineering | PE | 3 | - | - | 3 | 3 |
| 4 | BM24P42 | Medical Innovation and Entrepreneurship | PE | 3 | - | - | 3 | 3 |
| 5 | BM24P43 | Biomaterials | PE | 3 | - | - | 3 | 3 |
| 6 | BM24P44 | Biomedical Optics and Photonics | PE | 3 | - | - | 3 | 3 |

## OPEN ELECTIVES

| OPEN ELECTIVE I | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | AS24901 | Space Science | OE | 3 | - | - | 3 | 3 |
| 2 | IE24901 | Introduction to Industrial Engineering | OE | 3 | - | - | 3 | 3 |
| 3 | FD24901 | Food, Nutrition and Health | OE | 3 | - | - | 3 | 3 |
| 4 | CE24902 | Environmental and Social Impact Assessment | OE | 3 | - | - | 3 | 3 |
| 5 | EE24901 | Renewable Energy System | OE | 3 | - | - | 3 | 3 |
| 6 | EI24901 | Introduction to Industrial Instrumentation and Control | OE | 3 | - | - | 3 | 3 |
| 7 | MA24901 | Graph Theory | OE | 3 | - | - | 3 | 3 |
| 8 | AD24906 | Neural Networks and Deep Learning | OE | 2 | - | 2 | 4 | 3 |
| 9 | CS24901 | Digital Marketing | OE | 3 | - | - | 3 | 3 |

| OPEN ELECTIVE II | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | IE24902 | Resource Management Techniques | OE | 3 | - | - | 3 | 3 |
| 2 | MG24901 | Fintech Regulation | OE | 3 | - | - | 3 | 3 |
| 3 | FD24903 | Holistic Nutrition | OE | 3 | - | - | 3 | 3 |
| 4 | AI24902 | IT in Agricultural System | OE | 3 | - | - | 3 | 3 |
| 5 | EE24903 | PLC and SCADA | OE | 3 | - | - | 3 | 3 |
| 6 | CS24904 | DevOps | OE | 3 | - | - | 3 | 3 |
| 7 | RA24901 | Robotic Process Automation | OE | 2 | - | 2 | 4 | 3 |
| 8 | IP24901 | Intellectual Property Rights | OE | 3 | - | - | 3 | 3 |
| 9 | CE24901 | Climate Change and its Impact | OE | 3 | - | - | 3 | 3 |

| OPEN ELECTIVE III | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| S.NO | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
| | | | | L | T | P | | |
| 1 | SF24901 | Fire Safety Engineering | OE | 3 | - | - | 3 | 3 |
| 2 | MR24901 | Mechatronics | OE | 3 | - | - | 3 | 3 |
| 3 | EC24902 | VLSI Design | OE | 3 | - | - | 3 | 3 |
| 4 | BT24903 | Biotechnology for Waste Management | OE | 3 | - | - | 3 | 3 |
| 5 | FD24902 | Food safety and Quality Regulations | OE | 3 | - | - | 3 | 3 |
| 6 | AU24901 | Batteries and Management system | OE | 3 | - | - | 3 | 3 |
| 7 | RA24903 | Foundation of Robotics | OE | 3 | - | - | 3 | 3 |
| 8 | AD24903 | Multivariate Data Analysis | OE | 3 | - | - | 3 | 3 |
| 9 | AI24904 | Agriculture Entrepreneurship Development | OE | 3 | - | - | 3 | 3 |
| 10 | RA24904 | Drone Technologies | OE | 3 | - | - | 3 | 3 |

**SEMESTER-I**
**Common To All Branches**
**(B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH)**

| HS24101 | PROFESSIONAL ENGLISH | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- Improve the communicative competence of learners.
- Help learners use language effectively in academic /work contexts.
- Build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
- Develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.
- Use language efficiently in expressing their opinions via various media

**UNIT I INTRODUCTION OF EFFECTIVE COMMUNIATION 1**

What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?

**INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8**

**Reading** - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Why/ Yes or No/ and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

**UNIT II NARRATION AND SUMMATION 9**

**Reading**-Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.) Grammar–Past tense(simple); Subject Verb Agreement; and Prepositions. Vocabulary-Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs

**UNIT III DESCRIPTION OF PROCESS AND PRODUCT 9**

**Reading** – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).

**UNIT IV CLASSIFICATION 9**

Reading–Newspaper articles; Journal reports–and Non-Verbal Communication (tables, pie charts etc.,). Writing–Note-making/Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from nonverbal ( chart , graph etc., to verbal mode) Grammar–Forms of Verbs, Articles; Pronouns- Possessive & Relative pronouns. Vocabulary-Collocations; Fixed/Semi fixed expressions.

**UNIT V EXPRESSION OF VIEWS 9**

Reading–Reading editorials; and Opinion Blogs; Writing–Minutes of Meeting, Essay Writing (Descriptive or narrative). Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary-Cause & Effect Expressions–Content vs Function words.

**Total: 45 Periods**

**COURSE OUTCOMES:**

After completion of this course, the students should be able to

**CO1:** Use appropriate words in a professional context**.**

**CO2:** Gain understanding of basic grammatical structures and use them in right context.

**CO3:** Read and interpret and also infer information presented in tables, charts, denotative and connotative meanings of technical texts and other graphic forms.

**CO4:** Write definitions, descriptions, narrations and essays on various topics.

**TEXTBOOKS:**


1. English for Engineers & Technologists Orient Black Swan Private Ltd. Department of English, Anna University, (2020 edition)
2. English for Science & Technology CambridgeUniversityPress,2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. K N. Shoba, and Dr. Lourdes Joevani Department of English, Anna University.


**REFERENCEBOOKS:**


1. Technical Communication– Principles and Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book on Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English for Technical Communication (With CD) By Aysha Viswa Mohan, McGraw Hill Education, ISBN: 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate–Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 2 | | 2 | | 2 | 2 | | 3 | 3 | 2 | 2 | 1 | | |
| **CO2** | | 2 | | 2 | | 2 | 2 | | 3 | 3 | 2 | 2 | 1 | | |
| **CO3** | | 2 | | 2 | | 2 | 2 | | 3 | 3 | 2 | 3 | 1 | | |
| **CO4** | | 1 | | 2 | | 3 | 2 | | 3 | 3 | 2 | 3 | 1 | | |
| **Avg** | | **1.75** | | **2** | | **2.25** | **2** | | **3** | **3** | **2** | **2.5** | **1** | | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-I**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| MA24101 | ALGEBRA AND CALCULUS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
- To introduce integral ideas in solving areas, volumes and other practical problems in vector.

**UNIT I MATRICES 9+3**

Eigen values and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.

**UNIT II DIFFERENTIAL CALCULUS 9+3**

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications: Maxima and Minima of functions of one variable.

**UNIT III FUNCTIONS OF SEVERAL VARIABLES 9+3**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

**UNIT IV MULTIPLE INTEGRALS 9+3**

Double integrals in Cartesian and polar coordinates - Change of order of integration in Cartesian coordinates - Area enclosed by plane curves - Change of variables in double integrals -Triple integrals - Volume of Solids. Applications: Moments and centres of mass, moment of inertia.

**UNIT V VECTOR CALCULUS 9+3**

Gradient, divergence and curl (excluding vector identities) – Directional derivative –Irrotational and Solenoidal vector fields – Vector integration – Green's theorem in a plane and Gauss divergence theorem and Stoke's theorem (without proof) – Simple applications involving cubes and rectangular parallelopipeds.

**Total: 60 Periods**

**COURSE OUTCOMES:**

After completion of this course, the students should be able to

**CO1:** Demonstrate the matrix techniques in solving the related problems in engineering and technology.

**CO2:** Apply differential calculus tool to solve engineering applications.

**CO3:** Use differential calculus ideas on functions several variables.

**CO4:** Evaluate the area and volume by applying the concept of multiple integration.

**CO5:** Utilize the concept of vector calculus in evaluating integrals.

**TEXTBOOKS:**


1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition,
2. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.


**REFERENCEBOOKS:**


1. M. K. Venkataraman, "Engineering Mathematics", Volume I, 4th Edition, The National Publication Company, Chennai, 2003.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, 5th Edition, New Delhi, 2017.
3. H. K. Dass and Er. Rajnish Verma, "Higher Engineering Mathematics", S. Chand Private Limited, 3rd Edition 2014.
4. B.V. Ramana, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 6th Edition, New Delhi, 2008.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | | | | | 2 | | 2 | 3 | | 1 | 1 |
| **CO2** | 3 | 3 | 1 | 2 | | | | | 2 | | 2 | 3 | | 1 | 1 |
| **CO3** | 3 | 3 | 2 | 2 | | | | | 2 | | 2 | 3 | | 1 | 1 |
| **CO4** | 3 | 3 | 1 | 1 | | | | | 2 | | 2 | 3 | | 1 | 1 |
| **CO5** | 3 | 3 | 2 | 2 | | | | | 2 | | 2 | 3 | | 1 | 1 |
| **Avg** | **3** | **3** | **1.6** | **1.6** | | | | | **2** | | **2** | **3** | | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-I**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| PH24101 | ENGINEERING PHYSICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To make the students achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves and its applications.
- To introduce the basics of oscillations, optics and lasers.
- Equipping the students to successfully understand the importance of quantum physics.
- To motivate the students towards the applications of quantum mechanics.

**UNIT I MECHANICS 9**

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of the system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M. I – moment of inertia continuous bodies – M.I of a diatomic molecule-rotational energy state of a rigid diatomic molecule - torque – rotational dynamics of rigid bodies – conservation of angular momentum - gyroscope - torsional pendulum.

**UNIT II ELECTROMAGNETIC WAVES 9**

The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - Source of electromagnetic waves. EM waves: Energy, momentum, intensity and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium vacuum interface for normal incidence.

**UNIT III OSCILLATIONS, OPTICS AND LASERS 9**

Simple harmonic motion – resonance –analogy between electrical and mechanical oscillating systems – waves on a string – standing waves – traveling waves – Energy transfer of a wave – sound waves – Doppler effect. Reflection and refraction of light waves – total internal reflection – interference –Michelson interferometer – Theory of air wedge and experiment. Theory of laser – characteristics – Spontaneous and stimulated emission – Einstein's coefficients – population inversion – Nd-YAG laser, CO2 laser, semiconductor laser –Basic applications of lasers in industry.

**UNIT IV BASIC QUANTUM MECHANICS 9**

Photons and light waves – Electrons and matter waves –Compton effect – Schrodinger equation (Time dependent and time independent forms) – Physical meaning of wave function – particle in a infinite one dimensional (1D) potential well - Normalization, probabilities and the correspondence principle.

**UNIT V APPLIED QUANTUM MECHANICS 9**

The harmonic oscillator (qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope – Resonant diode – Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.

**Total: 45 Periods**

**COURSE OUTCOMES:**

After completion of this course, the students should be able to

**CO1:** Recognized the importance of mechanics.

**CO2:** Express their knowledge in electromagnetic waves.

**CO3:** Demonstrate a strong foundational knowledge in oscillations, optics and lasers.

**CO4:** Illustrate the importance of quantum physics.

**CO5:** Comprehend and apply quantum mechanical principles towards the formation of energy bands.

**TEXTBOOKS:**


1. D. Kleppner and R. Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. E.M. Purcell and D.J. Morin, Electricity and Magnetism, Cambridge Univ.Press, 2013.
3. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.


**REFERENCEBOOKS:**


1. R. Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physic – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K. Thyagarajan and A. Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. Halliday, R. Resnick and J. Walker. Principles of Physics, Wiley (Indian Edition), 2015.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | - | - | 1 | - | - | 1 | - | 1 | - | - | - | - | - |
| **CO2** | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | - | 1 | - | 2 | - | 1 | |
| **CO3** | 3 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | - | 1 | - | 2 | - | 1 | - |
| **CO4** | 3 | 3 | 2 | 2 | 2 | - | 1 | 2 | - | 1 | - | 2 | - | 1 | 1 |
| **CO5** | 2 | 3 | 2 | 1 | 1 | 1 | - | 2 | - | 1 | - | 2 | - | - | - |
| **Avg** | **2.8** | **2.6** | **1.75** | **1.25** | **1.6** | **1** | **1.3** | **1.6** | **-** | **1** | **-** | **2** | - | 1 | 1 |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-I**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| CY24101 | ENGINEERING CHEMISTRY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

**UNIT I WATER AND ITS TREATMENT 9**

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride and arsenic. Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and Calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

**UNIT II NANOCHEMISTRY 9**

Basics: Distinction between molecules, non-materials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of non-material's: Definition, properties and uses of – nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapor deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, agriculture, energy, electronics and catalysis.

**UNIT III PHASE RULE AND COMPOSITES 9**

Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process. Composites: Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

**UNIT IV FUELS AND COMBUSTION 9**

Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil – cetane number; Power alcohol and biodiesel. - natural gas- compressed natural gas (CNG)- liquefied petroleum gases(LPG).

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO2 emission and carbon footprint.

**UNIT V ENERGY SOURCES AND STORAGE DEVICES 9**

Stability of nucleus: mass defect (problems), binding energy; Nuclear energy: light water nuclear power plant, breeder reactor- environmental consequences of fossil fuel- Importance of renewable energy sources -Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Batteries: Types of batteries- lead acid battery- Solid Battery – Lithium Battery, Lithium-ion; Battery Electric vehicles-working principles; Fuel cells: H2-O2 fuel cell, microbial fuel cell.

**Total: 45 Periods**

**COURSE OUTCOMES:**

After completion of this course, the students should be able to

**CO1:** Infer the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.

**CO2:** Identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nonmaterial for engineering and technology applications.

**CO3:** Apply the knowledge of phase rule and composites for material selection.

**CO4:** Analyze the quality of fuel and its various uses.

**CO5:** Recognize different forms of energy resources and apply them for suitable applications in energy sectors.

**TEXTBOOKS:**


1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.


**REFERENCEBOOKS:**


1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | 1 | 1 | 2 | | | | | | | |
| **CO2** | 2 | | 1 | 1 | 2 | 2 | 2 | 1 | | | | 3 | | 1 | 1 |
| **CO3** | 3 | 1 | | | | - | - | 2 | | | | 3 | | | |
| **CO4** | 3 | 1 | 1 | | | 1 | 3 | 2 | | | | 2 | | | |
| **CO5** | 3 | 2 | 2 | 2 | | 3 | 3 | 1 | | | | 3 | | | 1 |
| **Avg** | **2.8** | **1.5** | **1.33** | **1.5** | **2** | **1.75** | **2.25** | **1.6** | | | | **2.75** | | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-I**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| GE24101 | PROBLEM SOLVING AND PYTHON PROGRAMMING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

**UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 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). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

**UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9**

Python interpreter and interactive mode, debugging; values and types: int, float, Boolean, string, and list; variables, expressions, statements, tuple assignment, operators, 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 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, PACKAGES 9**

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, Predefined modules (Numpy Pandas, Matplotlib, Scipy, Django) packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

**Total: 45 Periods**

**COURSE OUTCOMES:**

Upon completion of the course, students will be able to

**CO1:** Develop algorithmic solutions to simple computational problems.

**CO2:** Develop and execute simple Python programs.

**CO3:** Write simple Python programs using conditionals and loops for solving problems.

**CO4:** Represent compound data using Python lists, tuples, dictionaries etc.

**CO5:** Read and write data from/to files in Python programs.

**TEXT BOOKS:**


1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.
3. Python Data Science Handbook: Essential Tools for Working with Data, Second Edition (Grayscale Indian Edition) by Jake VanderPlas.


**REFERENCES:**


1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.Comparison of Existing and Revised Syllabus


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | 2 | | | | | | | 1 | 1 | | |
| **CO2** | 3 | 3 | 3 | | 2 | | | | | | | 1 | 1 | | |
| **CO3** | 3 | 3 | 3 | | 2 | | | | | | | 1 | 1 | 1 | |
| **CO4** | 3 | 3 | 3 | | 2 | | | | | | 1 | 1 | 1 | 1 | |
| **CO5** | 3 | 2 | 1 | | 1 | | | | | | 1 | 1 | 1 | 1 | |
| **Avg** | **3** | **2.8** | **2.6** | | **1.8** | | | | | | **0.5** | **1** | **1** | **1** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER I**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| TA24101 | HERITAGE OF TAMILS | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 0 | 1 |

**UNIT I 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 II 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 III FOLK AND MARTIAL ARTS 3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance Sports and Games of Tamils.

**UNIT IV 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 V 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 Periods**

**SEMESTER-I**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| TA24101 | தமிழர் மரபு | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 0 | 1 |

**அலகு I மொழி மற்றும் இலக்கியம் 3**

இந்திய மொழிக் குடும்பங்கள் - திரொவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலயக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலயக்கித்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் - பங்களிப்பு.

**அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை 3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள் -பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் 3**

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள் 3**

தமிழகத்தின் தாவரங்களும், விலங்களும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாடடிற்குத் தமிழர்களின் பங்களிப்பு 3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில்,

சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

**Total: 15 Periods**

**TEXT CUM REFERENCE BOOKS**


1. தமிழக வரலாறு மக்களும் பண்பாடு மற்றும் கல்வியியல் பணிகள் கழகம்.
2. கணினித் தமிழ் முனைவர் இல.சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தோல்லியல் துறை வெளியீடு).
4. பொருநை ஆற்றங்கரை நாகரிகம் (தோல்லியல் 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 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) (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.

**SEMESTER-I**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| GE24102 | PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

- To understand the problem-solving approaches.
- To learn the basic programming constructs in Python.
- To practice various computing strategies for Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

**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 (pandas, numpy, Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (Copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (Divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

**Total: 60 Periods**

**COURSE OUTCOMES:**

On completion of the course, students will be able to:

**CO1 :** Develop algorithmic solutions to simple computational problems

**CO2 :** Develop and execute simple Python programs.

**CO3 :** Implement programs in Python using conditionals and loops for solving problems.

**CO4 :** Process compound data using Python data structures.

**CO5 :** Utilize Python packages in developing software applications.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 2 | | | | | | 3 | 2 | 1 | | |
| **CO2** | 3 | 3 | 3 | 3 | 2 | | | | | | 3 | 2 | 1 | | |
| **CO3** | 3 | 3 | 3 | 3 | 2 | | | | | | 3 | | 1 | 1 | |
| **CO4** | 1 | 2 | | | 1 | | | | | | 1 | | 1 | 1 | |
| **CO5** | 2 | 2 | | | 2 | | | | | | 2 | | 1 | 1 | |
| **Avg** | **2.4** | **2.6** | **3** | **3** | **1.8** | | | | | | **2.4** | **2** | **1** | **1** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-I**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| PC24101 | PHYSICS AND CHEMISTRY LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

## PHYSICS LABORATORY

**COURSE OBJECTIVES:**

- To learn the proper use of various kinds of physics laboratory equipment
- To learn how data can be collected, presented and interpreted in a clear and concise manner.
- To learn problem solving skills related to physics principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.

**EXPERIMENT TOPICS: (Any seven experiments to be conducted)**

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects.
2. Simple harmonic oscillations of cantilever.
3. Non-uniform bending - Determination of Young's modulus
4. Uniform bending – Determination of Young's modulus
5. Laser- Determination of the wave length of the laser using grating
6. Air wedge - Determination of thickness of a thin sheet/wire
7. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
8. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
9. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
10. Post office box -Determination of Band gap of a semiconductor.
11. Photoelectric effect
13. Michelson Interferometer.
14. Melde's string experiment
15. Experiment with lattice dynamics kit.

## CHEMISTRY LABORATORY

**COURSE OBJECTIVES:**

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electro analytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and alloys.
- To demonstrate the synthesis of nanoparticles.

**EXPERIMENT TOPICS: (Any seven experiments to be conducted)**

1. Preparation of Na2CO3 as a primary standard and estimation of acidity of a water sample using the primary standard
2. Determination of types and amount of alkalinity in water sample.Split the first experiment into two
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Estimation of TDS of a water sample by gravimetry.
8. Determination of strength of given hydrochloric acid using pH meter.
9. Determination of strength of acids in a mixture of acids using conductivity meter.
10. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
11. Estimation of iron content of the given solution using potentiometer.
12. Estimation of sodium /potassium present in water using flame photometer.
13. Preparation of nanoparticles (TiO2/ZnO/CuO) by Sol-Gel method.
14. Estimation of Nickel in steel
15. Proximate analysis of Coal

**COURSE OUTCOMES:**

Upon completion of the course, the students should be able to

**CO1 :** Analysis the Modulus of elasticity of materials.
**CO2 :** Illustrate the Laser and Optical fiber.
**CO3 :** Determine the wavelength of Ultrasonic wave in Liquid.
**CO4 :** Analyze the effect of chloride in water and DO present in sample water.
**CO5 :** Identify basicity acidity and pH of the materials

**TEXT BOOKS:**

1. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas and B. Sivasankar, Vogel's, Textbook of Quantitative Chemical Analysis (2009).

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | 1 | | | 2 | 2 | 1 | | | | 2 | | | |
| **CO2** | 3 | 1 | 2 | | | 1 | 2 | 2 | | | | 1 | | 1 | 1 |
| **CO3** | 3 | 2 | 1 | 1 | | | 1 | 1 | | | | | | 1 | 1 |
| **CO4** | 2 | 1 | 2 | | | 2 | 2 | 2 | | | | | | | |
| **CO5** | 2 | 1 | 2 | | 1 | 2 | 2 | 2 | | | | 1 | 1 | | 1 |
| **Avg** | **2.6** | **1.3** | **1.6** | **1** | **1** | **1.4** | **1.8** | **1.6** | | | | **1.3** | **1** | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-I**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| HS24102 | ENGLISH LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 2 | 1 |

**COURSE OBJECTIVES:**

- To improve the communicative competence of learners
- To help learners use language effectively in academic/work contexts
- To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
- To build on students' English languages kills by engaging the listening, speaking and grammar learning activities that is relevant to authentic contexts.
- To use language efficiently in expressing their opinions via various media.

**UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 6**

Listening for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages; Listening and filling a form. Speaking - making telephone calls-Self Introduction; Introducing a friend; - politeness strategies- making polite requests, making polite offers, replying to polite requests and offers- understanding basic instructions (filling out a bank application for example).

**UNIT II NARRATION AND SUMMATION 6**

Listening - Listening to podcasts, anecdotes / stories / event narration; documentaries and interviews with celebrities. Speaking - Narrating personal experiences / events-Talking about current and temporary situations & permanent and regular situations* - describing experiences and feelings- engaging in small talk- describing requirements and abilities.

**UNIT III DESCRIPTION OF PROCESS/ PRODUCT 6**

Listening - Listen to product and process descriptions; a classroom lecture; and advertisements about products. Speaking – Picture description- describing locations in workplaces- Giving instruction to use the product-explaining uses and purposes- Presenting a product- describing shapes and sizes and weights- talking about quantities (large & small)-talking about precautions.

**UNIT IV CLASSIFICATOIN AND RECOMMENDATIONS 6**

Listening – Listening to TED Talks; Listening to lectures - and educational videos. Speaking – Small Talk; discussing and making plans-talking about tasks-talking about progress- talking about positions and directions of movement-talking about travel preparations- talking about transportation-

**UNIT V DISCUSSION 6**

Listening –Listening to debates/discussions; different viewpoints on an issue; and panel discussions. Speaking –making predictions- talking about a given topic-giving opinions- understanding a website- describing processes

**Total: 30 Periods**

**COURSE OUTCOMES:**

At the end of the course, learners will be able

**CO1 :** To listen and comprehend complex academic texts

**CO2 :** To speak fluently and accurately in formal and informal communicative contexts

**CO3 :** To express their opinions effectively in both oral and written medium of communication

**Assessment Pattern**

- Conduction of Assessment to test speaking and writing skills

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 2 | | 3 | | 2 | 3 | | 3 | 3 | 3 | 1 | 1 | | |
| **CO2** | | 2 | | 3 | | 2 | 3 | | 3 | 3 | 3 | 1 | 1 | | |
| **CO3** | | 2 | | 3 | | 1 | 1 | | 1 | 3 | 1 | 1 | 1 | | |
| **Avg** | | **2** | | **3** | | **1.6** | **2.3** | | **2.3** | **3** | **2.3** | **1** | **1** | | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-II**
**Common To All Branches**
**(B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH)**

| MA24201 | STATISTICS AND NUMERICAL TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

The student should be made to:

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

**UNIT I TESTING OF HYPOTHESIS 9+3**

Sampling distributions - Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

**UNIT II DESIGN OF EXPERIMENTS 9+3**

One way and two - way classifications - Completely randomized design – Randomized block design – Latin square design - $2^2$ factorial design.

**UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3**

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

**UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION 9+3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivates using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

**UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION 9+3**

Single step methods: Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order differential equations - Multi step methods: Milne's and Adams - Bash forth predictor corrector methods for solving first order differential equations.

**Total: 60 Periods**

**COURSE OUTCOMES**

At the end of the course, the students should be able to

**CO1 :** Apply the concept of testing of hypothesis for small and large samples in real life problems.

**CO2 :** Apply the basic concepts of classifications of design of experiments in the field of agriculture.

**CO3 :** Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.

**CO4 :** Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

**CO5 :** Solve the partial and ordinary differential equations with initial and boundary condition by using certain techniques with engineering applications.

**TEXT BOOKS:**


1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.


**REFERENCES:**


1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outlines on Probability and Statistics ", Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 1 | 1 | 1 | | | | | | 2 | 2 | | | |
| **CO2** | 3 | 2 | 1 | 2 | 2 | | | | | | 2 | 3 | | 1 | |
| **CO3** | 2 | 2 | 1 | 1 | 1 | | | | | | 2 | 2 | | 1 | |
| **CO4** | 2 | 3 | 1 | 1 | 1 | | | | | | 1 | 3 | | | |
| **CO5** | 2 | 3 | 1 | 1 | 1 | | | | | | 2 | 2 | | | |
| **Avg** | **2.2** | **2.6** | **1** | **1.2** | **1.2** | | | | | | **1.8** | **2.4** | | 1 | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-II**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| GE24201 | ENGINEERING GRAPHICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 3 | 4 |

**COURSE OBJECTIVES:**

- To understand the importance of the drawing in engineering applications.
- To develop graphic skills for communication of concepts, ideas and design of engineering products.
- To expose them to existing national standards related to technical drawings.
- To improve their visualization skills so that they can apply this skill in developing new products.
- To improve their technical communication skill in the form of communicative drawings.

**UNIT-I PLANE CURVES AND PROJECTION OF POINTS 5+9**

Importance of graphics in engineering applications–Use of drafting instruments– BIS conventions and specifications–size, layout and folding of drawing sheets– lettering and dimensioning. (Not for examination)
Curves used in engineering practices: Conics–construction of ellipse, parabola and hyperbola by eccentricity method, cycloidal curves–construction of cycloid, construction of involutes of square and circle–drawing of tangents and normal to the above curves. Orthographic projection – principles – principal planes – first angle projection – projection of points.

**UNIT-II PROJECTION OF LINES AND PLANE SURFACES 5+9**

Projection of straight lines (only first angle projection) inclined to both the principal planes – determination of true lengths and true inclinations by rotating line method and traces.
Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

**UNIT-III PROJECTION OF SOLIDS AND SECTION OF SOLIDS 5+9**

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.
Sectioning of solids in simple position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.

**UNIT-IV DEVELOPMENT OF SURFACE AND ISOMETRIC PROJECTIONS 5+9**

Development of lateral surfaces of simple and sectioned solids – prisms, pyramids cylinders and cones. Principles of isometric projection – isometric scale –isometric projections of simple solids and truncated solids –prisms, pyramids, cylinders, cones and combination of two solid objects in simple vertical positions.

**UNIT-V FREE HAND SKETCHING AND PERSPECTIVE PROJECTIONS 5+9**

Visualization concepts–representation of three dimensional objects – layout of views–freehand sketching of multiple views from pictorial views of objects.
Principle of perspective projection – terminology –perspective projection of simple solids-prisms, pyramids, cylinder and cone by visual ray method.

**UNIT-VI COMPUTER AIDED DRAFTING (Not for examination) 5**

Introduction to drafting packages: Initial Setup Commands, Coordinate system in AutoCAD, UCS, WCS, and MCS. Draw Commands, Modify Commands, View Commands, Annotation commands, 2D Drawings and 3D Models -Simple Exercises.

**Total: 75 Periods**

**COURSE OUTCOMES**

On successful completion of this course, the student will be able

**CO1 :** To construct different plane curves and to comprehend the theory of projection.

**CO2 :** To project orthographic projections of lines and plane surfaces.

**CO3 :** To draw the projection of simple solids and sectional solids.

**CO4 :** To draw the development of lateral surfaces of sectional solids and Isometric projections of solids.

**CO5 :** To perform freehand sketching of multiple views from pictorial viewand visualize perspective view of simple solids.

**TEXT BOOKS:**


1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 51th Edition, 2012.
2. Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 31th Edition, 2018.


**REFERENCE BOOKS:**


1. Varghese P I., "Engineering Graphics", McGraw Hill Education (I) Pvt. Ltd., First Edition, 2013.
2. Venugopal K. and PrabhuRaja V., "Engineering Graphics", New Age International (P) Limited, 12th Edition, 2014.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 23th Edition, 2017.
4. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill Publishing Company Limited, New Delhi, 2nd Edition, 2008.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | - | - | - | - | 2 | - | 3 | - | 2 | 2 | 2 | |
| **CO2** | 3 | 2 | 2 | - | - | - | - | 2 | - | 3 | - | 2 | 2 | 2 | |
| **CO3** | 3 | 2 | 2 | - | - | - | - | 2 | - | 3 | - | 2 | 2 | 2 | |
| **CO4** | 3 | 2 | 2 | - | - | - | - | 2 | - | 3 | - | 2 | 2 | 2 | |
| **CO5** | 3 | 2 | 2 | - | - | - | - | 2 | - | 3 | - | 2 | 2 | 2 | |
| **Avg** | **3** | **2** | **2** | - | - | - | - | **2** | - | **3** | - | **2** | **2** | **2** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-II**

# B.E. - BIOMEDICAL ENGINEERING

| PH24203 | MEDICAL PHYSICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

- To provide understanding of the application of the radiation concepts and methods of Physics in Medical science
- To accentuate the principle, effects and clinical applications of ionizing, non-ionizing and electromagnetic radiation.
- To instill the basics of logical information about the interaction of light with material.
- To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications
- To study effects of sound and light in human body

**UNIT I LOW ENERGY ELECTROMAGNETIC SPECTRUM AND ITS MEDICAL APPLICATION 9**

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. Thermography– Application.

**UNIT II PRINCIPLES OF RADIOACTIVE NUCLIDES 9**

Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology, Decay series, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radionuclide-fission and neutron capture reaction, radionuclide Generator-Technetium generator.

**UNIT III 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 IV OPTICAL PROPERTIES OF MATERIALS 9**

Classification of optical materials – carrier generation and recombination processes - Absorption emission and scattering of light in metals, insulators and semiconductors (concepts only) – photo current in a P- N diode – solar cell – photo detectors - LED – Organic LED – Optics in quantum structures – quantum well laser.

**UNIT V PRINCIPLES AND APPLICATIONS OF SOUND IN MEDICINE 9**

Physics of sound, Normal sound levels, ultrasound fundamentals, Generation of ultrasound (Ultrasound Transducer), Interaction of Ultrasound with matter- Cavitation's, Reflection, Transmission, Scanning methods, Artifacts, Ultrasound- Doppler effect, Clinical Applications

**Total: 45 Periods**

**COURSE OUTCOMES:**

At the end of the course, the students should be able to

**CO1 :** Interpret the properties of electromagnetic radiations and its effect on human.

**CO2 :** Apply the principles and understand the production of radioactive nuclides.

**CO3 :** Explain the interaction of radiation with matter

**CO4 :** Illustrate the optical properties of materials and working principles of various optical devices

**CO5 :** Demonstrate the knowledge on the properties of sound and its application in medicine.

**TEXT BOOKS:**


1. S.O. Kasap. Principles of Electronic Materials and Devices, McGraw Hill Education (Indian Edition), 2020.
2. R.F.Pierret. Semiconductor Device Fundamentals. Pearson (Indian Edition), 2006.
3. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.
4. B.H. Brown, R.H. Smallwood, D.C. Barber, P.V. Law ford, D.R. Hose, ―Medical Physics and Biomedical
5. Engineering‖, Institute of physics publishing, Bristol and Philadelphia, 1999.
6. Gopal B. Saha ―Physics and Radiobiology of Nuclear Medicine‖ Fourth edition Springer, 2006.


**REFERENCES:**


1. Laszlo Solymar, Walsh, Donald, Syms and Richard R.A., Electrical Properties of Materials, Oxford Univ. Press (Indian Edition) 2015.
2. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Education (Indian Edition), 2019.
3. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
4. W.J. Meredith and J.B. Massey "Fundamental Physics of Radiology" Varghese Publishing house, Third Edition, 2013.
5. Steve Webb, The Physics of Medical Imaging, Taylor & Francis, New york, Second Edition, 2012.
6. R.S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | - | 1 | - | - | - | - | 1 | - | - | - | - | 1 | - | 1 |
| **CO2** | 3 | 2 | 1 | 2 | - | 2 | - | 2 | - | - | - | - | - | - | - |
| **CO3** | 3 | 2 | 2 | - | 2 | - | - | 2 | - | - | - | - | 2 | - | 2 |
| **CO4** | 3 | - | 1 | - | 3 | 2 | 3 | 1 | - | - | - | 1 | - | - | 1 |
| **CO5** | 3 | - | 2 | 1 | - | 2 | - | 2 | - | - | - | 1 | - | - | 2 |
| **Avg** | **3** | **2** | **1.4** | **1.5** | **2.5** | **2** | **3** | **1.6** | **-** | **-** | **-** | **1** | **1.5** | **-** | **1.5** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-II**
**Common To All Branches**
**(B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH)**

| TA24201 | TAMILS AND TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | 0 | 0 | 1 |

**UNIT I WEAVING AND CERAMIC TECHNOLOGY 3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

**UNIT II 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 in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

**UNIT III MANUFACTURING TECHNOLOGY 3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold-Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads -Terracotta beads - Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

**UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu 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 V SCIENTIFIC TAMIL & TAMIL COMPUTING 3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries –Sorkuvai Project.

**Total: 15 Periods**

**SEMESTER-II**
**Common To All Branches**
**(B.Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH)**

| TA242001 | தமிழரும் மற்றும் தொழில்நுட்பம் | L | T | P | C |
|---|---|---|---|---|---|
| | | 1 | - | - | 1 |

**அலகு I நெசவு மற்றும் பானை தொழில்நுட்பம் 3**

சங்க காலத்தில் நெசவுத் தொழில் - பானை தொழில்நுட்பம் - கருப்பு மற்றும் சிவப்பு பாண்டங்கள் பாண்டங்களில் கீறல் குறியீடுகள்.

**அலகு II வடிவமைப்பு மற்றும் கட்டுமான தொழில்நுட்பம் 3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமானப் பொருட்களும் நடுகல்லும் - சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெரியகோவில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோவில்கள் - மாதிரி கட்டமைப்புகள் பற்றிய அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாடு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ- சாரோசெனிக் கட்டிடக் கலை.

**அலகு III உற்பத்தி தொழில்நுட்பம் 3**

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற் சாலை- இரும்பு உருகுதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சாடித்தல் - மணிகள் உருவக்கும் தொழிற் சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத் துண்டுங்கள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

**அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசன தொழில்நுட்பம் 3**

அணை, ஏரி, குளங்கள், மதகு, - சோழர்காலக் குமிழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக் குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.

**அலகு V அறிவியல் தமிழ் மற்றும் கணிதத்தமிழ் 3**

அறிவியல் தமிழின் வளர்ச்சி – கணிதத்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் -சொற்குவைத் திட்டம்.

**Total: 15 Periods**

**TEXT-CUM-REFERENCE BOOKS**


1. தமிழக வரலாறு மக்களும் பண்பாடு மற்றும் கல்வியியல் பணிகள் கழகம்.
2. கணினித் தமிழ் முனைவர் இல.சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தோல்லியல் துறை வெளியீடு).
4. பொருநை - ஆற்றங்கரை நாகரிகம் (தோல்லியல் 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 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) (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.

**SEMESTER-II**

# B.E. - BIOMEDICAL ENGINEERING

| BM24201 | ANATOMY AND HUMAN PHYSIOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

The student should be:

- To integrate the individual functions of all the cells and tissues and organs into functional whole, the human body.
- Function is dependent on a structure, the curriculum lays stress on functional anatomy of the organs.
- Emphasizes on the cardiovascular, respiratory, urinary and nervous system and their interrelatedness.
- Stimulate the students to understand the basic functioning of every system and the resultant unified organization.

**UNIT I 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 II 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 III 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 IV 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 V NERVOUS AND SENSORY SYSTEM 9**

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

**Total: 45 Periods**

**LIST OF EXPERIMENTS:**

1. Collection of Blood Samples
2. Identification of Blood groups (Forward and Reverse)
3. Bleeding and Clotting time
4. Estimation of Haemoglobin

5. Total RBC and WBC Count
6. Differential count of Blood cells
7. Estimation of ESR, PCV, MCH, MCV, MCHC
8. Hearing test – Tuning fork
9. Visual Activity – Snellen's Chart and Jaeger's Chart

**Total: 30 Periods**
**Total: 75 Periods**

**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

**TEXT BOOKS:**


1. Elaine.N. Marieb, "Essential of Human Anatomy and Physiology", Ninth Edition, Pearson Education, New Delhi, 2018.


**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. Sarada Subramanyam, K Madhavan Kutty, Singh H D, "Textbook of Human Physiology", S. Chand and Company Ltd, New Delhi, 2012.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | - | - | 1 | - | 1 | - | - | - | 1 | 3 | 3 | - |
| **CO2** | 3 | 3 | 2 | - | - | 1 | - | 1 | - | - | - | 1 | 3 | 3 | - |
| **CO3** | 3 | 3 | 2 | - | - | 1 | - | 1 | - | - | - | 1 | 3 | 3 | - |
| **CO4** | 3 | 3 | 3 | - | - | 1 | - | 1 | - | - | - | 1 | 3 | 3 | - |
| **CO5** | 3 | 3 | 3 | - | - | 1 | - | 1 | - | - | - | 1 | 3 | 3 | - |
| **Avg** | **3** | **3** | **2** | - | - | **1** | - | **1** | - | - | - | **1** | **3** | **3** | - |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-II**
**Common To B.E. – EEE & MECH**

| EE24201 | BASIC ELECTRICAL AND ELECTRONICS ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

- To illustrate the basics of electric circuits and analysis of DC & AC circuits.
- To understand the knowledge in the basics of working principles and application of electrical machines.
- To evaluate the fundamentals of analog electronics and their characteristics.
- To demonstrate the fundamental concepts of digital electronics.
- To compute the functional elements and working of measuring instruments.

**UNIT - I BASIC ELECTRIC CIRCUITS 9**

DC Circuits: Basic Circuit elements – Ohm's Law - Kirchhoff's Laws with Independent Sources – Resistors in Series and Parallel- Current division and Voltage division- Nodal Analysis, Mesh analysis with Independent sources only - Thevenin's and Norton's Theorem. Introduction to AC circuit Fundamentals: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor.

**UNIT II ELECTRICAL MACHINES 9**

Construction and Working principle - DC Machines, EMF equation, Types and Applications. Construction and Working Principle of Transformers & Induction Motors, V/F drives.

**UNIT III ANALOG ELECTRONICS 9**

PN Junction Diode, Zener Diode – V-I Characteristics & Applications, BJT, SCR, MOSFET, IGBT Types– Basics of Rectifier and Inverter.

**UNIT IV DIGITAL ELECTRONICS 9**

Number system and its conversion, binary codes, Combinational logic - representation of logic functions-SOP and POS forms, K-map representations - minimization using K maps.

**UNIT V MEASUREMENTS AND INSTRUMENTATION 9**

Functional elements of an instrument, Standards, Operating Principle, types -Moving Coil and Moving Iron meters, Measurement of three phase power, Energy Meter, Instrument Transformers - CT and PT, DSO – Block diagram – Data Acquisition.

**Total: 45 Periods**

**LIST OF EXPERIMENTS:**

1. Simulation and experimental verification of electrical circuit using Mesh analysis.
2. Simulation and experimental verification of electrical circuit using Nodal analysis.
3. Measurement of Three Phase Power using two Wattmeter method.
4. Load test on single-phase transformer.
5. Load test on DC shunt motor.
6. VI characteristic of PN junction diode.

7. VI characteristic of Zener Diode.
8. Study Of solar PV.

**Total: 30 Periods**

**Total: 75 Periods**

**COURSE OUTCOMES**

After completing this course, the students will be able to

**CO1 :** Compute the electric circuit parameters.

**CO2 :** Illustrate the working principle and applications of electrical machines.

**CO3 :** Plot the characteristics of analog electronics.

**CO4 :** Summarize the basic concepts of digital electronics.

**CO5 :** Interpret the operating principles of measuring instruments.

**TEXT BOOKS:**


1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020.
2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017.
3. Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., Third Edition, 2015.
4. James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
5. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.


**REFERENCES**:


1. Thomas L. Floyd, 'Digital Fundamentals', 11th Edition, Pearson Education, 2017.
2. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 9th edition, 2021.
3. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 7th Edition 2017.
4. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 4th Edition, 2019.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | - | - | - | - | 1 | - | 1 | - | 2 | - | 1 | 1 |
| **CO2** | 2 | 2 | 1 | - | - | - | - | 1 | - | 1 | - | 2 | - | 1 | 1 |
| **CO3** | 2 | 2 | 1 | - | - | - | - | 1 | - | 1 | - | 2 | - | 1 | 1 |
| **CO4** | 2 | 2 | 1 | - | - | - | - | 1 | - | 1 | - | 2 | - | 1 | 1 |
| **CO5** | 2 | 2 | 1 | - | - | - | - | 1 | - | 1 | - | 2 | - | 1 | 1 |
| **Avg** | **2** | **2** | **1** | **-** | **-** | **-** | **-** | **1** | **-** | **1** | **-** | **2** | **-** | **1** | **1** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-II**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| GE24201 | ENGINEERING PRACTICES LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to provide hands on training to the students in:

- Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planning; making joints in wood materials used in common household wood work.
- Welding various joints in steel plates using arc welding; machining various simple processes like turning, drilling, and tapping in parts.
- Wiring various electrical joints in common household electrical wire work.
- Soldering and testing simple electronic circuits; assembling and testing simple electronic components on PCB.

**GROUP – A (CIVIL & MECHANICAL ENGINEERING)**

**PART I CIVIL ENGINEERING PRACTICES 15**

**PLUMBING WORK:**

a. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in household fittings.
b. Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
c. Preparation of plumbing line sketches for water supply.
d. Laying pipe connection to the suction and delivery side of a pump
e. Mixed pipe material connection – Pipe connections with different joining components.

**WOOD WORK:**

a. Study of the joints in roofs, doors, windows and furniture.
b. Making joints like Mortise and Tenon joint, T-Joint and Dovetail joint by sawing, planning and cutting.

**PART II MECHANICAL ENGINEERING PRACTICES 15**

**WELDING WORK:**

a. Welding of Butt joints, Lap joints and Tee joints using arc welding.
b. Gas welding practice

**BASIC MACHINING WORK:**

a. Simple step turning, taper turning
b. Simple drilling.

**ASSEMBLY WORK:**

a. Study of centrifugal pump
b. Study of air conditioner
c. Study of household mixer.

**SHEET METAL WORK:**

a. Making models of a square/Rectangular tray and funnels.

**FOUNDRY WORK:**

a. Demonstrating basic foundry operations.

**GROUP B (ELECTRICAL & ELECTRONICS ENGINEERING)**

**PART III ELECTRICAL ENGINEERING PRACTICES 15**

a. Introduction to switches, fuses, indicators and lamps - Basic switch board wiring with lamp, fan and three pin socket.
b. Staircase Wiring.
c. Fluorescent Lamp wiring with introduction to CFL and LED types.
d. Energy meter wiring and related calculations/ calibration.
e. Study of Iron Box wiring and assembly.
f. Study of Fan Regulator (Resistor type and Electronic type using Diac/Triac/quadrac).
g. Study of emergency lamp wiring/Water heater.

**PART IV ELECTRONIC ENGINEERING PRACTICES 15**

**STUDY OF ELECTRONIC COMPONENTS**

a. Measurement of Resistance of a resistor using Color Coding.
b. Measurement of AC signal parameters (Peak-Peak, RMS period, Frequency) using CRO.

**SOLDERING WORK:**

a. Soldering simple electronic circuits and checking continuity.

**ELECTRONIC ASSEMBLY AND TESTING WORK:**

a. Assembling and testing electronic components on a small PCB.

**STUDY OF LOGIC GATES:**

a. Verification of logic gates - AND, OR, NOT, NAND, NOR, EXOR, EX-NOR.

**ELECTRONIC EQUIPMENT STUDY:**

a. Study on elements of smart phone.
b. Assembly and dismantle of LED TV.
c. Assembly and dismantle of computer/ laptop.

**Total = 60 Periods**

***At end of the semester students should submit the prototypes of their stem projects.**

**COURSE OUTCOMES**

On successful completion of this course, the student will be able to:

**CO1:** draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.

**CO2:** weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, and tapping in parts.

**CO3:** assemble simple mechanical assembly of common household equipment's; Make a simple model using sheet metal work.

**CO4:** wiring of various electrical joints in common household electrical wire work.

**CO5:** solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

**CO6:** understand the concept and verification of logic gates.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 1 | | |
| **CO2** | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 1 | | |
| **CO3** | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 1 | | |
| **CO4** | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 1 | | |
| **CO5** | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 1 | | |
| **CO6** | 3 | 2 | | | 1 | 1 | 1 | | | | | 2 | 1 | | |
| **Avg** | **3** | **2** | | | **1** | **1** | **1** | | | | | **2** | **1** | | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-II**
**Common To All Branches**
**B. Tech – AI&DS, IT, B.E – BME, CSE, ECE, EEE & MECH**

| HS24202 | ENGLISH COMMUNICATION LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

- To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
- To be able to communicate effectively through writing.

**UNIT I SELF INTRODUCTION AND EMAIL DRAFTING 12**

**Speaking**: Role Play Exercises Based on Workplace Contexts, - talking about competition- discussing progress toward goals-talking about experiences-talking about events in life-discussing past events.
**Writing:** Writing emails (formal & semi-formal).

**UNIT II INDIVIDUAL DISCUSSION ON SOCIAL ISSUES 12**

**Speaking:** discussing news stories-talking about frequency-talking about travel problems- discussing travel procedures- talking about travel problems- making arrangements-describing arrangements-discussing plans and decisions- discussing purposes and reasons- understanding common technology terms.
**Writing:** Writing different types of emails.

**UNIT III PRESENTATION ON TECHNICAL AND NON-TECHNICAL TOPICS 12**

**Speaking:** discussing predictions-describing the climate-discussing forecasts and scenarios-talking about purchasing-discussing advantages and disadvantages-making comparisons-discussing likes and dislikes-discussing feelings about experiences-discussing imaginary scenarios.
**Writing:** Short essays and reports-formal/semi-formal letters.

**UNIT IV IMPORTANCE OF DESCRIPTIVE WRITING & INSTRUCTIONS 12**

**Speaking:** discussing the natural environment-describing systems-describing position and movement-explaining rules-( example- discussing rental arrangements)- understanding technical instructions.
**Writing:** Writing instructions. Writing a short article.

**UNIT V GROUP DISCUSSION AND IMPORTANCE OF RESUME WRITING 12**

**Speaking:** describing things relatively-describing clothing-discussing safety issues (making recommendations) talking about electrical devices-describing controlling actions.
**Writing:** Job application (Cover letter+ Curriculum vitae)- product presentation)

**Total: 60 Periods**

**COURSE OUTCOMES**

After completion of this course, the students should be able to

**CO1 :** Speak effectively in group discussions held in a formal/semi formal contexts.
**CO2 :** Discuss, analyse and present concepts and problems from various perspectives to arrive at suitable solutions

**CO3 :** Write emails, letters and effective job applications.
**CO4 :** Write critical reports to convey data and information with clarity and precision.
**CO5 :** Give appropriate instructions and recommendations for safe execution of tasks.

**Assessment Pattern**

- Conduction of Assessment to test speaking and writing skills

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 3 | | 3 | | 3 | 3 | | 3 | 3 | 3 | 3 | | | |
| **CO2** | | 3 | | 3 | | 3 | 3 | | 3 | 3 | 3 | 3 | | | |
| **CO3** | | 2 | | 3 | | 3 | 3 | | 3 | 3 | 3 | 3 | | | |
| **CO4** | | 3 | | 3 | | 3 | 3 | | 3 | 3 | 3 | 3 | | | |
| **CO5** | | 3 | | 3 | | 3 | 3 | | 3 | 3 | 3 | 3 | | | |
| **Avg** | | **2.8** | | **3** | | **3** | **3** | | **3** | **3** | **3** | **3** | | | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-III**
**(B.E - BME)**

| MA24302 | TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the concepts of Fourier series, Transforms and formation of partial differential equations, which will enable them to model and analyze the physical phenomena.
- Implementing the Fourier analysis, an elegant method in the study of heat flow, fluid mechanics and electromagnetic fields.
- Developing enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.

**UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3**

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - First order partial differential equations reducible to standard types Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

**UNIT II FOURIER SERIES 9+3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series and cosine series – Root mean square value – Parseval's identity – Harmonic analysis.

**UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3**

Classification of PDE – Method of separation of variables - Fourier series solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction (Cartesian coordinates only).

**UNIT IV Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3**

Z-transforms - Elementary properties – Convergence of Z-transforms - Initial and final value theorems - Inverse Z-transform using partial fraction- Residue method - convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.

**UNIT V FOURIER TRANSFORMS 9+3**

Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

**TOTAL PERIODS: 60**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Exemplify the concepts of partial differential equations and able to apply them to solve real scenarios.

**CO2:** Analyze the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series.

**CO3:** Appreciate the physical significance of Fourier series techniques in solving one and two-dimensional heat flow problems and one-dimensional wave equations.

**CO4:** Apply the Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.

**CO5:** Apply Fourier transform to convert the function in time domain into a sum of sine waves of different frequencies, each of which represents a frequency component.

**TEXT BOOKS:**


1. Grewal B.S., "Higher Engineering Mathematics", 44thEdition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2016.
3. Sankara Rao. K, "Numerical Methods for Scientists and Engineers", PHI Learning Pvt Ltd., New Delhi, 2007.


**REFERENCES:**


1. Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
2. Bali. N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 10th Edition, Laxmi Publications Pvt. Ltd, 2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4thEdition, Pearson Education, New Delhi,2016.
4. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi, 2016.
5. Peter V O Neil., Advanced Engineering Mathematics, 7th Edition, TBH Publishers, 2013.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 1 | | | | | 2 | | | 2 | 1 | 1 | |
| **CO2** | 2 | 3 | 1 | 1 | | | | | 2 | | | 3 | 1 | 1 | |
| **CO3** | 3 | 2 | 1 | 1 | | | | | 2 | | | 3 | 1 | 1 | |
| **CO4** | 3 | 2 | 1 | 1 | | | | | 2 | | | 3 | 1 | 1 | |
| **CO5** | 2 | 3 | 2 | 2 | | | | | 2 | | | 2 | 1 | 1 | |
| **Avg** | **2.6** | **2.4** | **1.2** | **1.2** | | | | | **2** | | | **2.6** | **1** | **1** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-III**
**(B.E - BME)**

| BM24301 | SIGNALS AND SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the various types and classifications of continuous-time and discrete-time signals.
- Exploring the representation and classification of continuous-time and discrete-time systems.
- Learning ability to analyze signals in the frequency domain using Fourier Series, Fourier Transform, Laplace Transform, DTFT, and Z-Transform.
- Understanding the frequency response and system behavior of continuous-time LTI systems using Laplace transforms and differential equations.
- Understanding the discrete-time LTI systems using difference equations, convolution, Z-transforms, and frequency domain techniques such as the DFT.

**UNIT I CONTINUOUS AND DISCRETE TIME SIGNALS 9**

Standard Elementary Signals of Continuous time signals (CT signals) & Discrete time signals (DT signals): Step, Ramp, Pulse, Impulse, Complex exponential and Sinusoidal signals. Classification of CT and DT signals: Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals, Even and Odd signals.

**UNIT II CONTINUOUS AND DISCRETE TIME SYSTEMS 7**

Classification of CT systems and DT systems: Static & Dynamic, Linear & Nonlinear, Time-variant & Time invariant, Causal & Non-causal, Stable & Unstable.

**UNIT III ANALYSIS OF CONTINOUS AND DISCRETE TIME SIGNALS 11**

Representation of Fourier series, Trigonometric Fourier Series, Fourier Transform and their properties, Laplace Transform and their properties. Discrete Time Fourier Transform (DTFT), Properties of DTFT, Z-Transforms, Region of convergence, Properties of Z transforms, Inverse Z Transform using Partial Fraction Method.

**UNIT IV LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9**

Convolution Integrals, Frequency response of LTI systems, Analysis and characterization of LTI systems using Laplace transform, Computation of impulse response and transfer function using Laplace transform, Computation of impulse response from differential equation.

**UNIT V LINEAR TIME INVARIANT DISCRETE TIME SYSTEMS 9**

LTI-DT systems -Difference equation– Impulse response, Convolution Sum and Frequency response -Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Identify and classify different types of continuous and discrete time signals.

**CO2:** Comprehend and categorize various CT and DT systems.

**CO3:** Apply various transforms (FS, FT, Laplace, DTFT, Z-transform) to analyze and characterize signals.

**CO4:** Determine the behavior of continuous-time LTI systems using Laplace Transform techniques.

**CO5:** Extract the behavior of discrete-time LTI systems using convolution, Z-transform, and DFT.

**TEXT BOOKS:**


1. Simon Haykin, Barry Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002
2. Oppenheim, Willsky and Hamid, "Signals and Systems", 2nd Edition, Pearson Education, New Delhi, 2015.
3. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", Pearson, 2nd edition, 2007.


**REFERENCES:**


1. B. P. Lathi, "Principles of Linear Systems and Signals", Second Edition, Oxford, 2009.
2. R.E.Zeimer, W.H.Tranter and R.D.Fannin, "Signals & Systems - Continuous and Discrete",Pearson, 2007.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.
4. M.J.Roberts, "Signals & Systems Analysis using Transform Methods & MATLAB", TataMcGrawHill, 2007.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | | | | | | | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | | | | | | | 2 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | | | | | | | 2 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | | | | | | | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | | | | | | | 2 | 2 | 2 | 2 | 2 |
| **Avg** | **3** | **3** | **3** | **2** | | | | | | | **2** | **2** | **2** | **2** | **2** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-III**
**(B.E - BME)**

| CS24307 | FUNDAMENTALS OF DATA STRUCTURES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Introducing the basics of C programming language.
- Learning the concepts of advanced features of C.
- Understanding the concepts of ADTs and linear data structures.
- Learning the concepts of non-linear data structure and hashing.
- Familarizing the concepts of sorting and searching techniques.

**UNIT I C PROGRAMMING FUNDAMENTALS 9**

Data Types – Variables – Operations – Expressions and Statements – Conditional Statements – Basic Debugging and Error Handling– Functions – Recursive Functions – Arrays – Single and Multi-Dimensional Arrays.

**UNIT II C PROGRAMMING - ADVANCED FEATURES 9**

Structures – Union – Enumerated Data Types – Pointers: Pointers to Variables, Arrays and Functions – File Handling – Preprocessor Directives.

**UNIT III LINEAR DATA STRUCTURES 9**

Abstract Data Types (ADTs) – List ADT – Array-Based Implementation – Linked List – Doubly- Linked Lists – Time Complexity Basics– Stack ADT – Implementation of Stack – Applications – Queue ADT – Priority Queues – Queue Implementation – Applications.

**UNIT IV NON-LINEAR DATA STRUCTURES 9**

Trees – Binary Trees – Tree Traversals – Binary Search Tree – Hashing - Hash Functions – Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing.

**UNIT V SORTING AND SEARCHING TECHNIQUES 9**

Insertion Sort – Quick Sort – Heap Sort – Merge Sort –Linear Search – Binary Search.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Develop C programs for any real world/technical application.
**CO2:** Apply advanced features of C in solving problems.
**CO3:** Write functions to implement linear and non–linear data structure operations.
**CO4:** Suggest and use appropriate linear/non–linear data structure operations for solving a given problem.
**CO5:** Appropriately use sort and search algorithms for a given application.

**TEXT BOOKS:**

1. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 1997.
2. Reema Thareja, “Programming in C”, Second Edition, Oxford University Press, 2016.

**REFERENCES:**

1. Brian W. Kernighan, Rob Pike, “The Practice of Programming”, Pearson Education, 1999.
2. Paul J. Deitel, Harvey Deitel, “C How to Program”, Seventh Edition, Pearson Education, 2013.
3. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education,1983.
4. Ellis Horowitz, Sartaj Sahni and Susan Anderson, “Fundamentals of Data Structures”, Galgotia, 2008.

**List of Open-Source Software/ Learning website:**

https://www.coursera.org/specializations/data-structures- algorithms
https://nptel.ac.in/courses/112107243
https://nptel.ac.in/courses/112105598

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 2 | 2 | 3 | | | 2 | 2 | 3 | 2 | 2 | |
| **CO2** | 2 | 2 | 2 | 2 | 3 | | | | | 3 | 3 | 2 | 2 | |
| **CO3** | 2 | 3 | 3 | 2 | 3 | | | | | 3 | 2 | 3 | 2 | |
| **CO4** | 2 | 2 | 3 | 2 | | | | | | 3 | 2 | 3 | 2 | |
| **CO5** | 2 | 2 | 2 | 2 | 2 | 3 | | | 2 | 2 | 2 | 2 | 2 | |
| **Avg** | **2.00** | **2.40** | **2.40** | **2.00** | **2.25** | **3.00** | | | **2.00** | **2.60** | **2.40** | **2.40** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-III**
**(B.E - BME)**

| BM24302 | BIOSCIENCES FOR MEDICAL ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Studying the basic fundamentals to biochemistry.
- Exploring the structural and functional properties of carbohydrates, proteins, lipids and amino acids.
- Emphasizing the role of enzymes by providing basic information on specific enzyme activities.
- Gaining knowledge on the structural and functional aspects of living organisms.
- Learning the etiology and remedy in treating the pathological diseases.

**UNIT I FUNDAMENTALS TO BIOCHEMISTRY 9**

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson - Hasselbalch equation, physiological buffers in living systems-Properties of water and their applications in biological systems.

**UNIT II CARBOHYDRATES, LIPIDS, PROTEIN 9**

Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates. Classification of lipids- simple, compound, and derived lipids. Nomenclature of fatty acid-Physical and chemical properties of triglycerides. Nucleic acid: Structural aspects – Components of DNA and RNA, Double helical structure of DNA (Watson-Crick model), various forms of DNA. Amino acid: Classification. Protein: structural organization.

**UNIT III ENZYMES 9**

Enzymes: classification, Factors affecting enzymatic activity, kinetics – Michaelis-Menten equation, Line weaver burk plot, Mode of action, Regulation: Feedback, allosteric and covalent regulation. Clinical significance of enzymes – case studies

**UNIT IV CELL DEGENERATION, REPAIR AND NEOPLASIA & FLUID 9**

Cell injury - Reversible cell injury and Irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification- Dystrophic and Metastatic. Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, chronic venous congestion.

**UNIT V FUNDAMENTALS OF MICROBIOLOGY AND IMMUNOPATHOLOGY 9**

Structure of Bacteria and Virus - Morphological features and structural organization of bacteria and virus - List of common bacterial, fungal and viral diseases of human beings. - Basics of Microscopes: Light microscope, Electron microscope (TEM & SEM). - Natural and artificial immunity.

**TOTAL PERIODS: 45**

**LIST OF EXPERIMENTS:**

1. General tests for Carbohydrates.
2. General tests for Proteins.
3. General tests for Lipids.
4. Separation of proteins by SDS electrophoresis (Demo) and amino acids by thin layer chromatography (Demo).
5. Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood).
6. Preparation of serum and plasma from blood.
7. Estimation of creatinine, urea and Uric acid.
8. Types of Staining: Simple stain, Gram stains Hematoxylin and eosin staining.
9. Study of parts of compound microscope.
10. Study of Histopathological and Hematology slides of anemia, leukemia and slides of benign and malignant tumors.

**TOTAL PERIODS: 30**

**TOTAL PERIODS: 75**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe the Fundamentals of Biochemistry.
**CO2:** Analyze structural and functional properties of carbohydrates, proteins, lipids and amino acids.
**CO3:** Identify the role of enzymes by providing basic information on specific enzyme activities.
**CO4:** Elucidate the structural and functional aspects of living organisms.
**CO5:** Relate methods involved in analysis the pathological diseases.

**TEXT BOOKS:**


1. RAFI MD "Text book of biochemistry for Medical Student" Fourth Edition, Universities Press, Orient Blackswan Private Limited - New Delhi 2021.
2. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 10th edition: South Asia Edition Elsevier India, 2020. (Units IV).
3. Ananthanarayanan & Panicker, "Microbiology" Orientblackswan, 2017 10th edition. (Units IV and V).


**REFERENCES:**


1. Keith Wilson & John Walker, "Practical Biochemistry - Principles & Techniques", Oxford University Press, 2009.
2. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
3. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2007
4. Prescott, Harley and Klein, "Microbiology", 10th edition, McGraw Hill, 2017


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | | | | | | 2 | | | 2 |
| **CO2** | 2 | 2 | | | | | | | | | 2 | | | 2 |
| **CO3** | 2 | 2 | 2 | | | 3 | | | | | 2 | | | 2 |
| **CO4** | 2 | 2 | 2 | | 3 | 3 | | | | | 2 | | | 2 |
| **CO5** | 2 | 2 | 2 | 2 | 3 | 3 | 2 | | 1 | | 2 | | | 2 |
| **Avg** | **2.00** | **2.00** | **2.00** | **2.00** | **3.00** | **3.00** | **2.00** | | **1.00** | | **2.00** | | | **2.00** |

**1 - Low, 2 - Medium, 3 – High**

## LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

| Sl. No. | Description of Equipment | Required numbers |
|---|---|---|
| 1 | Microscope | 2 |
| 2 | SDS gel electrophoresis | 1 |
| 3 | Centrifuge Normal | 1 |
| 4 | Spectrophotometer | 1 |
| 5 | Colorimeter | 2 |
| 6 | Microslides (packets) | 2 |
| 7 | Refrigerator | 1 |
| 8 | TLC, ready TLC plates | 1 |
| 9 | Weighing balance | 1 |
| 10 | Heparinized Syringe (box) | 1 |

**SEMESTER-III**
**(B.E - BME)**

| BM24303 | BIOSENSORS AND MEASUREMENTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of measurement systems, transducers, and error analysis.
- Learning the principles and applications of displacement, pressure, and temperature sensors.
- Understanding the operation of photoelectric and piezoelectric sensors.
- Knowing the signal conditioning circuits and electronic measuring instruments.
- Exploring the recording devices, biosensors, smart sensors, and MEMS.

**UNIT I FUNDAMENTALS OF MEASUREMENTS 9**

Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis- methods of error analysis, - uncertainty analysis-expression of uncertainty: accuracy, precision index and propagation of errors– Calibration – Primary and secondary standards.

**UNIT II DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS 9**

Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gauge. Capacitive transducer, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Active type: Thermocouple - characteristics.

**UNIT III PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS 9**

Phototube, scintillation counter, photovoltaic, photo conductive cells, photo diodes, phototransistor- Optical displacement sensors and optical encoders. Piezoelectric active transducer- Equivalent circuit and its applications.

**UNIT IV SIGNAL CONDITIONING CIRCUITS AND METERS 9**

Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, AC and DC Bridges - wheat stone bridge, Kelvin, Maxwell, Hay, Schering, Digital voltmeter – Multi meter.

**UNIT V RECORDING DEVICES AND ADVANCED BIOSENSORS 9**

CRO, LCD monitor, thermal recorder, photographic recorder, magnetic tape recorder, - Electronic nose - Biosensors: Introduction, Advantages and limitations, various components of Biosensors - Introduction to Smart Sensors, Semiconductor sensors and MEMS.

**TOTAL PERIODS: 45**

**LIST OF EXPERIMENTS:**

1. Characteristics of thermistor.
2. Characteristics of thermocouple
3. Characteristics of Photo Diode.
4. Characteristics of Photo Transistor.
5. Characteristics of RTD.
6. Characteristics of LVDT.
7. Measurement of unknown Resistance using Wheatstone Bridge.
8. Measurement of unknown Inductance using Hay's Bridge.
9. Characteristics of strain gauge.
10. Characteristics of Gas Sensor.

**TOTAL PERIODS: 30**

**TOTAL PERIODS: 75**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1 :** Measure various electrical parameters with accuracy, precision, resolution.

**CO2 :** Select appropriate displacement, pressure, and temperature sensors.

**CO3 :** Describe the working principles and applications of photoelectric and piezoelectric sensors.

**CO4 :** Design and evaluate signal conditioning circuits and utilize digital measuring instruments.

**CO5 :** Demonstrate the working principles of various recording devices and advanced biosensors.

**TEXT BOOKS:**


1. A.K. Sawhney, "Electrical & Electronics Measurement and Instrumentation",10th edition, Dhanpat Rai & Co, New Delhi, 19th Revised edition 2011, Reprint 2014.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.


**REFERENCES:**


1. Khandpur R.S, "Handbook of Biomedical Instrumentation", 3rd edition,Tata McGraw-Hill, New Delhi, 2014.
2. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice Hall of India, New Delhi, 2015.
3. Advances in biosensors, B. D. Malhotra & A. P. F. Turner (eds), Volume 5, Elsevier science 2003.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | | | | | 1 | | | | 1 | 1 | | |
| **CO2** | 3 | 3 | 2 | | | | | | | | | 1 | 1 | | |
| **CO3** | 3 | 3 | 2 | | | | | | | | | 1 | 1 | | |
| **CO4** | 3 | 3 | 3 | | | | | | | | | 1 | 1 | | |
| **CO5** | 3 | 3 | 3 | | | | | 1 | | | | 1 | 1 | | |
| **Avg** | **3** | **3** | **2** | | | | | **1** | | | | **1** | **1** | | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-III**
**(B.E - BME)**

| BM24304 | FUNDAMENTALS OF ELECTRONIC DEVICES AND CIRCUITS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Introducing the concept of diodes, Bipolar Junction Transistors and FET.
- Studying the various model parameters of Transistors.
- Learning the characteristics, operation, and modeling of MOSFETs.
- Imparting the knowledge of various BJT amplifiers.
- Exploring the principles of feedbacks in amplifiers and functioning of various oscillator circuits.

**UNIT I PN JUNCTION SEMICONDUCTOR DIODE 9**

Introduction to PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, Transition and Diffusion Capacitances, Breakdown in PN Junction Diodes, Zener Diode.

**UNIT II BIPOLAR JUNCTION TRANSISTORS 9**

BJT types (NPN, PNP), Operations (NPN, PNP), Current equations, Input and Output characteristics of CE, CB, CC, Hybrid -π model - h-parameter model, Ebers Moll Model- Gummel Poon- model.

**UNIT III FIELD EFFECT TRANSISTORS 9**

MOSFETs: Drain and Transfer characteristics, Current Equations, Pinch off voltage and its significance, Threshold voltage, Channel length modulation, small signal Characteristics, D- MOSFET, E-MOSFET, Characteristics, Comparison of MOSFET with BJT.

**UNIT IV BJT AMPLIFIERS 9**

Introduction to BJT Amplifiers: Need for Biasing, DC Load line and Bias Point, Various Biasing methods of BJT, Analysis of CB, CE, and CC amplifiers, Differential amplifier - Common mode and Difference mode analysis.

**UNIT V FEEDBACK AMPLIFIERS AND OSCILLATORS 9**

Advantages of negative feedback, Voltage / Current, Series, Shunt feedback Amplifiers, positive feedback, Condition for oscillations, Wien bridge, Hartley and Crystal oscillators.

**TOTAL PERIODS: 45**

**LIST OF EXPERIMENTS:**

1. Characteristics of PN Junction Diode.
2. Characteristics of ZENER Diode.
3. Characteristics of CE configurations.
4. Characteristics of CB configurations.
5. Drain and Transfer Characteristics of CS configurations.
6. Drain and Transfer Characteristics of CD configurations.
7. Design and construct BJT Amplifier.
8. Construct a Differential amplifier using BJT.
9. Frequency response of Series and Shunt feedback amplifiers.
10. Characteristics of Hartley Oscillator.

**TOTAL PERIODS: 30**

**TOTAL PERIODS: 75**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1 :** Describe the construction, operation, and characteristics of PN junction diodes.
**CO2 :** Analyze the characteristics of Bipolar Junction Transistors (BJTs) in different configuration
**CO3 :** Examine the structure, characteristics, and operation of various Field Effect Transistors (FETs).
**CO4 :** Interpret the functioning of BJT amplifier circuits.
**CO5 :** Explain the concepts of feedback in amplifiers and Oscillator Circuits.

**TEXT BOOKS:**


1. Millman and Halkias, "Electronic Devices and Circuits", 4th Edition, McGraw Hill, 2015.
2. Mohammad Rashid, "Electronic Devices and Circuits", Cengage Learning Pvt. Ltd, 2015.
3. Salivahanan. S, Suresh Kumar. N, "Electronic Devices and circuits", 4th Edition, McGraw Hill, 2016.


**REFERENCES:**


1. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory" Pearson Prentice Hall, 11th Edition, 2014.
2. Bhattacharya and Sharma, "Solid State Electronic Devices", 2nd Edition, Oxford University Press, 2014.
3. R.S.Sedha, "A Textbook of Electronic Devices and Circuits", 2nd Edition, S.Chand Publications, 2008.
4. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2008.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | | | | | | | 2 | 2 | 2 | | |
| **CO2** | 3 | 3 | 2 | 2 | | | | | | | 2 | 2 | 2 | | |
| **CO3** | 3 | 3 | 2 | 2 | | | | | | | 2 | 2 | 2 | | |
| **CO4** | 3 | 3 | 3 | 2 | | | | | | | 2 | 2 | 2 | | |
| **CO5** | 3 | 3 | 3 | 2 | | | | | | | 2 | 2 | 2 | | |
| **Avg** | **3** | **3** | **2** | **2** | | | | | | | **2** | **2** | **2** | | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-III**
**(B.E - BME)**

| CS24308 | FUNDAMENTALS OF DATA STRUCTURES LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

- To develop applications in C
- To implement linear and non-linear data structures
- To understand the different operations of search trees
- To get familiarized to sorting and searching algorithms

**LIST OF EXPERIMENTS**

1. Practice of C programming using statements, expressions, decision making and iterative statements
2. Practice of C programming using Functions and Arrays
3. Implement C programs using Pointers and Structures
4. Implement C programs using Files
5. Development of real time C applications
6. Array implementation of List ADT
7. Array implementation of Stack and Queue ADTs
8. Linked list implementation of List, Stack and Queue ADTs
9. Applications of List, Stack and Queue ADTs
10. Implementation of Binary Trees and operations of Binary Trees
11. Implementation of Binary Search Trees
12. Implementation of searching techniques
13. Implementation of Sorting algorithms: Insertion Sort, Quick Sort, Merge Sort
14. Implementation of Hashing – any two collision techniques

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Use different constructs of C and develop applications.
**CO2:** Write functions to implement linear and non-linear data structure operations.
**CO3:** Suggest and use the appropriate linear / non-linear data structure operations for a given problem.
**CO4:** Apply appropriate hash functions that result in a collision free scenario for data storage and Retrieval.
**CO5:** Implement Sorting and searching algorithms for a given application.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 1 | 2 | 2 | 1 | | | 3 | 2 | 3 | 1 | 1 | 2 | 2 |
| **CO2** | 1 | 2 | 1 | 2 | 2 | | | | 2 | 1 | 1 | 2 | 2 | 1 | 2 |
| **CO3** | 2 | 3 | 1 | 2 | 3 | | | | 2 | 2 | 1 | 1 | 1 | 2 | 2 |
| **CO4** | 2 | 1 | | 1 | 1 | | | | 1 | 2 | 1 | 2 | 1 | 3 | 2 |
| **CO5** | 1 | 2 | 1 | 2 | 2 | 1 | | | 3 | 2 | 3 | 2 | 2 | 2 | 1 |
| **Avg** | **1.6** | **2.2** | **0.8** | **1.8** | **2** | **0.4** | | | **2.2** | **1.8** | **1.8** | **1.6** | **1.4** | **2** | **1.8** |

**1 - Low, 2 - Medium, 3 – High**

**SEMESTER-IV**
**(B.E - BME)**

| MA24402 | RANDOM PROCESSES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 1 | 4 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic concepts of probability with characteristics and also two-dimensional random variables
- Acquainting the student with the concept of Random Processes.
- Providing the basic knowledge to the student with correlation and spectral densities.

**UNIT I PROBABILITY AND RANDOM VARIABLES 9+3**

Axioms of probability - Conditional probability - Total probability - Bayes theorem - Random variables - Probability mass function - Probability density functions - Properties.

**UNIT II STANDARD DISTRIBUTIONS 9+3**

Discrete distributions: Binomial - Poisson - Negative Binomial - Continuous distributions: Uniform - Exponential - Normal distributions and their properties.

**UNIT III TWO- DIMENSIONAL RANDOM VARIABLES 9+3**

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

**UNIT IV RANDOM PROCESSES 9+3**

Definition and examples - first order, second order, strictly stationary, wide sense stationary and Ergodic processes - Markov process - Poisson and Normal processes.

**UNIT V CORRELATION AND SPECTRAL DENSITIES 9+3**

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

**TOTAL PERIODS: 60**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Demonstrate and apply the basic probability axioms and concepts in their core areas of random phenomena.

**CO2:** Apply the concepts of probability distributions in an appropriate place of science and Engineering.

**CO3:** Execute the knowledge of solving two-dimensional random variables using correlation Techniques**.**

**CO4:** Apply the concept of random process.

**CO5:** Evaluate the autocorrelation and spectral density of a random process and recognize the relation between them.

**TEXT BOOKS:**

1. Ibe.O.C., “Fundamentals of Applied Probability and Random Processes", Elsevier, 1st Indian Reprint, 2007.
2. Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata Mc Graw Hill, 4th Edition, New Delhi, 2002.

**REFERENCES:**

1. Stark. H and Woods. J.W "Probability and Random Processes with Applications to Signal Processing", 3rd Edition,Pearson Education, Asia, 2002.
2. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications", Academic Press, 2004.
3. Hwei Hsu, Schaum’s Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata Mc Graw Hill Edition, New Delhi, 2004.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | | | | | | | | 2 | 1 | 2 | |
| **CO2** | 2 | 2 | 1 | | | | | | | | | 3 | 1 | 2 | |
| **CO3** | 2 | 2 | 1 | | | | | | | | | 2 | 1 | 2 | |
| **CO4** | 3 | 2 | 1 | | | | | | | | | 3 | 1 | 2 | |
| **CO5** | 3 | 3 | 1 | | | | | | | | | 2 | 1 | 2 | |
| **Avg** | **2.6** | **2.2** | **1** | | | | | | | | | **2.4** | **1** | **2** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-IV**
**(B.E - BME)**

| BM24401 | ANALOG AND DIGITAL INTEGRATED CIRCUITS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the operation of operational amplifier circuits such as inverting, non-inverting, integrator, and differentiator.
- Exploring the working of filters using operational amplifiers and timer circuits using IC 555.
- Learning the principles and performance of digital-to-analog and analog-to-digital conversion techniques.
- Understanding the Boolean algebra and minimization techniques for designing combinational logic circuits.
- Investigating the behaviour of sequential logic circuits using flip-flops, counters, and registers.

**UNIT I INTRODUCTION TO OPERATIONAL AMPLIFIER AND ITS APPLICATIONS 9**

Basic OPAMP configurations and characteristics, Linear & Non-Linear Applications, Inverting and Non inverting amplifier, Differentiator, Integrator, Voltage to Current converter, Instrumentation amplifier.

**UNIT II FILTERS AND TIMERS 9**

Introduction to Filters: Low pass, High pass and band pass filters, IC 555 Timer: Working Principle, Astable and Monostable Multivibrator, Design of basic active filters using ICs.

**UNIT III DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS 9**

Analog switches, High speed sample and hold circuit and IC ‘s, Types of D/A converter -Weighted resistor, R-2R ladder DAC, D/A Accuracy and Resolution. A/D converter - Flash, Dual slope, Successive approximation, A/D Accuracy and Resolution. Voltage controlled oscillator, Voltage to Frequency converters.

**UNIT IV COMBINATIONAL LOGIC CIRCUITS 9**

Boolean algebra; Logic Gates, Standard POS and SOP form, Minimization of Boolean functions using K map, Combinational Logic Circuits; Arithmetic circuits, decoders, encoders, multiplexers, de-multiplexers, Magnitude Comparator.

**UNIT V SEQUENTIAL LOGIC CIRCUITS 9**

Latches and Flip Flops (SR, JK, D, T), Basic concepts and design of Moore and Mealy machines examples, state minimization, state assignment, Counters, Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In -Serial Out, Parallel In - Parallel Out.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe the Non inverting, inverting, integrator, Differentiator amplifier circuits using op-amp.

**CO2:** Explain the operation of filter using operational amplifiers and timer circuits using IC 555.

**CO3:** Examine the performance of DAC and ADC conversion techniques.

**CO4:** Apply Boolean algebra and minimization techniques to design combinational logic circuits.

**CO5:** Analyze the behaviour of sequential logic circuits using flip-flops, counters, and registers.

**TEXT BOOKS:**


1. Sergio Franco, "Design with operational amplifiers and analog integrated circuits", Mc Graw Hill Education, 3rd Edition, 2017.
2. John.F.Wakerly, "Digital design principles and practices", Pearson Education, 5th Edition, 2018
3. M.Morris Mano, "Digital logic and Computer design" Prentice Hall 1994.
4. Ramakant A. Gayakwad, "OP AMP and linear IC'S" Prentice Hall, 1994


**REFERENCES:**


1. Taub and Schilling, "Digital Integrated Electronics", Mc Graw Hill, 2017.
2. Charles H.Roth, Jr, "Fundamentals of Logic Design", Jaico Books, 7th Edition, 2013.
3. M. Morris Mano and Michael D.Ciletti, "Digital Design", Pearson, 5th Edition, 2013.
4. S Salivahanan and V S Kanchana Bhaaskaran, Linear Integrated Circuits, McGraw Hill Education, 3rd Edition, 2018


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | | | | | 2 | | 1 | 2 | 1 | 2 | 1 |
| **CO2** | 3 | 3 | 3 | 2 | | | | | 2 | | 1 | 2 | 1 | 2 | 1 |
| **CO3** | 3 | 3 | 3 | 2 | | | | | 2 | | 1 | 2 | 1 | 2 | 1 |
| **CO4** | 3 | 3 | 3 | 2 | | | | | 2 | | 1 | 2 | 1 | 2 | 1 |
| **CO5** | 3 | 3 | 3 | 2 | | | | | 2 | | 1 | 2 | 1 | 2 | 1 |
| **Avg** | **3** | **3** | **3** | **2** | | | | | **2** | | **1** | **2** | **1** | **2** | **1** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-IV**
**(B.E - BME)**

| EC24407 | MICROPROCESORS AND MICROCONTROLLERS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the architecture, addressing modes, instruction set, and basic programming concepts of the 8086 microprocessors.
- Exploring the system bus structure, multiprogramming concepts, and processor configurations of the 8086 microprocessors.
- Learning the interfacing techniques and programming of peripheral ICs with microprocessors for data acquisition and control.
- Understanding the architecture, programming, and peripheral features of the 8051 microcontrollers.
- Gaining insight into modern embedded platforms and RTOS concepts using microcontrollers like Arduino, ARM Cortex-M, and ESP32.

**UNIT I THE 8086 MICROPROCESSOR 9**

Introduction to 8086 - Microprocessor architecture - Addressing modes - Instruction set and assembler directives - Assembly language programming - Modular Programming - Linking and Relocation - Interrupts and interrupt service routines.

**UNIT II 8086 SYSTEM BUS STRUCTURE 9**

8086 signals - Basic configurations - IO programming - Introduction to Multiprogramming - System Bus Structure - Multiprocessor configurations - Coprocessor, closely coupled and loosely Coupled configurations - Introduction to advanced processors.

**UNIT III INTERFACING BASICS AND IC's 9**

Study of Architecture and programming of ICs: 8255 PPI, 8259PIC, 8251USART, 8279 Keyboard display controller and 8254 Timer/Counter – Interfacing with 8086 -A/D and D/A converter interfacing.

**UNIT IV THE 8051 MICROCONTROLLER 9**

Architecture of 8051 – Special Function Registers (SFRs) - I/O Pins Ports and Circuits - Instruction set - Addressing modes - Programming 8051 Timers - Serial Communication.

**UNIT V ADVANCED MICROCONTROLLERS WITH EMBEDDED PLATFORMS 9**

Introduction to real-time operating systems (RTOS) - Comparison of CISC and RISC Architecture - Overview of modern microcontrollers: Arduino, ARM Cortex-M, ESP32 - Embedded Tools and Development Environments (IDE, Debuggers and Emulators)

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe the architecture, instruction set, and programming techniques of the 8086 microprocessors to develop basic assembly-level applications.

**CO2:** Analyze the system bus structure and processor configurations of the 8086 to design simple multiprocessor and I/O interfacing systems.

**CO3:** Interface and program peripheral ICs such as 8255, 8259, 8251, 8279, and 8254 with microprocessors for real-world data acquisition and control.

**CO4:** Develop embedded programs using the 8051 microcontrollers for timing, serial communication, and I/O operations.

**CO5:** Apply knowledge of modern microcontrollers and embedded platforms, including RTOS concepts, to design basic biomedical and IoT systems.

**TEXT BOOKS:**


1. Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design", Second Edition, Prentice Hall of India, 2007. (UNIT I-III)
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011. (UNIT IV)


**REFERENCES:**


1. Doughlas V.Hall, "Microprocessors and Interfacing, Programming and Hardware", TMH,2012
2. A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata McGrawHill, 2012


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 3 | 3 | | | | | 1 | 2 | | 2 | 1 |
| **CO2** | 3 | 2 | 2 | 1 | 3 | 3 | | | | | 1 | 2 | | 2 | 1 |
| **CO3** | 3 | 2 | 2 | 1 | 3 | 3 | | | | | 1 | 2 | | 2 | 1 |
| **CO4** | 3 | 2 | 2 | 1 | 3 | 3 | | | | | 1 | 2 | | 2 | 1 |
| **CO5** | 3 | 2 | 2 | 1 | 3 | 3 | | | | | 1 | 2 | | 2 | 1 |
| **Avg** | **3** | **2** | **2** | **1** | **3** | **3** | | | | | **1** | **2** | | **2** | **1** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-IV**
**(B.E - BME)**

| GE24402 | ENVIRONMENTAL SCIENCES AND SUSTAINABILITY | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 2 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Introducing ecological concepts and biodiversity, emphasizing conservation and public awareness.
- Understanding pollution types, impacts, and waste management practices, with industrial safety focus.
- Exposing students to various renewable energy technologies and their practical applications.
- Studying how people harm the environment and learn ways to prevent and manage disasters.
- Promoting sustainability awareness and application of sustainable practices in industry and society.

**UNIT I ENVIRONMENT AND BIODIVERSITY 6**

Definition, scope, and importance of environment; need for public awareness. Ecosystem and energy flow with ecological succession. Types and values of biodiversity; India as a mega-diversity nation and biodiversity hotspots. Threats like habitat loss, poaching, man-wildlife conflict, impacts from industrial and infrastructure development. Endangered and endemic species of India and conservation methods (in-situ and ex-situ), Role of information technology in species monitoring.

**UNIT II ENVIRONMENTAL POLLUTION 6**

Causes, Effects and Preventive measures of water, air, soil, noise, and radioactive pollution. Waste management covers municipal solid waste, hazardous waste, and E-Waste - gold extraction. Carbon Credit and Footprint concepts related to industry. Environmental protection acts. Case studies on OHASMS (Occupational health and safety management systems) emphasizing industrial safety practices and engineering risk management.

**UNIT III RENEWABLE SOURCES OF ENERGY 6**

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy. Case studies on biofuel production from agricultural waste.

**UNIT IV HUMAN POPULATION AND ENVIRONMENT IMPACT 6**

Human population -Importance of value education, human rights. Land degradation and deforestation- Man-Made Disasters: Industrial Accidents-Nuclear Accidents-Oil Spills - Prediction and management. Science and technology of Carbon Sequestration - Ozone depletion and environmental responsibility. Case Study: A low-cost water purification project implemented in a densely populated village.

**UNIT V SUSTAINABILITY MANAGEMENT AND PRACTICES 6**

Suitability Management - Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability and protocols Sustainable Development Goals-targets. Suitability Practices - Zero waste and R concept, Circular economy, ISO 14000 Series, Environmental Impact Assessment. Sustainable habitat: green buildings, green materials, energy efficiency, sustainable transports. Sustainable energy. Case studies on sustainable building design in industrial facilities.

**TOTAL PERIODS: 30**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explore ecosystem functions, biodiversity, and the importance of species protection.

**CO2:** Identify types of pollution, their effects, and preventive measures including waste management.

**CO3:** Describe renewable energy sources and their applications in sustainable energy production.

**CO4:** Analyze human impact on the environment and propose disaster management strategies.

**CO5:** Apply sustainability concepts and practices in environmental and industrial systems.

**TEXT BOOKS:**


1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.


**REFERENCES:**


1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice Hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 1 | 1 | | | 1 | 3 | 2 | | 1 | - | 1 | | | 2 |
| **CO2** | 1 | 2 | 2 | | 1 | 2 | 3 | 2 | | 1 | - | 2 | | | 2 |
| **CO3** | 1 | 1 | 2 | | 2 | 3 | 3 | 2 | | 1 | - | 2 | | | 2 |
| **CO4** | 1 | | | | | 3 | 3 | 3 | | 1 | - | 2 | | | 2 |
| **CO5** | | 1 | 2 | | 1 | 3 | 3 | 3 | | 1 | - | 2 | | | 2 |
| **Avg** | **1** | **1.25** | **1.75** | | **1.33** | **2.40** | **3** | **2.40** | | **1.00** | **-** | **1.80** | | | **2** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-IV**
**(B.E - BME)**

| BM24402 | BIOSIGNAL PROCESSING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the continuous time and discrete time signals and systems.
- Exploring the analysis of LTI systems using Laplace and Z transform.
- Representing the signal in frequency domain using FFT.
- Understanding the architecture, programming, and peripheral features of the 8051 microcontrollers.
- Gaining the knowledge about the design of IIR and FIR filters.

**UNIT I DISCRETE FOURIER TRANSFORM 9**

DFT and its properties, magnitude and phase representation-Linear Convolution- Correlation-Circular Convolution, Overlap-add and overlap-save methods. FFT - Decimation in Time Algorithm, Decimation in Frequency Algorithm

**UNIT II INFINITE IMPULSE RESPONSE FILTERS 9**

Realization structures for IIR filters –direct, cascade and parallel forms, Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method, Design of digital filters – Butterworth, Chebyshev Type I for LPF, BPF, BSF& HPF.

**UNIT III FINITE IMPULSE RESPONSE FILTERS 9**

Realization structures for FIR filters – Transversal and Linear phase structures, Design of linear phase FIR filters – windowing techniques – Rectangular window, Hamming window & Hanning Window, Frequency sampling methods.

**UNIT IV BIOSIGNAL DETECTION AND COMPRESSION 9**

QRS detection methods – Differentiation based and template-based approach. Rhythm analysis and Arrhythmia detection algorithms. Data compression techniques: Data reduction algorithms- Lossy and Lossless types, Turning Point algorithm, AZTEC, CORTES.

**UNIT V BIOSIGNAL ANALYSIS USING WAVELETS 9**

Wavelets in Medicine: Need for wavelets, Types of wavelets, Selection of a wavelet for an application, Decomposition and reconstruction of signals using wavelets, Denoising using wavelets, Typical medical applications.

**TOTAL PERIODS: 45**

**LIST OF EXPERIMENTS:**

1. Generation of unit step, unit ramp & unit impulse signal.
2. Generation of Sine, Cosine & Exponential signal
3. Analyze the stability of a CT System with various inputs.
4. Analyze the stability of a DT System with various inputs.
5. Reconstruct a signal from samples and study the effect of Aliasing.
6. DFT of a discrete sequence.
7. Spectrum Analysis using FFT
8. Impulse and Step response of Digital filter.
9. IIR Filter Design Using Butterworth Low Pass and High Pass filter Approximation.
10. IIR Filter Design Using Butterworth Band Pass and Band Reject filter Approximation.

**TOTAL PERIODS: 30**

**TOTAL PERIODS: 75**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1 :** Compute the DFT and FFT algorithms for efficient spectral analysis and convolution operations.

**CO2 :** Design and realize IIR digital filters using appropriate mathematical techniques.

**CO3 :** Realize FIR digital filters using appropriate mathematical techniques.

**CO4 :** Analyze the Biosignal using different detection and compression techniques.

**CO5 :** Evaluate the Biosignal using Wavelets.

**TEXT BOOKS:**


1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, “Signals and Systems”, Pearson, Indian Reprint, 2nd Edition, 2015.
2. John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Pearson, 4 th Edition, 2014.
3. Rangaraj M. Rangayyan, “Biomedical Signal Analysis”, John Wiley & Sons, 2nd Edition, 2015.


**REFERENCES:**


1. S. Haykin and B. Van Veen, "Signals and Systems", Wiley, 2 nd Edition, 2007
2. B. P. Lathi, “Principles of Linear Systems and Signals”, Oxford, 2nd Edition, 2009.
3. Emmanuel Ifeachor, Barrie Jervis, “Digital Signal Processing- A practical approach”, Pearson, 2nd Edition, 2002.
4. M. H. Hayes, “Digital Signal Processing, Schaum’s outlines”, Tata McGraw Hill, 2nd Edition,2011.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **CO2** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **CO3** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **CO4** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **CO5** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **Avg** | **3** | **2** | **2** | **2** | **1** | | | | **1** | **1** | **1** | | **2** | **1** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-IV**
**(B.E - BME)**

| BM24403 | BIOMEDICAL INSTRUMENTATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the origin of various biological signals and electrode configurations specific to bio-potential measurements.
- Exploring the characteristics of Bio signals.
- Understanding the design of bio amplifiers.
- Explaining the different techniques used for measurement of non-electrical bio parameters.
- Representing the biochemical measurement techniques as applicable for diagnosis and treatment.

**UNIT I ELECTRODE CONFIGURATIONS 9**

Bio signals characteristics – Origin of bio potential and its propagation. Frequency and amplitude ranges. Electrode configurations: Electrode-electrolyte interface, electrode–skin interface impedance, polarization effects of electrode – non-polarizable electrodes. Unipolar and bipolar configuration, classification of electrodes.

**UNIT II BIOSIGNAL CHARACTERISTICS 9**

Bio signals characteristics – ECG-frequency and amplitude ranges – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. EMG - Electrode configuration -unipolar and bipolar mode.

**UNIT III BIOAMPLIFIERS 9**

Need for bio-amplifier - Differential bio-amplifier – Single ended amplifier - Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.

**UNIT IV MEASUREMENT OF BIO SIGNALS 9**

Temperature, respiration rate and pulse rate measurements. Blood Pressure - direct and indirect methods, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurements.

**UNIT V BIOCHEMICAL MEASUREMENTS 9**

Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors. Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer.

**TOTAL PERIODS: 45**

**LIST OF EXPERIMENTS:**

1. Design of preamplifiers to acquire bio signals.
2. Design of frontal EEG amplifier
3. Design of EOG amplifier to detect eye blink
4. Design and study the characteristics of optical Isolation amplifier.
5. Measurement of pulse-rate using Photo Transducer.
6. Measurement of pH and conductivity.
7. Measurement of blood pressure using sphygmomanometer.
8. Measurement and recording of peripheral blood flow.
9. Simulation of a PCB layout for any bio amplifier using LABVIEW.

**TOTAL PERIODS: 30**

**TOTAL PERIODS: 75**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1 :** Illustrate the origin of various biological signals and their characteristics.

**CO2 :** Gain knowledge on characteristics of bio signals.

**CO3 :** Acquire knowledge on various amplifiers involved in monitoring and transmission of bio signals.

**CO4 :** Explain the different measurement techniques for non-electrical bio-parameters.

**CO5 :** Demonstrate the biochemical measurement techniques as applicable for diagnosis.

**TEXT BOOKS:**


1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003


**REFERENCES:**


1. John Enderle, Susan Blanchard, Joseph Bronzino, "Introduction to Biomedical Engineering", second edition, Academic Press,2005..
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **CO2** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **CO3** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **CO4** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **CO5** | 3 | 2 | 2 | 2 | 1 | | | | 1 | 1 | 1 | | 2 | 1 | |
| **Avg** | **3** | **2** | **2** | **2** | **1** | | | | **1** | **1** | **1** | | **2** | **1** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER-IV**
**(B.E - BME)**

| BM24404 | ANALOG AND DIGITAL INTEGRATED CIRCUITS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 2 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Designing the digital logic and circuits
- Learning the function of different ICs
- Understanding the applications of operation amplifier.
- Learning the working of multivibrators
- Designing circuits for generating waveforms using ICs

**LIST OF EXPERIMENTS:**

1. Inverting, non-inverting amplifier.
2. Integrator and Differentiator.
3. Design and analysis of active filters using Operational amplifier.
4. Instrumentation amplifier using operational amplifier.
5. Study of logic gates, Half adder and Full adder.
6. Encoder, decoder and Multiplexer, demultiplexer using digital ICs.
7. Register using flip flops.
8. Design of mod-N counter.
9. Multivibrators using IC555 Timer
10. Simulation and analysis of Electronic circuits using PSPICE software.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Design and analyze analog circuits using operational amplifiers.
**CO2:** Develop and evaluate digital logic circuits using standard digital ICs.
**CO3:** Construct and analyze multivibrators and timing circuits using IC 555.
**CO4:** Implement and demonstrate the functionality of sequential circuits.
**CO5:** Simulate and interpret the behavior of analog and digital circuits using simulation software tools.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 1 | 1 | | | | 1 | 1 | | | 1 | | |
| **CO2** | 3 | 3 | 1 | 1 | 1 | | | | 1 | 1 | | | 1 | | |
| **CO3** | 3 | 3 | 1 | 1 | 1 | | | | 1 | 1 | 1 | | 1 | | |
| **CO4** | 3 | 3 | 1 | 1 | 1 | | | | 1 | 1 | 1 | | 1 | | |
| **CO5** | 3 | 3 | 1 | 1 | 1 | | | | 1 | 1 | 1 | | 1 | | |
| **Avg** | **3** | **3** | **1** | **1** | **1** | | | | **1** | **1** | **1** | | **1** | | |

**1 - Low, 2 - Medium, 3 – High**

**SEMESTER-IV**
**(B.E - BME)**

| GE24S03 | SOFT SKILLS & APTITUDE | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Enhancing students' interpersonal skills by focusing on the dynamics of leadership, teamwork, and networking, essential for academic and professional success.
- Developing leadership capabilities that include effective communication, managing change, and stepping out of comfort zones.
- Providing strategies for managing stress through emotional intelligence and self-awareness techniques.
- Improving the aptitude skills of the students.
- Nourishing the students with decision-making abilities with aptitude techniques.

**UNIT I LEADERSHIP SKILLS 3**

Team Management and Time Management- Stress Management- Types of Stress- How to prevent stress and depression- Stress Busters- Habit Cycle, Forming Good Habits.

**UNIT II INTERPERSONAL SKILLS 3**

Understanding the relationship between Leadership, Networking, and Teamwork. Realizing one's skills in Leadership, Networking & Teamwork. Assessing interpersonal skills. Situation description of interpersonal skill.

**UNIT III SETS AND SERIES 3**

Set Theory- Types of sets-Set operations -Representation of Sets- Number- Series- ODD man out series-Letter Series-Logical Sequence of Words.

**UNIT IV CODING AND ARRANGEMENT 3**

Coding and De-coding LED – Letter Coding- Number Coding- Symbol Coding- Seating Arrangement-Circular Seating Arrangement-Linear Seating Arrangement.

**UNIT V CLASSIC REASONING 3**

Blood Relations- Family Tree- Jumbled Descriptions- Relationship Puzzle – Coded Relations- Syllogism-Statement of Syllogisms- Major Premise- Minor Premise.

**TOTAL PERIODS: 15**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Demonstrate interpersonal skills including leadership, teamwork, and networking.

**CO2:** Exhibit leadership qualities and manage change effectively.

**CO3:** Apply stress management techniques and understand emotional intelligence.

**CO4:** Resolve issues of multiple kinds with Aptitude Skills

**CO5:** Apply Logical Reasoning for making life comfortable for all living beings.

**TEXT BOOKS:**

1. Frederick H. Wentz, McGraw, Hill (2020). Soft Skills Training: A Workbook to Develop Skills for Employment.
2. A modern practical workbook for classroom and workshop-based soft skills development.

**REFERENCES:**

1. Dr. R.S Agarval, "Quantitative Aptitude for Competitive Examinations" ( English), 7th Edition, S Cahnd Publications.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 2 | | 2 | | | 2 | | 3 | 3 | 3 | 3 | | 1 | |
| **CO2** | | 2 | | 2 | | | 2 | | 3 | 3 | 3 | 3 | | 1 | |
| **CO3** | | 2 | | 2 | | | 2 | | 3 | 3 | 3 | 2 | | 1 | |
| **CO4** | 3 | 2 | 3 | 2 | | 2 | 2 | | 3 | 3 | 3 | 1 | | 1 | |
| **CO5** | 2 | 2 | 2 | 2 | | 3 | 2 | | 3 | 3 | 3 | 1 | | 1 | |
| **Avg** | **1** | **2** | **1** | **2** | | **1** | **2** | | **3** | **3** | **3** | **2** | | **1** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER V**
**(Common To B. E – BME, ECE)**

| BM24501 / BM24P38 | DIAGNOSTIC AND THERAPEUTIC EQUIPMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the devices used for measuring cardiology-related parameters.
- Analyzing the recording and measurement techniques of EEG.
- Learning the EMG recording system and its applications.
- Studying the diagnostic and therapeutic devices used for respiratory parameters.
- Introducing the various sensory measurements and their clinical importance.

**UNIT I CARDIAC EQUIPMENT 9**

Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, ECG machine maintenance and troubleshooting, Cardiac Pacemaker Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External, Defibrillator Protection Circuit, Cardiac ablation catheter.

**UNIT II NEUROLOGICAL EQUIPMENT 9**

Clinical significance of EEG, multi-channel EEG recording systems, epilepsy, seizure, evoked potentials such as visual, auditory, and somatosensory responses, magnetoencephalography, and EEG system maintenance and troubleshooting.

**UNIT III MUSCULAR AND PHYSIOTHERAPY EQUIPMENT 9**

Recording and analysis of EMG waveforms, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation, Physiotherapy equipments.

**UNIT IV RESPIRATORY MEASUREMENT AND ASSIST SYSTEM 9**

Instrumentation for measuring the mechanics of breathing – Spirometer -Lung Volume and vital capacity, measurements of residual volume, Whole body Plethysmograph, Apnoea Monitor, Types of Ventilators – Pressure, Volume, and Time controlled, Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

**UNIT V SENSORY DIAGNOSTIC EQUIPMENT 9**

Psychophysiological Measurements – basal skin resistance (BSR), galvanic skin resistance (GSR), Sensory responses - Audiometer-Pure tone, Speech, Eye Tonometer, Applanation Tonometer, slit lamp.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the working principles and recording setup of basic cardiac equipment.

**CO2:** Describe the working and recording methods of neurological equipment.

**CO3:** Discuss the operation of diagnostic and therapeutic equipment related to EMG.

**CO4:** Interpret the measurement of respiratory system parameters.

**CO5:** Analyze the techniques used for measuring sensory responses.

**TEXT BOOKS:**


1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd,New Delhi, 2015.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012.


**REFERENCES:**


1. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
2. Khandpur. R.S.,"Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003.
3. Antony Y.K.Chan,"Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
4. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 2 | | | | | | 3 | 2 | 1 | |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | | | | | 3 | 2 | 2 | |
| **CO3** | 3 | 3 | 2 | 2 | 1 | | | | | | 3 | 2 | 2 | |
| **CO4** | 3 | 3 | 2 | 2 | 2 | | | | | | 3 | 2 | 2 | |
| **CO5** | 3 | 3 | 2 | 3 | 2 | | | | | | 3 | 2 | 3 | |
| **Avg** | **3.00** | **2.80** | **2.00** | **2.00** | **1.80** | | | | | | **3.00** | **2.00** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER V**
**(B. E / BME)**

| BM24502 | BIOCONTROL SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the block diagrams, signal flow graphs, and biological control systems.
- Analyzing the time response characteristics of dynamic systems.
- Learning the concepts and analysis of system stability.
- Studying the frequency response analysis using plots and charts.
- Introducing the knowledge in modeling physiological and biomedical systems.

**UNIT I INTRODUCTION 9**

Open and Closed loop Systems, Block diagram and signal flow graph representation of systems - reduction of block diagram and signal flow graph, Introduction to Physiological control systems- Illustration, Linear models of physiological systems, Difference between engineering and physiological control systems.

**UNIT II TIME RESPONSE ANALYSIS 9**

Step and impulse responses of first order and second order systems - time domain specifications of first and second order systems - steady state error constants.

**UNIT III FREQUENCY RESPONSE ANALYSIS 9**

Frequency domain specifications - Polar plots - Bode plots - Nyquist plot - Nyquist stability criterion, closed loop stability - Constant M and N circles, Applications of HRV.

**UNIT IV STABILITY ANALYSIS 9**

Definition of stability, Routh- Hurwitz criteria of stability, Root locus technique - construction of root locus and study of stability.

**UNIT V BIOLOGICAL CONTROL SYSTEM ANALYSIS 9**

Simple models of muscle stretch reflex action - steady state analysis of muscle stretch reflex action, transient response analysis of neuromuscular reflex model action, frequency response of circulatory control model, Stability analysis of Pupillary light reflex.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the importance of block diagrams, signal flow graphs, and biological control systems.

**CO2:** Analyze the time response of different systems.

**CO3:** Interpret the concept of system stability.

**CO4:** Examine system frequency response using various plots and charts.

**CO5:** Evaluate the modeling of basic physiological systems.

**TEXT BOOKS:**

1. I.J. Nagarath and M. Gopal, Control Systems Engineering, New Age International Publishers, 1st September, 2018.
2. Michael C K Khoo, Physiological Control Systems, IEEE Press, Prentice Hall India, 2005.

**REFERENCES:**

3. Salivahanan S. Rengaraj R. and Venkatakrishnan G. R., Control Systems Engineering, Pearson Education India, 2015.
4. Benjamin C. Kuo, Automatic Control Systems, Prentice Hall of India, 1995.
5. Ogata, Katsuhiko and Yanjuan Yang, Modern control engineering, Vol 4, Prentice-Hall, 2002.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 2 | | | | | | 3 | 2 | | |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | | | | | 3 | 2 | | |
| **CO3** | 3 | 3 | 2 | 2 | 1 | | | | | | 3 | 2 | | |
| **CO4** | 3 | 3 | 2 | 2 | 2 | | | | | | 3 | 2 | | |
| **CO5** | 3 | 3 | 2 | 3 | 2 | | | | | | 3 | 2 | | |
| **Avg** | **3.00** | **2.80** | **2.00** | **2.00** | **1.80** | | | | | | **3.00** | **2.00** | | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER V**
**(B. E / BME)**

| BM24503 | MEDICAL IMAGE PROCESSING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 2 | 4 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of medical image processing and image transforms.
- Learning the image enhancement and filtering techniques for medical images.
- Studying the segmentation and restoration methods used in medical imaging.
- Gaining the knowledge of medical image registration and visualization techniques.
- Understanding medical image analysis applications and computer-aided diagnosis systems.

**UNIT I FUNDAMENTALS OF MEDICAL IMAGE PROCESSING 9**

Overview of Image Processing system and human Visual system- Image representation – pixel and voxels, Gray scale and color models- Medical image file formats- DICOM, ANALYZE 7.5 - Discrete sampling model and Quantization. Image Transforms- 2D DCT, DFT.

**UNIT II ENHANCEMENT TECHNIQUES 9**

Gray level transformation- Log transformation - Histogram processing- Histogram equalization, Histogram Matching. Spatial domain Filtering-Smoothing filters, sharpening filters. Frequency domain filtering-Smoothing filters, Sharpening filters- Homomorphic filtering - Performance measures for enhancement techniques.

**UNIT III SEGMENTATION TECHNIQUES 9**

ROI definition -Detection of discontinuities–Edge linking and boundary detection – Region based segmentation- Morphological processing.

**UNIT IV RESTORATION TECHNIQUES 9**

Image Restoration- Noise models– Restoration in the presence of Noise – spatial filtering, Periodic noise reduction by frequency domain filtering- Inverse filter, Weiner filtering.

**UNIT V APPLICATIONS OF MEDICAL IMAGE ANALYSIS 9**

Medical Image compression- DCT and Wavelet transform based image compression, Pre-processing of medical images -Retinal images, Ultrasound –liver, kidney. Segmentation of ROI -blood vessels, lung nodules. Computer aided diagnosis system – performance measures (confusion matrix, ROC, AUC).

**TOTAL PERIODS: 45**

**LIST OF EXPERIMENTS**

1. Implementation of image digitization and quantization techniques in MATLAB.
2. Analysis of Discrete Fourier Transform (DFT) for medical images.
3. Histogram equalization for contrast enhancement of medical images.
4. Frequency domain smoothing and sharpening using Filters.
5. Morphological operations for medical image segmentation.
6. Boundary detection and edge linking techniques for region identification.

7. Implementation of image restoration and compression techniques.
8. Texture analysis with statistical properties.

**TOTAL PERIODS: 30**
**TOTAL PERIODS: 75**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the fundamentals of medical image processing and transforms.
**CO2:** Apply image enhancement and filtering techniques for medical images.
**CO3:** Analyze medical image segmentation and restoration methods.
**CO4:** Describe image registration and visualization techniques in healthcare applications.
**CO5:** Interpret medical image analysis and CAD systems.

**TEXT BOOKS:**


1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Pearson Education, 3rd edition, 2016.
2. Isaac N. Bankman, Handbook of Medical Image Processing and Analysis, 2nd Edition, Elsevier, 2009.


**REFERENCES:**


1. Anil Jain K, Fundamentals of Digital Image Processing, PHI Learning Pvt. Ltd., 2011.
2. Atam P.Dhawan, Medical Image Analysis, Wiley-Interscience Publication, NJ, USA 2003.
3. Joseph V.Hajnal, Derek L.G.Hill, David J Hawkes, "Medical image registration", Biomedical Engineering series, CRC press, 2001.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | | | 2 | | 2 | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 2 | 3 | | | 2 | | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | | 2 | | 2 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 3 | 2 | 3 | | | 2 | | 2 | 2 | 3 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | | | 2 | | 2 | 2 | 3 | 3 | 2 |
| **Avg** | **3.00** | **2.60** | **2.80** | **2.20** | **2.80** | | | **2** | | **2** | **2** | **3.00** | **2.60** | **2.20** |

**1 - Low, 2 - Medium, 3 – High**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

| Sl. No. | Description of Equipment | Required numbers |
|---|---|---|
| 1 | Personal System | 30 |
| 2 | MATLAB Software | 15 |

**SEMESTER V**
**(B. E / BME)**

| BM24504 | DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the measurement of different bioelectrical signals.
- Learning the recording of physiological signals using telemetry systems.
- Studying the segmentation and restoration methods used in medical imaging.
- Gaining the knowledge about electrical safety measurements in medical equipment.
- Understanding the bio signals using suitable tools and techniques.

**LIST OF EXPERIMENTS:**

1. Galvanic skin resistance (GSR) measurement.
2. Measurement of output intensity from shortwave and ultrasonic diathermy.
3. Measurement of stimulation current waveforms used in medical stimulator.
4. Analyze the working of ESU–cutting and coagulation modes.
5. Design the working of Defibrillator and pacemakers.
6. Biomedical Signal Acquisition Using ECG, EEG, and EMG Electrodes.
7. Design of ventilators.
8. Measurement of Oxygen Saturation and Heart Rate using Pulse-oximeter.
9. Recording of Audiogram.
10. Measurement of various physiological signals using biotelemetry.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Measure different bioelectrical signals.
**CO2:** Record physiological signals using telemetry systems.
**CO3:** Explain various diagnostic and therapeutic techniques.
**CO4:** Evaluate electrical safety measurements.
**CO5:** Analyze bio signals using suitable tools and techniques.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 3 | 2 | |
| **CO2** | 3 | 3 | 3 | 2 | 3 | | 2 | 2 | 2 | 2 | 2 | 3 | 3 | |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | 3 | 2 | 3 | 2 | 2 | 3 | 3 | |
| **CO4** | 3 | 2 | 3 | 2 | 3 | | 2 | 2 | 2 | 2 | 2 | 3 | 2 | |
| **CO5** | 3 | 3 | 3 | 2 | 3 | | 2 | 2 | 2 | 2 | 2 | 3 | 3 | |
| **Avg** | **3.00** | **2.60** | **2.80** | **2.20** | **2.80** | | **2.20** | **2** | **2.20** | **2** | **2** | **3.00** | **2.60** | |

**1 - Low, 2 - Medium, 3 – High**

## LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

| Sl. No. | Description of Equipment | Required numbers |
|---|---|---|
| 1 | EEG Machine with Visually and Auditory evoked potential setup | 1 No. |
| 2 | Multi-output power supply (+15v, -15v, +30V variable, +5V, 2A) | 2 Nos. |
| 3 | Short wave Diathermy | 1 No. |
| 4 | Ultrasonic diathermy | 1 No. |
| 5 | ECG Simulator | 1 No. |
| 6 | Medical stimulator | 1 No. |
| 7 | Surgical diathermy with analyzer | 1 No. |
| 8 | Audiometer | 1No. |
| 9 | Pacemaker and Defibrillator | 1 No. each |
| 10 | Hemodialysis model and Heart lung Model | 1 No. each |
| 11 | Ventilator | 1 No. |
| 12 | Ultrasound Scanner | 1 No. |

**SEMESTER V**
**(B. E / BME)**

| BM24S01 | DESIGN THINKING AND INNOVATION LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 0 | 1 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- To apply engineering knowledge for solving real-time problems.
- To encourage innovation in the design of products, processes, and systems.
- To develop creative thinking skills for identifying effective solutions to engineering and non-engineering problems.

**ACTIVITY 1: DESIGN THINKING INTRODUCTION**

Phases of design thinking- a study approach - Group Discussion on Ideation- Users perspective Formation of team – Thinking skills- Brain storming**.**

**ACTIVITY 2: PROBLEM IDENTIFICATION (PHASE I)**

Selecting user requirements - Survey on various user's applications - Specific Problem selection to proceed with the work – Team presentation on identified problems and various possible solutions.

**ACTIVITY 3: PROBLEM IDENTIFICATION (PHASE II)**

Study of an application and its importance to end user - Various models of an applications - Finalize the identified problem.

**ACTIVITY 4: DESIGN IDEATION AND VARIOUS STAGES**

Sketch design diagram - Architecture or full diagrammatic study

**ACTIVITY 5: REVIEW AND UPGRADATION**

Review of the ideation (one to one interaction) - Feedback - Upgradation plan.

**ACTIVITY 6: IMPLEMENTATION (PHASE I)**

Build the prototype using available resources - Record Module diagrams.

**ACTIVITY 7: IMPLEMENTATION (PHASE II)**

Display and review of the prototype - Record its functionality and its Usage-Technical manual.

**ACTIVITY 8: TESTING**

To test the product design with real time environment - Record Process-user manual.

**TOTAL PERIODS: 30**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the principles of design thinking for problem solving.

**CO2:** Analyze real-time problems through teamwork and surveys.

**CO3:** Develop innovative design ideas for selected problems.

**CO4:** Demonstrate prototypes using available resources and technical documentation.

**CO5:** Evaluate product performance in real-time environments for further improvement.

**REFERENCES:**


1. Mueller-Roterberg, Christian. "Handbook of Design Thinking." Hochschule Ruhr West (2018).
2. Design Kit by IDEO.org. "The field guide to human centered design." (2015), ISBN: 978-0-9914063-1-9.
3. https://www.interaction-design.org/literature/article/design-thinking-getting-started-with-empathy
4. https://www.interaction-design.org/literature/article/stage-4-in-the-design-thinking-process-prototype.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 2 |
| **Avg** | **2.60** | **2.60** | **2.00** | **2.00** | **2.40** | **2.40** | **2.00** | **2.60** | **2.60** | **2.40** | **2.00** | **2.60** | **2.40** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

| Sl. No. | Description of Equipment | Required numbers |
|---|---|---|
| 1 | Arduino (open source) | 10 No. |
| 2 | Circuit Simulation Software | Open Source |
| 3 | Labview | 10 users |
| 4 | Personal System | 30 No. |
| 5 | Python | Open Source |

**SEMESTER VI**
**(B. E / BME)**

| BM24601 | BIOMECHANICS AND REHABILITATION ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of biomechanics and human movement.
- Learning the concepts of rehabilitation and disability assessment.
- Studying rehabilitation engineering, assistive technology, and ergonomics.
- Identifying therapeutic exercises, gait training techniques and stimulation systems
- Acquiring the principles and applications of orthotic and prosthetic devices.

**UNIT I INTRODUCTION TO BIOMECHANICS 9**

Introduction to biomechanics – biomechanics of human movement – statics and dynamics – kinetics and kinematics of human motion – force, torque, and equilibrium – Resolution and composition of forces, Newton's laws of motion, Velocity and acceleration, biomechanical analysis of gait and posture, Motion analysis using video – applications in rehabilitation engineering.

**UNIT II INTRODUCTION TO REHABILITATION 9**

What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team Classification of members, The Role of Rehabilitation team members.

**UNIT III PRINCIPLES OF REHABILITATION 9**

Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles - Practice of Rehabilitation and Assistive Technology.

**UNIT IV THERAPEUTIC EXERCISE TECHNIQUE & RESTORATION TECHNIQUES 9**

Co-ordination exercises, Frenkel's exercises, Gait Analyses-Pathological Gaits, Gait Training,
Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises. Functional Electrical Stimulation Systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

**UNIT V ORTHOTIC & PROSTHETIC DEVICES 9**

General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Callipers-FO, AFO, KAFO, HKAFO. Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myoelectric controlled and externally powered limb prosthetics.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

On successful completion of this course, the student will be able to

**CO1.** Explain the basics of biomechanics and human movement in rehabilitation.
**CO2.** Describe rehabilitation concepts and disability assessment methods.
**CO3.** Apply rehabilitation engineering and assistive technology principles in healthcare.
**CO4.** Analyse therapeutic exercises, gait training methods and stimulation systems used in rehabilitation.
**CO5.** Describe the design and applications of orthotic, prosthetic devices.

**TEXTBOOKS:**


1. Y.C. Fung, Bio-Mechanics- Mechanical Properties of Tissues, Springer-Verlag, 1998.
2. Subrata Pal, Textbook of Biomechanics, Viva Books Private Limited, 2009
3. Sunder, "Textbooks of Rehabilitation", Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.
4. Roy A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering" CRC Press, 2000


**REFERENCE BOOKS:**


1. Özkaya, Nihat, Dawn Leger, David Goldsheyder, and Margareta Nordin. Fundamentals of biomechanics: equilibrium, motion, and deformation. Springer, 2016.
2. Joseph D Bronzino, "The Biomedical Engineering Handbook". 2nd edition, CRC Press, 2000.
3. Robinson C.J, "Rehabilitation Engineering", CRC Press, 2006.
4. Warren E. Finn, Peter G. Lopressor, "Handbook of Neuroprosthetic Methods",CRC, 2002.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 3 | | | | | 1 | 2 | 3 | 2 | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | | | | 2 | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | | | | | 2 | 2 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | | | | | 2 | 2 | 3 | 3 | 2 |
| **Avg** | **3.00** | **2.80** | **2.40** | **2.00** | **3.00** | | | | | **1.80** | **2.00** | **3.00** | **3.00** | **1.80** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER VI**
**(B. E / BME)**

| BM24602 | VIRTUAL INSTRUMENTATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic concepts and architecture of virtual instrumentation.
- Learning the programming techniques and tools used in LabVIEW.
- Studying the real-time data acquisition methods using virtual instrumentation.
- Analyzing the integrated real-time biomedical system design using LabVIEW.
- Exploring the LabVIEW-based real-time biomedical devices and applications.

**UNIT I INTRODUCTION 9**

Historical perspective, advantages, block diagram and architecture of a virtual instrument, data-flow techniques, data types and data structures, graphical programming in data flow, comparison with conventional programming, Front Panel, and block diagram objects.

**UNIT II PROGRAMMING TECHNIQUES 9**

VIS and sub-VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input. Publishing measurement data in the web. Flat and Stacked sequence structures - Event structures- Formula Node.

**UNIT III DATA COMMUNICATION & SYNCHRONIZATION 9**

Local, global, and shared variables – Data Socket - TCP and UDP – Synchronization – Notifiers – Queues - VI Server - configuring the VI Server - Error handling VIs and functions - Debugging tools and techniques.

**UNIT IV DESIGN OF INTEGRATED REAL-TIME BIOMEDICAL SYSTEMS 9**

Getting started with LabVIEW Field-Programmable gate array (FPGA) 2 7. Programming using LabVIEW FPGA - Synchronizing FPGA loops and I/O 2 8. Sharing physiological data like ECG, EEG, on FPGA.

**UNIT V APPLICATION OF VI 9**

VI based ECG monitor, ECG and EEG signal Processing, Image acquisition and processing, – ON/OFF controller – P-I-D controller – Emulation of CRO - Simulation of a simple second order system – Generation of HTML page.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Understand the basic concepts of virtual instrumentation.

**CO2:** Acquire knowledge about the programming techniques in LabVIEW.

**CO3:** Apply the knowledge in acquiring real time data.

**CO4:** Analyze the integrated real-time design of biomedical systems using LabVIEW.

**CO5:** Develop LabVIEW based real time biomedical devices.

**TEXT BOOKS:**

1. Kevin James, P.C. Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.
2. Gupta S., Gupta J.P., PC Interfacing for Data Acquisition and Process Control, ISA, 2nd Edition, 2004.

**REFERENCES:**

1. Technical Manuals for DAS Modules of Advantech and National Instruments, 2008.
2. Jerome, Virtual Instrumentation Using LabView, PHI, 2010.
3. Jon B. Olansen, Eric Rosow, Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in LabVIEW, 2001.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 3 | | | | | 1 | 2 | 3 | 2 | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | | | | 2 | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | | | | | 2 | 2 | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | | | | | 2 | 2 | 3 | 3 | 2 |
| **Avg** | **3** | **2.8** | **2.4** | **2** | **3** | | | | | **1.8** | **2** | **3** | **3** | **1.8** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER VI**
**(B. E / BME)**

| BM24603 | BIOMECHANICS AND VIRTUAL INSTRUMENTATION LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

## COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of biomechanics and biomedical signal acquisition.
- Learning the operation of EMG, motion tracking, and pressure analysis systems.
- Studying virtual instrumentation concepts using DAQ and LabVIEW.
- Developing practical skills in biomedical monitoring and data analysis.
- Applying virtual instrumentation techniques for biomedical applications.

## LIST OF EXPERIMENTS:

1. Acquisition of Surface EMG Signals using 2-Channel EMG System.
2. Analysis of EMG Controlled Bionic Hand Movement.
3. Measurement of Joint Angles using Goniometers.
4. Motion and Orientation Analysis using 3D Accelerometer.
5. Human Skeletal Motion Tracking using Camera-Based Skeletal Tracking System.
6. Measurement and Analysis of Foot and Arm Pressure Distribution.
7. Biomedical Signal Filtering using Virtual Instrumentation.
8. Real-Time Biomedical Data Acquisition using DAQ and LabVIEW.
9. Heart Rate Measurement using LabVIEW.
10. Temperature Monitoring using Virtual Instrumentation.

## COURSE OUTCOMES

On successful completion of this course, the student will be able to

**CO1:** Identify biomedical signal acquisition and biomechanical measurement techniques.
**CO2:** Demonstrate the use of EMG, accelerometer, and motion tracking systems.
**CO3:** Analyse physiological signals and biomechanical parameters using biomedical instruments.
**CO4:** Develop virtual instrumentation applications using DAQ and LabVIEW.
**CO5:** Evaluate biomedical data for monitoring purposes.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 3 | | | | | | 2 | 3 | | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | | | 2 | 3 | | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | 3 | | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | | | | | | 2 | 3 | | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 2 | | | | | 2 | 3 | | 2 |
| **Avg** | **3.00** | **2.80** | **2.40** | **2.00** | **3.00** | **2.00** | | | | | **2.00** | **3.00** | | **1.80** |

**1 - Low, 2 - Medium, 3 - High**

## LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

| Sl. No. | Description of Equipment | Required numbers |
|---|---|---|
| 1 | Bionic Hand Kit DIY EMG Controlled Bionic Hand. includes Mechanical parts, Bio amplifier and digital servos. | 1 |
| 2 | Goniometer Set (Digital and analog) Set of 3 units of goniometer | 1 |
| 3 | 3D Accelerometer, gyroscope & Magnetometer Breakout board Breakout board with 3D digital linear acceleration sensor, a 3D digital angular rate sensor, and a 3D digital magnetic sensor. | 1 |
| 4 | SkelCam V2 Camera based Skeletal Tracking System with SkelCam Software. | 1 |
| 5 | Pressure Mat Foot Pressure Measurement,<br>Arm pressure measurement | 1 |
| 6 | EMG (2 channel) | 1 |
| 7 | Mbientlab MetamotionS Sensor pack | 1 |
| 8 | LabView | 10 users |

**SEMESTER VI**
**(B. E / BME)**

| BM24604 | MINI PROJECT | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

- To develop the skills required for formulating and planning a technical project.
- To enhance the student's ability to transform theoretical concepts into a functional Biomedical, Electronics, Mechatronics, or Instrumentation system.
- To familiarize students with modern tools, algorithms, and techniques necessary for project implementation.
- To provide guidance on product validation procedures and cost-effectiveness analysis.
- To enable students to gain practical experience in organizing and executing a mini project, thereby building confidence for undertaking major projects in the final year.
- To train students in the preparation and presentation of technical project reports

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Identify real-world problems and develop design solution.
**CO2:** Apply technical concepts and methodologies effectively.
**CO3:** Utilize modern tools, algorithms, and techniques.
**CO4:** Test, validate, and analyze cost effectiveness of prototypes.
**CO5:** Prepare technical reports and deliver presentations.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | | | 2 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | | | 2 | 2 | 2 | 3 |
| CO4 | 2 | 3 | 2 | 2 | 3 | | 3 | 3 | | 3 | 2 | 3 | 3 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 3 | | 3 | 2 | 3 | | 3 | 3 | 3 | 3 |
| **Avg** | **2.60** | **3.00** | **2.60** | **2.60** | **2.80** | **2.30** | **2.40** | **2.30** | **3.00** | **3.00** | **2.40** | **2.80** | **2.60** | **3.00** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER VII**
**(B.E - BME)**

| BM24701 | HEALTHCARE MANAGEMENT SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the Hospital classification.
- Learning the Hospital planning and biomedical waste management.
- Exploring the information system management in hospital.
- Demonstrating the activities of Biomedical Department in hospital.
- Knowing the various aspects of quality measures in hospital.

**UNIT I HOSPITAL CLASSIFICATION AND SUPPORTIVE SYSTEMS 9**

Classification of Hospital Systems: General, Specialist, Teaching and Research Hospitals, Primary Health Centre Their role, Functions. Aspects of Hospital Services: Outpatient, Inpatient, Supportive, Emergency and Ambulance services

**UNIT II HOSPITAL PLANNING 9**

Hospital Planning- Location, Orientation, Budgeting, Communication both within and outside the hospital. Electric power supply for various Theatres and Rooms, Diesel Generator, standby power supply. Air conditioning of important theatres and equipment housings, water supply requirements and management, lifts, firefighting and equipment. Sanitation within the hospitals and laundry services. Biomedical Waste Management – Types, Disposal.

**UNIT III INFORMATION SYSTEM & ELECTRICAL FACTORS IN HOSPITALS 9**

Information System: Registration, Administration, Discharge records of patients. Patients billing, Maintenance of patient's records, Maintenance of inventory of medicines and drugs. Electrical Factors in Hospital Design: Voltage stabilizer, uninterrupted power supply for intensive care units and computerized monitoring units. Importance of grounding for Medical Equipment.

**UNIT IV BIOMEDICAL DEPARTMENT IN A HOSPITAL 9**

Role of Biomedical Engineer and Biomedical Department, Biomedical equipment purchase, service and maintenance. Management of condemned equipment, Training on medical equipment usage (Doctors, Nurses and Technicians), Preventive and periodical maintenance procedures.

**UNIT V QUALITY MEASURES IN HOSPITAL 9**

Medical Audit – Introduction, Audit Types, Methods, Monitoring, Practice, Implementation, ISO 9000 Series, ISO 9002 and Hospital, Implementation, Benefits, National Accreditation Board for Hospitals & Healthcare Providers (NABH), National Accreditation Board for Testing & Calibration Laboratories (NABL, Joint Commission International (JCI) - Standard Protocols, Procedures, Benefits Health Insurance & Managing Health Care

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Classify different types of Hospitals.

**CO2:** Explain Hospital planning and services.

**CO3:** Discuss the information systems and electrical factors in hospital.

**CO4:** Outline the activities of Biomedical department in hospital.

**CO5:** Compare and Contrast Quality measures.

**TEXT BOOKS:**

1. V. Srinivasan, Managing a Modern Hospital, Sage Books, Second Edition.
2. S. L. Goel& Ram Kumar, Hospital Administration and Management, Deep and Deep Publications, New Delhi.

**REFERENCES:**

1. Ravi Bindra, Principles of Hospital Administration and Management by, Adroit Publishers
2. Ashok Sahni, Source book of Modern Technology for Hospitals and Healthcare, ISHA, Bangalore.
3. Donald Snook, Opportunities in Hospital Administration Careers, McGraw-Hill.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | 3 | 2 | | | 2 | | 2 | 2 | 2 | |
| **CO2** | | | 3 | 2 | 2 | 3 | | | 3 | 2 | 2 | 2 | 3 | |
| **CO3** | | 3 | 2 | 2 | 3 | 3 | 2 | | 2 | 2 | 2 | 2 | 3 | |
| **CO4** | 2 | | 2 | 3 | | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | |
| **CO5** | 3 | 3 | 2 | 2 | | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 3 | |
| **Avg** | **2.50** | **3.00** | **2.25** | **2.25** | **2.67** | **2.60** | **2.00** | **2.00** | **2.40** | **2.25** | **2.40** | **2.20** | **2.80** | |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER VII**
**(B. E / BME)**

| BM24702 | HOSPITAL INTERNSHIP WITH TRAINING | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Observing the patient-centered healthcare practices and quality patient care.
- Developing the effective communication skills with healthcare professionals and patients.
- Recognizing the importance of inter-professional collaboration in healthcare delivery.
- Learning the strategies for developing patient-focused healthcare improvement plans.
- Applying the multidisciplinary knowledge to address patient and community healthcare needs.

**ASSESSMENT**

Students are required to undergo a 15-day training program in any leading multi-speciality hospital. After completion of the training, they must prepare a detailed report and submit it to their respective course in-charges during the academic session.

Among the departments listed, training in any 10 departments is mandatory. The remaining departments may be covered through student presentations conducted during laboratory hours.

| S. No | DEPARTMENTS FOR VISIT |
|---|---|
| 1 | Cardiology |
| 2 | ENT |
| 3 | Ophthalmology |
| 4 | Orthopaedic and Physiotherapy |
| 5 | ICU/CCU |
| 6 | Operation Theatre |
| 7 | Neurology |
| 8 | Nephrology |
| 9 | Radiology |
| 10 | Nuclear Medicine |
| 11 | Pulmonology |
| 12 | Urology |
| 13 | Obstetrics and Gynaecology |
| 14 | Emergency Medicine |
| 15 | Biomedical Engineering Department |
| 16 | Histo Pathology |
| 17 | Biochemistry |
| 18 | Paediatric/Neonatal |
| 19 | Dental |
| 20 | Oncology |
| 21 | PAC's |
| 22 | Medical Records / Telemetry |

. **TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Apply patient-centered healthcare practices.

**CO2:** Communicate effectively with healthcare professionals.

**CO3:** Recognize the value of inter-professional collaboration.

**CO4:** Develop patient-focused healthcare improvement plans.

**CO5:** Utilize multidisciplinary knowledge to address patient and community healthcare needs.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | | | 2 | 3 | 2 | 3 |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | | 3 | 3 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | | | 2 | 2 | 2 | 3 |
| **CO4** | 2 | 3 | 2 | 2 | 3 | | 3 | 3 | | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 2 | 3 | 3 | 3 | 3 | | 3 | 2 | 3 | | 3 | 3 | 3 | 3 |
| **Avg** | **2.60** | **3.00** | **2.60** | **2.60** | **2.80** | **2.30** | **2.40** | **2.30** | **3.00** | **3.00** | **2.40** | **2.80** | **2.60** | **3.00** |

**1 - Low, 2 - Medium, 3 - High**

**SEMESTER VIII**
**(B. E / BME)**

| BM24801 | PROJECT WORK / INTERNSHIP | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 20 | 10 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Identifying and analyzing real-world engineering problems through literature review.
- Designing the feasible methodologies and engineering solutions for identified problems.
- Implementing and validating the engineering solutions using appropriate tools and techniques.
- Developing the teamwork, project management, and professional ethics during project execution.
- Enhancing the technical communication skills through project presentation, reporting, and viva voce.

**ASSESSMENT**

- Students shall work in groups of 3 to 4 members on a project topic approved by the Head of the Department under the guidance of a faculty supervisor. After completing the project work to the satisfaction of the supervisor, the students must prepare a comprehensive project report.
- The progress of the project shall be assessed through a minimum of three review evaluations conducted by a review committee constituted by the Head of the Department.
- At the end of the semester, students are required to submit the project report. The final evaluation of the project will be carried out jointly by internal and external examiners appointed by the Head of the Department, based on the project report and oral presentation

.

**TOTAL: 300 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Formulate a real-world engineering problem through literature review and analysis.
**CO2:** Design an appropriate methodology for a feasible engineering solution..
**CO3:** Implement and validate the proposed engineering solution.
**CO4:** Demonstrate teamwork, project management, and professional ethics during project execution..
**CO5:** Present and defend the project work through technical reporting and viva voce.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | | | 2 | 3 | 2 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | | 3 | 3 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | | | | 2 | 2 | 2 | 3 |
| CO4 | 2 | 3 | 2 | 2 | 3 | | 3 | 3 | | 3 | 2 | 3 | 3 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 3 | | 3 | 2 | 3 | | 3 | 3 | 3 | 3 |
| Avg | 2.60 | 3.00 | 2.60 | 2.60 | 2.80 | 2.33 | 2.40 | 2.33 | 3.00 | 3.00 | 2.40 | 2.80 | 2.60 | 3.00 |

**1 - Low, 2 - Medium, 3 - High**

**NON-CREDIT MANDATORY COURSE I**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| MX24C71 | INTRODUCTION TO WOMEN AND GENDER STUDIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Defining and Evaluating gender as a social construct.
- Identifying the ways gender, power, privilege, and oppression play out across a range of cultures and human experiences.
- Identifying systemic oppression and promoting social equity.
- Promoting the women's empowerment.
- Learning the rights and obligations in all spheres of life.

**UNIT I CONCEPTS 9**

Sex vs. Gender, masculinity, femininity, socialization, patriarchy, public/ private, essentialism, binarism, power, hegemony, hierarchy, stereotype, gender roles, gender relation, deconstruction, resistance, sexual division of labour.

**UNIT II FEMINIST THEORY 9**

Liberal, Marxist, Socialist, Radical, Psychoanalytic, postmodernist, eco-feminist.

**UNIT III WOMEN'S MOVEMENTS: GLOBAL, NATIONAL AND LOCAL 9**

Rise of Feminism in Europe and America. Women's Movement in India.

**UNIT IV GENDER AND LANGUAGE 9**

Linguistic Forms and Gender, Gender and narratives, Gender Equality and Women's Empowerment through NEP 2020.

**UNIT V GENDER AND REPRESENTATION 9**

Advertising and popular visual media, Gender and Representation in Alternative Media, Gender and social media.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Recognize the concepts of gender roles and relations.
**CO2:** Evaluate various feminist theories and their contributions.
**CO3:** Analyze historical and contemporary women's movements.
**CO4:** Apply the concept of languages and gender.
**CO5:** Interpret media representation of gender.

**TEXT BOOKS:**

1. Melissa Gillis and Andrew T. Jacobs, "Introduction to Women's and Gender Studies", "An Interdisciplinary Approach", 2019.
2. Miliann Kang, Donovan Lessard, Laura Heston and Sonny Nordmarken, "Introduction to women, Gender, Sexuality Studies", 2017.

**REFERENCES:**


1. Deborah Holt, BS, MA, "HUM210 Introduction to Women and Gender Studies", 2020.
2. Gendered Lives: Communication, Gender, and Culture, Julia T. Wood, Cengage Learning,13th Edition (2021).
3. Feminist Theory: From Margin to Center ,bell hooks,2nd Edition (2000)
4. The Second Sex, Simone de Beauvoir, Vintage Books, Reprint Edition (2011, English translation).
5. Intersectionality, Patricia Hill Collins & Sirma Bilge, Polity Press,2nd Edition (2020)


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 1 | 1 | | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 |
| **CO2** | 2 | 2 | 1 | 2 | | 3 | 1 | 3 | 2 | 1 | 1 | 1 | 2 | 1 |
| **CO3** | 1 | 2 | 1 | 2 | | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 |
| **CO4** | 1 | 2 | 1 | 1 | | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 |
| **CO5** | 1 | 2 | 1 | 1 | | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 1 |
| **Avg** | **1.20** | **2.00** | **1.00** | **1.40** | | **2.80** | **2.40** | **2.80** | **2.00** | **1.80** | **1.20** | **1.00** | **1.60** | **1.20** |

**1 - Low, 2 - Medium, 3 - High**

**NON-CREDIT MANDATORY COURSE I**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| MX24C72 | ELEMENTS OF LITERATURE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the core elements of literature.
- Learning the structure and narrative techniques of fiction.
- Developing the evolution, elements, and expressive power of poetry.
- Analyzing the essential components and types of drama.
- Examining the major schools of literary criticism and critical approaches.

**UNIT I INTRODUCTION TO ELEMENTS OF LITERATURE 9**

Elements of Literature and Creative Communication, Relevance of Literature, Multidimensional Engagement with Literature, how to read and appreciate Literature, Literature - Learner's Perspective.

**UNIT II ELEMENTS OF FICTION 9**

Introduction to Fiction, Fiction vs Non-Fiction, Elements of Fiction, Fiction and its Branches, Narrative Techniques in Fiction, Fictional Modes and Patterns, Plot Character and Perspective, Internal and External Conflicts.

**UNIT III ELEMENTS OF POETRY 9**

Origins of Poetry, Poetry and its Tributaries, Elements of Poetry, English Poetry, Emotions and Imaginations, Figurative Language, Tone and mood in Poetry, Types of Poetry.

**UNIT IV ELEMENTS OF DRAMA 9**

Introduction to Drama, Elements of Drama, Drama and its types, Dialogue and Monologue, Tragedy vs Comedy vs Tragicomedy, Theoretical Performance, Drama as Narration, mediation and Persuasion.

**UNIT V LITERARY CRITICISM AND INTERPRETATION 9**

Introduction to literary theory and criticism, Schools of literary criticism: Formalism, Structuralism, Feminism, Postcolonialism, etc, Critical approaches to reading texts, Feminist Literary Criticism, Marxist Literary Criticism.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe the fundamental elements of literature.
**CO2:** Analyze the key components of fiction, including plot, character, narrative technique.
**CO3:** Identify and interpret the elements and types of poetry, including figurative language, tone, and mood.
**CO4:** Examine the structure and features of drama.
**CO5:** Apply various literary theories and critical approaches to evaluate literary texts.

**TEXT BOOKS:**

1. K. A. Sharma, R. S. Sharma, " A Textbook of English Literature", Vikas Publishing House.

**REFERENCES:**

1. X. J. Kennedy, Dana Gioia, “An Introduction to Fiction, Poetry, Drama, and Writing", 13th Edition, Pearson Education.
2. Peter Barry, " Beginning Theory: An Introduction to Literary and Cultural Theory", 4th Edition, Manchester University.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | 3 | 3 | 1 | 3 | 1 | 3 | 2 | | 2 |
| **CO2** | | | | | | 3 | 3 | 1 | 3 | 1 | 3 | 2 | | 3 |
| **CO3** | | | | | | 3 | 3 | 1 | 3 | 1 | 3 | | 3 | 3 |
| **CO4** | | | | | | 3 | 3 | 1 | 3 | 1 | 3 | 2 | | 2 |
| **CO5** | | | | | | 3 | 3 | 1 | 3 | 1 | 3 | 3 | 3 | 2 |
| **Avg** | | | | | | **3.00** | **3.00** | **1.00** | **3.00** | **1.00** | **3.00** | **2.25** | **3.00** | **2.40** |

**1 - Low, 2 - Medium, 3 – High**

**NON-CREDIT MANDATORY COURSE I**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| MX24C73 | DISASTER RISK REDUCTION AND MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Enhancing the awareness of disaster management and risk reduction methods
- Discussing the train in planning and managing disaster response operations.
- Understanding the various types of disasters and their management techniques.
- Understanding the tools and technologies used in disaster management.
- Analysing the real-life disaster management case studies and their outcomes.

**UNIT-I HAZRADS, VULNERABILITY AND DISASTER RISKS 9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, –Earthquake, Landslide, Flood, Drought, Fire etc. – Technological Disasters-Causes, Impacts including social, Economic, political, environmental, health, etc. - Global trends in disasters: urban disasters, pandemics.

**UNIT-II RISK MANAGEMENT IN DISASTERS 9**

Global Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation Based DRR, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System

**UNIT-III DISASTER MANAGEMENT 9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Management Act (2005) and Policy - Other related policies, plans, programmers and legislation - Institutional Processes and Framework at State and Central Level.

**UNIT-IV TOOLS AND TECHNOLOGIES IN DISASTER MANAGEMENT 9**

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements – Role of GIS and Response and Recovery Phases of Disaster – Standard operation Procedure for disaster response – Financial planning for Disaster Management.

**UNIT-V DISASTER MANAGEMENT: CASE STUDIES 9**

Analysis of Selected Disaster Case Studies - Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies - Field Work-Mock drill.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Impart knowledge on the concepts of Disaster, Vulnerability and Disaster Risk reduction (DRR).

**CO2:** Explain the Hazards, Vulnerability and Disaster Risk Assessment prevention and risk reduction.

**CO3:** Develop disaster response skills by adopting relevant tools and technology.

**CO4:** Discuss awareness of institutional processes for Disaster response in the country.

**CO5:** Develop awareness and Response Skills for Local Disasters

**TEXT BOOKS:**


1. Taimpo (2016), Disaster Management and Preparedness, CRC Publications.
2. Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications.


**REFERENCES:**


1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | 2 | 2 | | | 2 | | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | | 2 | 2 | | | 2 | | 2 | 2 | 3 |
| **CO3** | 2 | 2 | 3 | 3 | | 1 | 1 | | 2 | | 2 | 2 | 2 | 3 |
| **CO4** | 2 | 2 | 1 | 1 | | 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO5** | 2 | 3 | 2 | 2 | | 2 | 2 | | 2 | 2 | 2 | 2 | 2 | 2 |
| **Avg** | **2.20** | **2.40** | **2.00** | **2.00** | | **1.80** | **1.80** | | **2.00** | **2.00** | **2.00** | **2.00** | **2.00** | **2.40** |

**1 - Low, 2 - Medium, 3 – High**

**NON-CREDIT MANDATORY COURSE I**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| MX24C74 | FILM APPRECIATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Enabling to appreciate films by understanding its distinct language
- Familiarizing with early film history.
- Identifying different film genres and introduces them to the art of editing and sound
- Evaluating a variety of films, cinematic techniques, storytelling, and cultural impact.
- Exploring the enjoyment of films

**UNIT I INTRODUCTION TO FILM APPRECIATION 9**

Early Film History - The Silent Era, Evolution of Sound Cinema, Talkies, Film Formats Film Technology/Experience: Understanding film as an art form and cultural product- Basic film terminology shot, scene, sequence, mise-en-scene, Viewing and analyzing short films: identifying basic elements.

**UNIT II CINEMATIC TECHNIQUES AND STORYTELLING 9**

In-depth study of camera movements- Exploring the role of editing, sound, and lighting in storytelling- Screening and analysis: comparing different directorial styles. Cinematography – Scale of Shot, Extreme Long Shot, Long Shot, Medium Shot, Close up, Deep focus, Reverse shot, Over- the- Shoulder Shot, Angle, Long Take Basics of Film Editing - Chronological editing, Continuity editing, Cross cutting, Montage, Continuity cuts, Jump cuts, Match cuts, 30 Degree rule, 180 Degree rule

**UNIT III MASTERS OF CINEMA 9**

Alfred Hitchcock: Suspense and psychological thrillers- Akira Kurosawa: Epic storytelling and visual style- Quentin Tarantino: Non-linear narratives and stylized violence- Charlie Chaplin: Comedy and social commentary- Satyajit Ray: Realism and humanism in cinema.

**UNIT IV FILM GENRE 9**

Introduction to major film genres: drama, comedy, horror, science fiction, documentary- Characteristics and conventions of each genre- Screening and discussion of representative films from each genre. Denotative & Connotative meanings; Observation of Signs- Physiology of Perception: reading images & narrative; function of receptor organs – sight, hearing & comprehension

**UNIT V FILM THEORIES ANDCRITICISM/APPRECIATION 9**

Auteurists, Psychoanalytic, Ideological, Feminists, Film Criticism / Appreciation. Hands-on film analysis sessions- Group projects: Analyzing selected films and presenting findings- Final project: in-depth analysis of a chosen film.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Identify and analyze key cinematic techniques used in

**CO2:** Appreciate the narrative structures and storytelling methods

**CO3:** Critically evaluate films from different genres and cultural

**CO4:** Articulate informed critiques and analyses of films verbally.

**CO5:** Develop a personal aesthetic and critical approach to film

**TEXT BOOKS:**


1. Bordwell, David, and Kristin Thompson – Film Art: An Introduction – McGraw Hill Education.
2. Corrigan, Timothy, and Patricia White – The Film Experience: An Introduction – Bedford/St. Martin.
3. Film Art: An Introduction, David Bordwell & Kristin Thompson, McGraw-Hill Education.
4. Engaging Cinema: An Introduction to Film Studies, Bill Nichols, W.W. Norton.


**REFERENCES:**


1. Giannetti, Louis – Understanding Movies – Pearson
2. Monaco, James – How to Read a Film: Movies, Media, and Beyond – Oxford University Press
3. Phillips, William H – Film: An Introduction – Bedford/St. Martins
4. Louis Giannetti, Understanding Movies (2014), Pearson
5. N. M. Babu, ReejaThankachan and Binil Kumar M. R., Introducing Film Studies (2015), Mainspring Publishers.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 1 | 3 | | 1 | 2 | | | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 3 | | 1 | 3 | | | 2 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 3 | 1 | | | | | | | 2 | | 3 | 3 |
| **CO4** | 2 | 3 | 3 | 1 | | | | 2 | | | 2 | 2 | 3 | 3 |
| **CO5** | 2 | 3 | 2 | 1 | | | | | | | 2 | | 3 | 2 |
| **Avg** | **2.50** | **2.80** | **2.60** | **1.20** | **3.00** | | **1.00** | **2.33** | | | **2.00** | **2.33** | **2.80** | **2.60** |

**1 - Low, 2 - Medium, 3 - High**

**NON-CREDIT MANDATORY COURSE II**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| MX24C75 | WELL BEING WITH TRADITIONAL PRACTICES - YOGA, AYURVEDA AND SIDDHA | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Enjoying the life happily with fun filled new style activities that help to maintain health also
- Adapting few lifestyle changes that will prevent many health disorders
- Maintaining cool and handbill every emotion very smoothly in every walk of life
- Learning to eat cost effective but healthy foods that are rich in essential nutrients
- Developing immunity naturally that will improve resistance against many health disorders.

**UNIT I HEALTH AND ITS IMPORTANCE 9**

Health: Definition, Importance of maintaining health-ten types of health one has to maintain-Present health status-The life expectancy-Types of diseases and disorders: Lifestyle disorders-Obesity- Diabetes-cardiovascular diseases- Cancer-Strokes-COPD-Arthritis-Mental health issues-causes of the above diseases / disorders- Importance of prevention of illness- Simple lifestyle modifications to maintain health.

**UNIT II BALANCED DIET 9**

Role of diet in maintaining health- Balanced Diet and its 7 Components-Food additives and their merits & demerits- Effects of food additives- Types of food additives- Food additives and processed foods- Food additives and their reactions-Definition of BMI and maintaining it with diet- Common cooking mistakes.

**UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 9**

AYUSH systems and their role in maintaining health- preventive aspect of AYUSH- AYUSH as a soft therapy-Secrets of traditional healthy living-Principles of Siddha & Ayurveda systems- Macrocosm and Microcosm theory- Pancheekarana Theory / (Five Element Theory)-96 fundamental Principles- Uyir Thathukkal (Tri-Dosha Theory) - Udal Thathukkal- Prevention of illness with our traditional system of medicine.

**UNIT IV MENTAL WELLNESS 9**

Emotional health- Definition and types- Importance of maintaining emotional health- Role of emotions in daily life-leading a healthy life with emotions- Expressing a full range of emotions-Stress management- Sleep and its importance for mental wellness-Sleep and digestion- Immunity-Types and importance- Ways to develop immunity.

**UNIT V YOGA 9**

Definition and importance of yoga- Types of yoga- How to choose the right kind for individuals according to their age- The Eight Limbs of Yoga-Simple yogasanas for cure and prevention of health disorders- What yoga can bring to our life.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe the importance of different components of health.

**CO2:** Analyze the importance of diet and workouts in maintaining health.

**CO3:** Identify and interpret the new techniques to prevent lifestyle health disorders.

**CO4:** Gain confidence to lead a healthy life.

**CO5:** Develop immunity naturally that will improve resistance against many health disorders.

**TEXT BOOKS:**


1. Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA.
2. Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California.
3. B.K.S. Iyengar, "The Path of Holistic Health"June 15 2021, DK publishers ltd.
4. Michael Stone, "The Innerr Tradition of Yoga", July 17 2018, Shambhala publishers ltd.


**REFERENCES:**


1. WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England.
2. The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | | 2 | | 2 | 2 | | 2 | 2 | | 2 |
| **CO2** | 2 | 2 | 2 | | | 2 | | 2 | 2 | | 2 | 2 | | 3 |
| **CO3** | 2 | 2 | 2 | | | 2 | | 2 | 2 | | 2 | | 3 | 3 |
| **CO4** | 2 | 2 | 2 | | | 2 | | 2 | 2 | | 2 | 2 | | 2 |
| **CO5** | 2 | 2 | 2 | | | 2 | | 2 | 2 | | 2 | 3 | 3 | 2 |
| **Avg** | **2.00** | **2.00** | **2.00** | | | **2.00** | | **2.00** | **2.00** | | **2.00** | **2.25** | **3.00** | **2.40** |

**1 - Low, 2 - Medium, 3 –High**

**NON-CREDIT MANDATORY COURSE II**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| MX24C76 | HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the knowledge of India's scientific and technological achievements.
- Exploring how science and technology were intertwined with Indian Culture.
- Developing the role of Indian scientists in global fields.
- Analyzing the research, critical thinking, and analytical skills.
- Examining the post-independence developments in India's science and technology.

**UNIT I CONCEPTS AND PERSPECTIVES 9**

Meaning of History Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology- Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

**UNIT II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA 9**

Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.

**UNIT III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA 9**

Technology in pre-historic period Beginning of agriculture and its impact on technology Science and Technology during Vedic and Later Vedic times Science and technology from 1st century AD to C-1200.

**UNIT IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA 9**

Legacy of technology in Medieval India, Interactions with Arabs Development in medical knowledge, interaction between Unani and Ayurveda and alchemy Astronomy and Mathematics: interaction with Arabic Sciences Science and Technology on the eve of British conquest.

**UNIT V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA & POST –INDEPENDENT INDIA 9**

Science and the Empire Indian response to Western Science Growth of techno-scientific institutions. Science, Technology and Development discourse Shaping of the Science and Technology. Policy Developments in the field of Science and Technology Science and technology in globalizing India Social implications of new technologies like the Information Technology and Biotechnology.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Examine India's scientific and technological progress from ancient to modern times.

**CO2:** Learn how science and technology were linked to Indian culture, religion, and society.

**CO3:** Discuss the importance of Indian scientists in global fields.

**CO4:** Build skills to assess the impact of science and technology on India and the world.

**CO5:** Analyze post-independence scientific developments in India, including ISRO, IITs, IT, and biotech.

**TEXT BOOKS:**


1. Jha, Arun Kumar, and Seema Sahay. Aspects of Science and Technology in Ancient India. Routledge, 2023.
2. Paranjape, Makarand R., New Perspectives in Indian Science and Civilization. Routledge India, 2020.
3. Sarkar, Suvobrata, History of Science, Technology, Environment, and Medicine in India. Routledge, 2022.
4. Ray, N. Indian Science and Technology in the 18th Century. 2021.


**REFERENCES:**


1. Satpathy and Binod Bihari. A. A History of Science and Technology in India: History of Science, Technology, and Medicine in India. 1st ed., Himalaya Publishing House, 2025.
2. Sukumar, Arun Mohan. Midnight's Machines: A Political History of Technology in India. Penguin Random House India, 2024.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 1 | | 1 | | 2 | 1 | 1 | | 2 | | 3 | 2 | 3 |
| **CO2** | | 1 | | | | 3 | 2 | 2 | 1 | 2 | | 2 | 2 | 2 |
| **CO3** | | 1 | | 1 | | 2 | 1 | 1 | 1 | 2 | | 1 | 3 | 3 |
| **CO4** | | 2 | | 2 | | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 2 |
| **CO5** | 1 | 2 | | 2 | 1 | 3 | 2 | 1 | | 2 | 1 | 1 | 1 | 2 |
| **Avg** | **1.00** | **1.40** | | **1.50** | **1.00** | **2.60** | **1.60** | **1.40** | **1.00** | **2.00** | **1.00** | **1.80** | **1.80** | **2.00** |

**1 - Low, 2 - Medium, 3 – High**

**MANDATORY COURSE - II**

**COMMON TO B.E. BME., CSE., ECE., EEE., MECH., & B.TECH. AIDS., & IT.**

| MX24C77 | INDUSTRIAL SAFETY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of safety engineering and terminologies.
- Exploring the important statutory regulations and standards.
- Developing to conduct and participate the various safety activities in the industry.
- Analyzing about workplace exposures and hazards.
- Examining the hazards using various risk assessment techniques.

**UNIT-I SAFETY TERMINOLOGIES 9**

Hazard-Types of Hazards- Risk-Hierarchy of Hazards Control Measures-Lead indicators - Lag Indicators- Flammability- Toxicity Time-weighted Average - Threshold Limit Value - Short Term Exposure Limit- Immediately dangerous to life or health - Personnel Protective Equipment- Health and Safety Policy.

**UNIT-II STANDARDS AND REGULATIONS 9**

Factory Regulations in India -1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Risk Identification and Hazard Control - Code of practice IS 15656:2006.

**UNIT-III SAFETY ACTIVITIES 9**

Toolbox Talk- Role of safety Committee- Responsibilities of Industrial Safety Officials - Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment.

**UNIT-IV WORKPLACE HEALTH AND SAFETY 9**

Noise Related Safety Hazard - Particulate matter- Postural Disorders and Ergonomic Evaluation Techniques (RULE & REBA)- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety Toxic Gas Release**.**

**UNIT-V HAZARD DETECTION TECHNIQUES 9**

Job Hazard Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment-Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon successful completion of the course, students should be able to

**CO1:** Understand the basic concept of safety.

**CO2:** Familiarization of Statutory Regulations and Standards

**CO3:** Know about the safety Activities of the Working Place.

**CO4:** Analyze on the impact of Occupational Exposures and their Remedies

**CO5:** Obtain knowledge of Risk Assessment Techniques.

**TEXTBOOKS:**

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER.
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

**REFERENCE BOOKS:**


1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publication U4th Edition.
2. John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring. (1996). Safety management system: Chapman &Hall, England
5. Society of Safety Engineers, USA


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | 1 | 3 | | | | 2 | 1 | 1 | | |
| **CO2** | 2 | 3 | 2 | | 2 | 2 | | 2 | 2 | 3 | 2 | 3 | | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | 3 | 1 | 1 | 2 | |
| **CO4** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 2 | 2 |
| **Avg** | **2.66** | **2.40** | **2.40** | **2.00** | **1.80** | **2.20** | **2.00** | **2.33** | **2.00** | **2.80** | **1.80** | **2.00** | **2.00** | **2.33** |

**1 - Low, 2 - Medium, 3 - High**

**NON-CREDIT MANDATORY COURSE II**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| MX24C78 | POLITICAL AND ECONOMIC THOUGHT FOR A HUMAN SOCIETY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the human aspirations and contributing to the creation of a humane, ethical, and sustainable social order.
- Exploring the evolution of modern economic systems.
- Developing how communist theory relates to human desires, the pursuit of empowerment, and human satisfaction.
- Analyzing the core principles of Gandhian thought, emphasizing Swaraj, decentralized political and economic systems, and community empowerment.
- Examining the foundational elements of Indian civilization, with a focus on the role of technology and education in societal development.

**UNIT I HARMONY AND HUMAN ASPIRATIONS 9**

Considerations for humane society, holistic thought, human being's desires-harmony in self- harmony in relationships, society, and nature, societal systems.

**UNIT II MODERN IDEOLOGIES AND WORLD CONFLICTS 9**

Capitalism – Free markets, demand-supply, perfect competition, laissez-faire, monopolies, imperialism-Liberal democracy, Fascism and totalitarianism-World war I and II. Cold war.

**UNIT III COMMUNISM AND HUMAN FULFILLMENT 9**

Communism – Mode of production, theory of labor, surplus value, class struggle, dialectical materialism, historical materialism, Russian and Chinese models-Welfare state-Relation with human desires-Empowered human beings, satisfaction.

**UNIT IV SWARAJ AND SELF-DETERMINATION 9**

Gandhian thought-Swaraj, Decentralized economy & polity, Community-Control over one's lives, Relationship with nature.

**UNIT V CORE ELEMENTS OF INDIAN CIVILIZATION 9**

Essential elements of Indian civilization-technology as driver of society-Role of education in shaping of society-Future directions.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Examine the principles of a humane and just society based on harmony within self and society.

**CO2:** Assess the impact of free markets, demand–supply forces, and monopolies on capitalism's evolution.

**CO3:** Evaluate mode of production and surplus value theories.

**CO4:** Interpret the concepts of Swaraj and decentralized governance in Gandhian thought.

**CO5:** Identify and analyze the essential elements of Indian civilization.

**TEXT BOOKS:**


1. Acemoglu, Daron, and Simon Johnson. Power and Progress: Our Thousand-Year Struggle Over Technology and Prosperity. PublicAffairs, 2023.
2. Feldstein, Steven. Digital Empires: The Global Battle to Regulate Technology. Oxford University Press, 2023.
3. Slobodian, Quinn. Crack-Up Capitalism: Market Radicals and the Dream of a World Without Democracy. Metropolitan Books, 2023.


**REFERENCES:**


1. Marx, Karl, Friedrich Engels, and Robert C. Tucker. The Marx-Engels Reader. 2nd ed., W. W. Norton & Company, 2012.
2. Toffler, Alvin. The Third Wave. Updated ed., Bantam Books, 2022.
3. Kalam, A. P. J. Abdul, and Y. S. Rajan. India 2020: A Vision for the New Millennium. Penguin Books India, 2014.
4. Piketty, Thomas. A Brief History of Equality. Harvard University Press, 2022.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 1 | | | | 3 | 2 | 2 | 1 | 1 | | | | |
| **CO2** | | 2 | | 1 | | 2 | 2 | 2 | 1 | 1 | | | | 2 |
| **CO3** | | 2 | | 1 | | 2 | 2 | 3 | 1 | 1 | | | | 2 |
| **CO4** | | 1 | | | | 3 | 2 | 3 | 1 | 1 | | | | 2 |
| **CO5** | 1 | 2 | | 1 | 1 | 2 | 2 | 2 | | 2 | 1 | | | |
| **Avg** | **1.00** | **1.60** | | **1.00** | **1.00** | **2.40** | **2.00** | **2.40** | **1.00** | **1.20** | **1.00** | | | **2.00** |

**1 - Low, 2 - Medium, 3 – High**

**NON-CREDIT MANDATORY COURSE II**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| MX24C79 | STATE, NATION BUILDING AND POLITICS IN INDIA | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 0 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the meaning of the state and the functioning of its major organs such as the Legislature, Executive, and Judiciary.
- Exploring the importance of politics, political processes, and the changing concept of sovereignty in a globalized world.
- Developing the history, developments, and legacies of India's freedom struggle and Constitution-making process.
- Analyzing the reasons behind adopting the Parliamentary-federal system and the basic philosophy and features of the Constitution of India.
- Examining the national integration, nation-building, and contemporary political challenges to develop a vision for a stronger and better India.

**UNIT I STATE, POLITICS AND SOVEREIGNTY 9**

Understanding the need and role of the State and politics, Development of the Nation-State, Concept of sovereignty and sovereignty in a globalized world.

**UNIT II ORGANS AND FORMS OF GOVERNMENT 9**

Organs of the State: Executive, Legislature and Judiciary, Separation of powers, Forms of government: Unitary and Federal systems, Presidential and Parliamentary forms of government. Activity-Based Learning: Debate, Discussion and Mock Parliament.

**UNIT III NATIONAL MOVEMENT AND CONSTITUTIONAL DEVELOPMENT 9**

Revolt of 1857 and national awakening, Formation of the Indian National Congress in 1885, Development and legacies of the national movement, Constitution making and the Constitution of India.

**UNIT IV INDIAN CONSTITUTION AND NATION-BUILDING 9**

Goals, objectives and philosophy of the Constitution, Reasons for adopting a federal system, National integration and nation-building. Activity-Based Learning: Role Play

**UNIT V CONTEMPORARY CHALLENGES AND FUTURE OF INDIAN POLITICS 9**

Challenges of nation-building, State versus democracy (Rajni Kothari), New social movements, Changing nature of the Indian Political System, Future scenario and the role of citizens in building a better India.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe the concepts of State, politics, and sovereignty.

**CO2:** Explain the background and philosophy of the Indian Constitution.

**CO3:** Examine national integration and nation-building in India.

**CO4:** Analyze governance and democratic institutions in India.

**CO5:** Apply democratic values and responsible citizenship in society.

**TEXT BOOKS:**

1. Singh, M. P., and Rekha Saxena. Indian Politics: Constitutional Foundations and Institutional Functioning. 2021 ed., PHI Learning, 2021.
2. Muralidharan, Sukumar. India in the Pandemic Years: Governance, Economy and Democracy. 2022.

**REFERENCES:**

1. Sharma, Brij Kishore. Introduction to the Indian Constitution. 13th ed., PHI Learning, 2021.
2. Jaffrelot, Christophe. Modi's India: Hindu Nationalism and the Rise of Ethnic Democracy. Princeton University Press, 2021.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | 2 | 1 | 2 | 1 | 1 | | | 3 | |
| **CO2** | | | | | | 2 | 1 | 2 | 1 | 1 | | | 2 | 2 |
| **CO3** | | | | | | 3 | 2 | 2 | 1 | 1 | | 2 | 3 | 2 |
| **CO4** | | | | | | 3 | 2 | 2 | 1 | 2 | | 2 | 2 | 2 |
| **CO5** | | | | | | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | |
| **Avg** | | | | | | **2.60** | **1.80** | **2.20** | **1.20** | **1.40** | **3.00** | **2.00** | **2.60** | **2.00** |

**1 - Low, 2 - Medium, 3 – High**

**MANAGEMENT ELECTIVE**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| GE24M01 | PRINCIPLES OF MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the Evolution of Management.
- Analyzing the functions and principles of management.
- Learning the application of the principles in an organization.
- Studying the various HR related activities.
- Exploring the position of self and company goals towards business.

**UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9**

Definition of Management – Science or Art – Manager Vs Entrepreneur- types of managers managerial roles and skills – Evolution of Management –Scientific, human relations, system and contingency approaches– Types of Business organization- Sole proprietorship, partnership, company-public and private sector enterprises- Organization culture and Environment – Current trends and issues in Management.

**UNIT II PLANNING 9**

Nature and purpose of planning – Planning process – Types of planning – Objectives – Setting objectives – Policies – Planning premises – Strategic Management – Planning Tools and Techniques – Decision making steps and process.

**UNIT III ORGANISING 9**

Nature and purpose – Formal and informal organization – Organization chart – Organization structure – Types – Line and staff authority – Departmentalization – delegation of authority – Centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management.

**UNIT IV DIRECTING 9**

Foundations of individual and group behavior – Motivation – Motivation theories – Motivational techniques – Job satisfaction – Job enrichment – Leadership – types and theories of leadership – Communication – Process of communication – Barrier in communication – Effective communication – Communication and IT.

**UNIT V CONTROLLING 9**

System and process of controlling – Budgetary and non - Budgetary control techniques – Use of computers and IT in Management control – Productivity problems and management – Control and performance – Direct and preventive control – Reporting.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the managerial functions like planning, organizing, staffing, leading & controlling.

**CO2:** Describe the knowledge about the planning and decision making.

**CO3:** Discuss the concept of organising for the effective functioning of a management.

**CO4:** Evaluate leadership style to anticipate the consequences of each leadership style.

**CO5:** Classify the budget techniques with the usage of computers and IT in Management Control.

**TEXT BOOKS:**


1. Harold Koontz and Heinz Weihrich "Essentials of management" Tata McGraw Hill, 1998.
2. Stephen P. Robbins and Mary Coulter, "Management", Prentice Hall (India)Pvt. Ltd., 10th Edition, 2009.


**REFERENCES:**


1. Robert Kreitner and Mamata Mohapatra, "Management", Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, "Fundamentals of Management" Pearson Education, 7th Edition, 2011.
3. Tripathy PC and Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.
4. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | | 2 | 2 | | | 2 | 3 | | 2 | |
| **CO2** | | | | | | 3 | 3 | 3 | 3 | 2 | 3 | 2 | | |
| **CO3** | 2 | | | | | 3 | 3 | 2 | 2 | 2 | 3 | | 2 | |
| **CO4** | | | | 2 | | 3 | 3 | 3 | 2 | 2 | 3 | 3 | | |
| **CO5** | 3 | | | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | | | 2 |
| **Avg** | **2.33** | | | **2.50** | **3.00** | **2.80** | **2.60** | **2.75** | **2.25** | **2.20** | **3.00** | **2.50** | **2.00** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**MANAGEMENT ELECTIVE**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| GE24M02 | TOTAL QUALITY MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic quality management in engineering.
- Analyzing the various principles of TQM.
- Learning the management tools, six sigma and benchmarking.
- Studying the quality functions, TPM concepts, and continuous improvement methodologies.
- Exploring the quality systems and TQM implementation in manufacturing and service sectors.

**UNIT I INTRODUCTION 9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework -Contributions of Deming, Juran and Crosby – Barriers to TQM.

**UNIT II TQM PRINCIPLES 9**

Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal – Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

**UNIT III TQM TOOLS & TECHNIQUES I 9**

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

**UNIT IV TQM TOOLS & TECHNIQUES II 9**

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

**UNIT V QUALITY SYSTEMS 9**

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the importance of quality in engineering.

**CO2:** Improve the quality of the organization through using the total quality process.

**CO3:** Explore the knowledge of implementing various TQM tools.

**CO4:** Implement the tools and techniques for quality improvement.

**CO5:** Outline the key benefits of ISO 9000 and ISO 14000 implementation for service sector businesses.

**TEXT BOOKS:**


1. Dale H.Besterfiled, Carol B.Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and RashmiUrdhwareshe, Total Quality Management, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2020.


**REFERENCES:**


1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2019.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2018.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2020.
4. ISO 9001-2015 standards


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | 2 | 2 | 2 | 1 | 2 | 3 | 3 | | 3 | 3 | | 2 | |
| **CO2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | | |
| **CO3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | | 2 | 2 | | 2 | |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 3 | | |
| **CO5** | 1 | 2 | 3 | 2 | | 2 | 3 | 2 | | 3 | 3 | | | 2 |
| **Avg** | **2.50** | **2.60** | **2.80** | **2.60** | **2.50** | **2.40** | **3.00** | **2.60** | **2.00** | **2.80** | **2.40** | **2.50** | **2.00** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**MANAGEMENT ELECTIVE**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| GE24M03 | ENGINEERING ECONOMICS AND FINANCIAL ACCOUNTING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the principles of and techniques of managerial economics.
- Analyzing the various demand forecasting methods .
- Learning the business organizations.
- Studying the various costing methods.
- Exploring the financial accounting and analysis.

**UNIT I INTRODUCTION TO MANAGERIAL ECONOMICS 9**

Introduction –Economics Theories And Scope –Demand And Supply Analysis –Determinants of Demand – Law Of Demand – Elasticity Of Demand – Demand Forecasting –Demand Sensitivity –Price, Income ,Gross ,Advertisement –Law Of Supply –Elasticity Of Supply – Cost Concepts –Types –Cost Curves –Short Run And Long Run –Break Even Analysis – Pricing Concepts –Types ,Price –Determinations.

**UNIT II DEMAND & SUPPLY ANALYSIS 9**

Concepts– Firm, Industry, Market, Market power, Market Conduct, Market Performance. Market Structure-Types- Perfect Monopoly, Monopolistic and Oligopoly Competition. Manufacturing Practices-Diversification, Vertical and Horizontal Integration, Merger.

**UNIT III PRODUCTION AND COST ANALYSIS 9**

National Income: Concepts and Measurements –GNP, NNP- Methods of Measuring National Income-Inflation and Deflation, Unemployment. Money and Banking: Value of Money-Banking-Commercial Banks and Its Function. New Economic Environment: Economic Systems –Economic Liberalization, Privatization and Globalization.

**UNIT IV PRICING 9**

Introduction, Scope, Objectives, Basic Financial Concepts – Time Value Of Money And Method Of Appraising Project Profitability – Rate of Return –Pay Back Period – Percent Value, NPV Comparison – Cost – Benefit Analysis. Source of Finance – Internal And External –Long Term And Short Term – Securities, Debentures/ Bonds, Shares, Financial Institutions.

**UNIT V FINANCIAL ACCOUNTING 9**

Accounting System- Financial Statement – Types- Ledger, Cash Flow Statement Profit And Loss Account, Balance Sheet, Ratios/ Financial Analysis- Liquidity Leverage Activity, Profitability, Trends Analysis.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the demand in the present market.

**CO2:** Illustrate the product demand by using the demand forecasting techniques.

**CO3:** Apply the concept of cash flow.

**CO4:** Implement the analysis of economics of sampling and Replacement and Maintenance.

**CO5:** Describe the depreciation and Evaluation of public alternatives.

**TEXT BOOKS:**

1. Management Economics and Financial Analysis, Aryasri, 4/e, TMH, 2009.
2. Managerial Economics, Varshney & Maheswari, Sultan Chand, 2009.

**REFERENCES:**

1. Maheshwari S N "Management Accounting and Financial Accounting", S.ChandandCompany. 1993.
2. D N Drivedi, "Managerial Economics ", Vikas Publishing House.1980
3. R RBarthwal, Industrial Economics ", Wiley Eastern Ltd1996
4. G S Guptha, "Management Economics ", Tata McGraw Hill Ltd

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | | | 2 | 3 | 3 | | 3 | 3 | | 2 | 2 |
| **CO2** | 3 | 3 | 3 | | | 3 | 3 | 3 | | 3 | 3 | 2 | | 2 |
| **CO3** | 3 | 3 | 3 | | | 2 | 3 | 3 | | 2 | 2 | 2 | 2 | |
| **CO4** | 3 | 3 | 3 | | | 3 | 3 | 2 | | 3 | 1 | 3 | | |
| **CO5** | 1 | 2 | 3 | | | 2 | 3 | 2 | | 3 | 3 | 3 | 2 | 2 |
| **Avg** | **2.50** | **2.60** | **2.80** | | | **2.40** | **3.00** | **2.60** | | **2.80** | **2.40** | **2.50** | **2.00** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**MANAGEMENT ELECTIVE**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| GE24M04 | HUMAN RESOURCE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamental concepts, scope, and evolution of Human Resource Management.
- Learning the human resource planning, job analysis, recruitment, and selection processes.
- Developing insights into training, employee development, and performance management systems.
- Analyzing the components of compensation management and employee welfare.
- Examining the performance evaluation methods and organizational control processes.

**UNIT I INTRODUCTION TO HUMAN RESOURCE MANAGEMENT 9**

Definition, nature and scope of HRM, The importance of human resources, Evolution of HRM, Objective of Human Resource Management, Human resource policies, Role of human resource manager, HRM in the Digital Era.

**UNIT II HUMAN RESOURCE PLANNING AND RECRUITMENT 9**

Internal and External sources of Human Resources, Importance of Human Resource Planning, Job analysis, Recruitment, Selection, Socialization.

**UNIT III TRAINING, DEVELOPMENT, AND PERFORMANCE MANAGEMENT 9**

Training vs. development, Need for Training, Evaluation of Training, Types of training and Executive development methods, Performance management systems, Performance appraisals.

**UNIT IV COMPENSATION MANAGEMENT AND EMPLOYEE WELFARE 9**

Compensation structure: Components and strategies, Compensation plan, Reward, Motivation, Career Development, Mentor, Protege relationships.

**UNIT V PERFORMANCE EVALUATION AND CONTROL 9**

Performance evaluation, Feedback, The control process, Importance, Methods, Grievances, Causes, Redressal methods.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe the definition, scope, and evolution of Human Resource Management.

**CO2:** Analyze the human resource planning process, including recruitment, selection, and socialization.

**CO3:** Evaluate various training and development methods and assess performance appraisal systems.

**CO4:** Demonstrate an understanding of compensation structures, employee motivation strategies.

**CO5:** Apply methods of performance evaluation and control and suggest appropriate redressal mechanisms.

**TEXT BOOKS:**

1. Decenzo and Robbins, "Human Resource Management", 8th Edition, Wiley, 2007.
2. John Bernardin. H., "Human Resource Management – An Experimental Approach", 5th Edition, Tata McGraw Hill, 2013, New Delhi.

**REFERENCES:**

1. Luis R,. Gomez-Mejia, DavidB. Balkin and Robert L. Cardy, "Managing Human Resources", 7th Edition, PHI, 2012.
2. Dessler, "Human Resource Management", Pearson Education Limited, 2007.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | | 2 |
| **CO3** | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | |
| **CO4** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 1 | 3 | | |
| **CO5** | 1 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 3 | 2 | 2 |
| **Avg** | **2.50** | **2.60** | **2.80** | **3.00** | **2.00** | **2.40** | **3.00** | **2.60** | **2.00** | **2.80** | **2.40** | **2.50** | **2.00** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**MANAGEMENT ELECTIVE**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| GE24MO5 | KNOWLEDGE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals, concepts, and evolution of knowledge management.
- Learning the knowledge sharing, learning organizations, and knowledge management life cycles.
- Developing tools and information technologies used in knowledge management systems.
- Analyzing the knowledge management strategies and applications in various domains.
- Examining the future trends and case studies in knowledge management practices.

**UNIT I INTRODUCTION 9**

An Introduction to Knowledge Management - The foundations of knowledge management- including cultural issues- technology applications organizational concepts and processes- management aspects- and decision support systems. The Evolution of Knowledge management: From Information Management to Knowledge Management - Key Challenges Facing the Evolution of Knowledge Management - Ethics for Knowledge Management.

**UNIT II CREATING THE CULTURE OF LEARNING AND KNOWLEDGE SHARING 9**

Organization and Knowledge Management - Building the Learning Organization. Knowledge and role related issues-Basic types of knowledge management-Knowledge Management Life Cycle- Organizational Knowledge Sources Knowledge Markets: Cooperation among Distributed Technical Specialists – Tacit Knowledge and Quality Assurance.

**UNIT III KNOWLEDGE MANAGEMENT-THE TOOLS 9**

Telecommunications and Networks in Knowledge Management - Internet Search Engines and Knowledge Management - Information Technology in Support of Knowledge Management - Knowledge Management and Vocabulary Control - Information Mapping in Information Retrieval - Information Coding in the Internet Environment - Repackaging Information.

**UNIT IV KNOWLEDGE MANAGEMENT APPLICATION 9**

Components of a Knowledge Strategy - Case Studies (from Library to Knowledge Center, Knowledge Management in the Health Sciences-Knowledge Management in Developing Countries)

**UNIT V FUTURE TRENDS AND CASE STUDIES 9**

Advanced topics and case studies in knowledge management - Development of a knowledge management map/plan that is integrated with an organization's strategic and business plan - A case study on Corporate Memories for supporting various aspects in the process life - cycles of an organization

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the concepts, evolution, and ethical aspects of knowledge management.

**CO2:** Describe learning organizations, knowledge sharing processes, and knowledge life cycles.

**CO3:** Apply knowledge management tools and information technologies for information retrieval and management.

**CO4:** Analyze knowledge management strategies and applications in organizations and healthcare systems.

**CO5:** Evaluate future trends and case studies in knowledge management and organizational planning.

**TEXT BOOKS:**


1. Srikantaiah, T.K., Koenig, M., Knowledge Management for the Information Professional Information Today, Inc., 2000.
2. "Effective Knowledge Management: A Best Practice Blueprint" by Sultan Kermally (CBI, 2002)
3. Knowledge Management" by Elias M. Awad (Pearson, 1st Edition)


**REFERENCES:**


1. Nonaka, I., Takeuchi, H., The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation, Oxford University Press, 1995.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 | | | 3 | 2 | | | | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | | | 3 | 2 | | | 2 | | 2 |
| **CO3** | 2 | 3 | 3 | 3 | 2 | | | 3 | 2 | | | 2 | 2 | |
| **CO4** | 2 | 3 | 3 | 3 | 2 | | | 2 | 2 | | | 3 | | |
| **CO5** | 2 | 2 | 3 | 3 | 2 | | | 2 | 2 | | | 3 | 2 | 2 |
| **Avg** | **2.40** | **2.60** | **2.80** | **3.00** | **2.00** | | | **2.60** | **2.00** | | | **2.50** | **2.00** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**MANAGEMENT ELECTIVE**
**(Common To B. E – BME, ECE, EEE, CSE, B. Tech – IT, AI&DS)**

| GE24M06 | INDUSTRIAL MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic concepts and functions of management.
- Learning the planning, organizing, and staffing in professional organizations.
- Developing leading, controlling, and decision-making functions of management.
- Analyzing the organizational theory and behavior in professional organizations.
- Examining the productivity principles and modern management concepts.

**UNIT I INTRODUCTION TO MANAGEMENT 9**

Management: Introduction; Definition and Functions – Approaches to the study of Management – Mintzberg's Ten Managerial Roles – Principles of Taylor; Fayol; Weber; Parker – Forms of Organization: Sole Proprietorship; Partnership; Company (Private and Public); Cooperative – Public Sector Vs Private Sector Organization – Business Environment: Economic; Social; Political; Legal – Trade Union: Definition; Functions; Merits & Demerits.

**UNIT II FUNCTIONS OF MANAGEMENT - I 9**

Planning: Characteristics; Nature; Importance; Steps; Limitation; Planning Premises; Strategic Planning; Vision & Mission statement in Planning– Organizing: Organizing Theory; Principles; Types; Departmentalization; Centralization and Decentralization; Authority & Responsibility – Staffing: Systems Approach; Recruiting and Selection Process; Human Resource Development (HRD) Concept and Design.

**UNIT III FUNCTIONS OF MANAGEMENT - II 9**

Directing (Leading): Leadership Traits; Style; Morale; Managerial Grids (Blake-Mounton, Reddin) – Communication: Purpose; Model; Barriers – Controlling: Process; Types; Levels; Guidelines; Audit (External, Internal, Merits); Preventive Control – Decision Making: Elements; Characteristics; Nature; Process; Classifications.

**UNIT IV ORGANIZATION THEORY 9**

Organizational Conflict: Positive Aspects; Individual; Role; Interpersonal; Intra Group; Inter Group; Conflict Management – Maslow's hierarchy of needs theory; Herzberg's motivation-hygiene theory; McClelland's three needs motivation theory; Vroom's valence-expectancy theory – Change Management: Concept of Change; Lewin's Process of Change Model; Sources of Resistance; Overcoming Resistance; Guidelines to managing Conflict.

**UNIT V PRODUCTIVITY AND MODERN TOPICS 9**

Productivity: Concept; Measurements; Affecting Factors; Methods to Improve – Modern Topics (concept, feature/characteristics, procedure, merits and demerits): Business Process Reengineering (BPR); Benchmarking; SWOT/SWOC Analysis; Total Productive Maintenance; Enterprise Resource Planning (ERP); Management of Information Systems (MIS).

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the basic concepts and approaches of management in professional organizations.

**CO2:** Discuss planning, organizing, and staffing functions of management.

**CO3:** Apply leading, controlling, and decision-making functions in organizations.

**CO4:** Explain organizational theory in professional organizations.

**CO5:** Analyze productivity principles and modern management concepts in organizations.

**TEXT BOOKS:**


1. M. Govindarajan and S. Natarajan, "Principles of Management", Prentice Hall of India, New Delhi, 2009.
2. Koontz. H. and Weihrich. H., "Essentials of Management: An International Perspective", 8th Edition, Tata McGrawhill, New Delhi, 2010.


**REFERENCES:**


1. Joseph J, Massie, "Essentials of Management", 4th Edition, Pearson Education, 1987.
2. Saxena, P. K., "Principles of Management: A Modern Approach", Global India Publications, 2009.
3. S.Chandran, "Organizational Behaviours", Vikas Publishing House Pvt. Ltd., 1994.
4. Richard L. Daft, "Organization Theory and Design", South Western College Publishing, 11th Edition, 2012.
5. S. TrevisCerto, "Modern Management Concepts and Skills", Pearson Education, 2018.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | | 2 | 2 |
| **CO2** | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | | 2 |
| **CO3** | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | |
| **CO4** | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | | |
| **CO5** | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | 2 | 2 |
| **Avg** | **2.40** | **2.60** | **2.80** | **3.00** | **2.00** | **2.60** | **2.80** | **2.60** | **2.00** | **2.60** | **2.80** | **2.50** | **2.00** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL I - MANAGEMENT (HEALTHCARE)**
**(B.E - BME)**

| BM24P01 | CLINICAL ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics and importance of clinical engineering in healthcare.
- Analyzing the planning, management, and maintenance of medical equipment.
- Learning the Essential Health Care Technology Packages (EHTP).
- Studying the clinical engineering management and performance evaluation.
- Introducing the advanced technologies used for patient safety and reducing medical errors.

**UNIT I INTRODUCTION 9**

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System with patient safety.

**UNIT II MEDICAL TECHNOLOGY MANAGEMENT PRACTICES 9**

Strategic Medical Technology Planning, Scope, Strategic planning process – Technology assessment: Technology audit, Budget strategies, Prerequisite for medical technology assessment – Management Practice for Medical Equipment - Device evaluation, Risk reduction, Asset management, ESHTA.

**UNIT III ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP) 9**

Introduction – Health care technology management – Package development: Methodology, Logical framework, Implementation, Information promotion and dissemination – EHTP Justification – EHTP matrix – EHTP advantages.

**UNIT IV CLINICAL ENGINEERING PROGRAM INDICATOR 9**

Clinical engineering: program services, Program database – Clinical Engineering Program management, Program indicator, managing clinical engineering performance using program indicators.

**UNIT V ADVANCED TECHNOLOGY FOR PATIENT SAFETY 9**

Factors Contributing to Medical Errors: Heath Care Reimbursement, Health Care Failure Mode and Effect Analysis (HFMEA), Patient Safety Best Practices Model: Bar coding, Computerized Physician Order Entry (CPOE), and Clinical data repositories – Process analysis, Methodology. Computerized medical equipment management systems.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the basics and importance of clinical engineering in healthcare.

**CO2:** Apply methods for planning, evaluation, and management of medical equipment.

**CO3:** Analyze the development and benefits of Essential Health Care Technology Packages (EHTP).

**CO4:** Understand clinical engineering performance indicators and healthcare technology management.

**CO5:** Evaluate advanced technologies used for patient safety and reduction of medical errors.

**TEXT BOOKS:**

1. Ernesto Iadanza, Joseph Dyro, "Clinical Engineering Handbook", Elsevier Academic Press, 2014
2. Robert Miniati, "Clinical Engineering from Devices to Systems", Academic Press, 23-Dec2015 - Technology & Engineering

**REFERENCES:**

1. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, 4th Edition, Pearson Education, 2001.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | | | | | | | 3 | 3 | |
| **CO2** | 3 | 3 | | | 2 | 2 | 2 | 2 | | | | 3 | 3 | |
| **CO3** | 3 | 2 | | | 2 | 2 | 2 | | | 2 | | 2 | 2 | |
| **CO4** | 3 | 3 | 2 | | 2 | | 2 | 2 | | 2 | | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | | 3 | 2 | 3 | | | 3 | | 2 | 2 | 3 |
| **Avg** | **3.00** | **2.60** | **2.50** | | **2.20** | **2.00** | **2.25** | **2.00** | | **2.33** | | **2.40** | **2.40** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL I - MANAGEMENT (HEALTHCARE)**
**(B.E - BME)**

| BM24P02 | HOSPITAL PLANNING AND MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of hospital administration and planning.
- Studying the human resource management practices in hospitals.
- Learning the marketing research and consumer behavior in healthcare services.
- Understanding the hospital information systems and supportive services.
- Exploring the quality standards, safety measures, and accreditation systems in hospitals.

**UNIT I OVERVIEW OF HOSPITAL ADMINISTRATION 9**

Difference between hospital and industry, Challenges in hospital administration, Hospital planning and functional planning, Equipment planning and AMC (Annual Maintenance Contract), Current issues in hospital management, Introduction to telemedicine, Biomedical waste management and disposal methods

**UNIT II HUMAN RESOURCE MANAGEMENT IN HOSPITAL 9**

Principles and functions of Human Resource Management (HRM), Role of HR manager in hospitals, Human Resource Development (HRD) tools, Human resource inventory and manpower planning, Departments in a hospital, Recruitment and selection process, Staff training methods and evaluation, Leadership development, promotion and transfer policies.

**UNIT III MARKETING RESEARCH & CONSUMER BEHAVIOUR 9**

Marketing information systems, Assessing and sharing information, Market research process, Consumer markets and buyer behavior, Types of buying decisions, Buyer decision-making process, Business buyer behavior, Buying situations in healthcare sector, Global marketing in medical sector, WTO and its impact on healthcare marketing.

**UNIT IV HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES 9**

Management decisions and information needs, Clinical information systems, administrative information systems, technical support information systems, medical transcription and medical records department, Central Sterilization and Supply Department (CSSD), Pharmacy services, Food and laundry services in hospitals.

**UNIT V QUALITY AND SAFETY ASPECTS IN HOSPITAL 9**

Quality systems and implementation, Documentation and quality auditing, ISO standards: ISO 9000, ISO 9001, ISO 14000, ISO 13485, Environment Management Systems, Accreditation bodies: NABH, NABL, NABA, JCI, Hospital security and loss prevention, Fire safety and alarm systems, Safety rules in hospitals, Health insurance and healthcare management, medical audit, Hazard and safety management in hospitals.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the functions and challenges of hospital administration.

**CO2:** Describe HR management and staff training methods in hospitals.

**CO3:** Understand marketing research and consumer behavior in healthcare.

**CO4:** Explain hospital information systems and support services.

**CO5:** Apply quality standards and safety practices in hospital management.

**TEXT BOOKS:**


1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI–4th Edition,2006.
2. Cesar A.Caceres and Albert Zara, "The Practice of Clinical Engineering", Academic Press, New York,1977
3. G.D.Kunders, "Hospitals – Facilities Planning and Management", TMH, New Delhi – 5th edition Reprint 2007.


**REFERENCES:**


1. Peter Berman, "Health Sector Reform in Developing Countries", Harvard University Press, 1995.
2. Norman Metzger, "Handbook of Health Care Human Resources Management", Aspen Publication Inc. Rockville, Maryland, USA, 2nd Edition 1990.
3. Arnold D. Kalcizony & Stephen M.Shortell, "Health Care Management", 6th Edition, 2011.
4. Blane, David, Brunner, Eric, "Health and Social organization: Towards a health policy for the 21st century", Calrendon Press, 1994.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | | | | | | 2 | 2 | 3 | |
| **CO2** | 3 | 3 | 2 | | 3 | 2 | 2 | 2 | | 2 | 2 | 2 | 3 | |
| **CO3** | 2 | 3 | 2 | | 3 | | 2 | 2 | | 2 | 2 | | 3 | 2 |
| **CO4** | 2 | 2 | 3 | | 3 | | 2 | 2 | | 3 | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | | 2 | 2 | | | | 3 | 3 | 3 | 2 | 2 |
| **Avg** | **2.60** | **2.40** | **2.25** | | **2.60** | **2.00** | **2.00** | **2.00** | | **2.50** | **2.20** | **2.25** | **2.60** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL I - MANAGEMENT (HEALTHCARE)**
**(B.E - BME)**

| BM24P03 | MEDICAL WASTE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the healthcare hazards and accident prevention methods.
- Studying the biomedical waste management and safe disposal methods.
- Learning the hazardous materials and safety regulations in healthcare.
- Exploring the facility safety measures in hospitals and healthcare centers.
- Analyzing the infection control practices and patient safety methods.

**UNIT I HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS 9**

Introduction to healthcare hazards, Hazard control and safety management, Roles and responsibilities in hazard control, Personal Protective Equipment (PPE), System safety and ergonomics, Accident causes and theories, Human factors in accidents, Accident reporting and investigation, Accident prevention and worker training.

**UNIT II BIOMEDICAL WASTE MANAGEMENT 9**

Introduction to biomedical waste, Types of biomedical waste, Sources of biomedical waste, Classification of biomedical waste, Hazards of biomedical waste, Importance of waste disposal, Waste minimization methods, segregation, labeling, handling, collection, Storage and transportation of waste, Biomedical waste treatment methods and waste disposal techniques.

**UNIT III HAZARDOUS MATERIALS 9**

Introduction to hazardous materials, Hazardous substance safety, OSHA hazard communication standards, DOT hazardous material regulations, Hazardous materials in healthcare, medical gas systems safety, Hazardous waste operations, Emergency response procedures, Respiratory protection methods.

**UNIT IV FACILITY SAFETY 9**

Basics of facility safety, Facility safety guidelines, administrative area safety, Slip, trip, and fall prevention, Safety signs and color codes, Scaffolding safety, fall protection methods, Tool safety practices, Machine guarding techniques, Compressed air safety, Electrical safety measures, Hazardous energy control, Confined space safety, Hearing conservation methods, HVAC system safety, Indoor air quality assessment, Landscape and grounds safety, Fleet and vehicle safety.

**UNIT V INFECTION CONTROL, PREVENTION AND PATIENT SAFETY 9**

Healthcare immunization practices, Role of CDC in infection control, Disinfectants and antiseptics, Sterilization methods, OSHA bloodborne pathogen standards, Tuberculosis prevention, Opportunistic infections in healthcare, medical waste management, Basics of patient safety, medical errors and adverse events, Safety culture in hospitals, Patient-centered healthcare, Quality improvement strategies, Healthcare-associated infections, Medication safety practices

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain healthcare hazards and accident prevention techniques.

**CO2:** Describe biomedical waste management and disposal methods.

**CO3:** Understand hazardous materials handling and safety regulations.

**CO4:** Apply facility safety practices in healthcare environments.

**CO5:** Explain infection control methods and patient safety measures.

**TEXT BOOKS:**


1. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012)
2. Tweedy, James T., Healthcare hazard control and safety management-CRC Press Taylor and Francis (2014).


**REFERENCES:**


1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006
2. V.J. Landrum, "Medical Waste Management and disposal", Elsevier, 1991


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | | 2 | 3 | 2 | | | 2 | | | 3 |
| **CO2** | 2 | 2 | 3 | | | 2 | 2 | 2 | | | 2 | | | |
| **CO3** | 2 | 2 | 3 | | | 2 | 2 | 2 | | | 2 | | | |
| **CO4** | 3 | 2 | 3 | 2 | | 2 | 2 | 2 | | | 2 | | | 3 |
| **CO5** | 3 | 2 | 3 | 3 | | 2 | 3 | 3 | | | 2 | | | 3 |
| **Avg** | **2.40** | **2.00** | **3.00** | **2.67** | | **2.00** | **2.40** | **2.20** | | | **2.00** | | | **1.80** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL I – MANAGEMENT (HEALTHCARE)**
**(B.E - BME)**

| BM24P04 | ECONOMICS AND MANAGEMENT FOR ENGINEERS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamental economic principles.
- Studying the fundamental economic concepts of demand and supply.
- Learning the production processes and cost analysis.
- Understanding the basics of management and managerial functions.
- Exploring the fundamentals of Organizational Behavior.

**UNIT I INTRODUCTION TO ECONOMICS 9**

Introduction to Economics, Scope of Economics, Positive and Normative Science, Methodology of Economics, Economic Laws, Economy and its basic problems: Economy and its working, Kinds of economy systems, Basic problems of economy.

**UNIT II DEMAND AND SUPPLY ANALYSIS 9**

Introduction to Demand and Supply, Law of Demand and Determinants of Demand, Elasticity of Demand, Law of Supply and Determinants of Supply, Elasticity of Supply, Market Equilibrium, Applications of Demand and Supply Analysis.

**UNIT III 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 IV PRINCIPLES AND FUNCTIONS OF MANAGEMENT 9**

Introduction to Management: Definition, nature, and scope Functions of Management: Planning, Organizing, Leading, Controlling (POLC)Levels of Management and Managerial Roles (Mintzberg)Scientific Management and Administrative Management (Taylor &Fayol) Decision-Making Process in Management Skills for Engineers: Technical, human, and conceptual Application of Management in Engineering Projects and Organizations

**UNIT V ORGANIZATIONAL BEHAVIOR AND LEADERSHIP 9**

Introduction to Organizational Behavior (OB), Individual Behavior in Organizations: Personality, perception, attitudes, and motivation, Motivation Theories: Maslow's Hierarchy of Needs, Herzberg's Two-Factor Theory, McGregor's Theory X and Y, Leadership in Engineering Teams: Traits, styles, and approaches (Transformational, Transactional), Teamwork and Group Dynamics, Conflict Management and Negotiation Skills, Organizational Culture and Change Management

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain economic principles and laws used in engineering problems.

**CO2:** Analyze demand, supply, and elasticity concepts for market analysis.

**CO3:** Interpret short-run and long-run cost concepts in production systems.

**CO4:** Apply managerial skills for decision-making and problem-solving in organizations.

**CO5:** Analyze organizational behavior, motivation, and leadership theories.

**TEXT BOOKS:**


1. D.N.Dwivedi, "Principles of Economics", Second Edition, Vikas Publishing House (P) Limited, New Delhi, 2012.
2. J.S.Chandan, "Management Concepts and Strategies", Vikas Publishing House (P) Limited, New Delhi, 2003.


**REFERENCES:**


1. RanbirSingh,"Principles of Engineering Economics and Management", S.K.Kataria& Sons, New Delhi, 2013.
2. Manish Varshney and VidhanBanerjee,"Engineering and Managerial Economics",First Edition, CBS Publishers and Distributors Pvt. Ltd., 2015.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | 3 | | | | 2 | | | | 2 | 2 | 2 | |
| **CO2** | 3 | | 2 | 2 | | | 3 | | | | 3 | 2 | 2 | |
| **CO3** | 3 | | 3 | 2 | | | 3 | | | 2 | 3 | 2 | 3 | |
| **CO4** | 3 | | 2 | | | | 3 | | | 2 | 2 | 2 | 3 | |
| **CO5** | 3 | | 2 | 2 | | | 3 | | | 2 | 3 | 3 | 3 | |
| **Avg** | **3.00** | | **2.40** | **2.00** | | | **2.80** | | | **2.00** | **2.60** | **2.20** | **2.60** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL I - MANAGEMENT (HEALTHCARE)**
**(B.E - BME)**

| BM24P05 | BIOSTATISTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic concepts of statistics and probability.
- Studying the statistical parameters and hypothesis testing methods.
- Learning the regression and correlation analysis techniques.
- Understanding the interpretation of medical and epidemiological data.
- Exploring the analysis of variance and META analysis methods.

**UNIT I INTRODUCTION 9**

Introduction, Some basic concepts, Measurement and Measurement Scales, Simple random sample, Computers and medical data analysis, Introduction to probability, likelihood & odds, distribution variability.

**UNIT II STATISTICAL PARAMETERS 9**

Statistical parameters p-values, computation, level chi square test and distribution and hypothesis testing - single population proportion, difference between two population proportions, single population variance, ratio of two population variances and tests of goodness of fit, tests of independence, tests of homogeneity.

**UNIT III REGRESSION AND CORRELATION ANALYSIS 9**

Introduction, regression model, sample regression equation, evaluating the regression equation, using the regression equation, correlation model, correlation coefficient.

**UNIT IV INTERPRETING DATA 9**

Interpreting life tables clinical trials, epidemical reading and interpreting of epidemical studies, application in community health.

**UNIT V ANALYSIS OF VARIANCE 9**

META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis, completely randomized design, randomized complete block design, repeated measures design, factorial experiment.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain basic statistical concepts and data analysis methods.

**CO2:** Apply hypothesis testing and chi-square tests for data analysis.

**CO3:** Analyze relationships using regression and correlation techniques.

**CO4:** Interpret clinical, epidemiological, and community health data.

**CO5:** Use ANOVA and META analysis in research studies.

**TEXT BOOKS:**

1. Wayne W. Daniel, Biostatistics-A Foundation for Analysis in the Health Sciences, John Wiley & Sons Publication, 10th Edition, 2013.
2. Peter Armotage, Geoffrey Berry and J.N.S.Mathews, Statistical methods in Medical Research, Wiley-Blackwell, 4th Edition, 2001.
3. Bernard Rosner. Fundamentals of biostatistics. Nelson Education, 8th Edition 2015 ISBN: 978-1-305-26892-0
4. Editors: Chandan K. Reddy, Charu C. Agarwal, Healthcare Data Analytics, CRC Press,

**REFERENCES:**

1. Marcello Pagano and Kimberlee Gauvreu, Principles of Biostatistics, Chapman and Hall/CRC, 2ndEdition, 2018.
2. Ronald N Forthofer and EunSul Lee, Introduction to Biostatistics, Academic Press, 1st Edition, 2014.
3. Animesh K. Dutta, Basic Biostatistics and its Applications, New Central Book Agency, 1st Edition, 2006.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | | | 3 | | 2 | 2 | | 2 | 2 | | 2 |
| **CO2** | 2 | 3 | | | | 3 | | 3 | 2 | | 3 | 3 | | 2 |
| **CO3** | 3 | 3 | | | | 3 | | 3 | 3 | 2 | 3 | 2 | | 3 |
| **CO4** | 3 | 3 | | | | 3 | | 3 | 3 | 2 | 3 | 3 | | 3 |
| **CO5** | 2 | 2 | | | | 3 | | 2 | 2 | 2 | 3 | 2 | | 3 |
| **Avg** | **2.40** | **2.60** | | | | **3.00** | | **2.60** | **2.40** | **2.00** | **2.80** | **2.40** | | **2.60** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL I - MANAGEMENT (HEALTHCARE)**
**(B.E - BME)**

| BM24P06 | FORENSIC SCIENCE IN HEALTHCARE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals, history, and development of Forensic Science.
- Studying the crime scene observation, evidence collection, and documentation techniques.
- Learning the forensic microscopes, anthropology, and skeletal analysis methods.
- Understanding the blood stain identification, DNA analysis, and wildlife forensic applications.
- Exploring the knowledge about fingerprint analysis, classification, and forensic identification systems.

**UNIT I BASICS OF FORENSIC SCIENCE 9**

Forensic science, Introduction to the Forensic Sciences, History and Development of Forensic Science, Deductive Reasoning, Organization of a Crime Laboratory Case Studies: The Enrique Camarena Case. A Forensic Nightmare Organization of forensic science laboratories of center and state -NCRA AND NICFS, fundamental rights, criminal profiling, concept of quality control management in forensic institutions.

**UNIT II OBSERVATION AND CRIME SCENE 9**

Observational Skills - Sherlock Holmes and Deductive Reasoning - Observations by Witnesses. Case Studies. The Crime Scene -Locard's Exchange Principle, Securing and Recording the Crime Scene, Legal Considerations at the Crime Scene, Evidence Collection and Recordation Techniques. Mock Crime Scene: Processing and Documenting a Crime Scene.

**UNIT III FORENSIC MICROSCOPE AND ANTHROPOLOGY 9**

Forensic Use of the Microscope -The Compound, Comparison, and Stereoscopic Microscope, The Scanning Electron Microscope (SEM). Forensic Anthropology- Introduction, Human Anatomy–The Skeletal System, Skeletal Determination of Demographic Data from Skeletal Remains, Determining Types of Trauma and Disease from Skeletal Remains, Case Studies.

**UNIT IV BLOOD STAIN IDENTIFICATION 9**

Detection and identification of Blood stains, Determination of species of origin, Blood Group systems, Techniques of Determination of Blood groups of Blood stains, Determination of seminal and other fluids and their Blood Grouping, DNA, DNA Phenotyping and RNA Profiling & their applications. Wildlife forensics.

**UNIT V FINGERPRINT APPLICATION 9**

Fingerprints -Fundamental Principles of Fingerprint Analysis, Classification of Fingerprints, Collection of Fingerprint Evidence, Automated Fingerprint Identification Systems (AFIS), Track marks, Case Studies.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the basic principles, laboratory organization, and applications of Forensic Science.

**CO2:** Apply observational and deductive reasoning skills in crime scene investigation and evidence handling.

**CO3:** Describe the use of forensic microscopes and skeletal analysis in identifying human remains and injuries.

**CO4:** Analyze blood stains, body fluids, DNA, and biological evidence using forensic techniques.

**CO5:** Identify, classify, and compare fingerprints and track marks using modern forensic methods such as AFIS.

**TEXT BOOKS:**


1. Nanda, B.B. and Tewari, R.K. (2001) Forensic Science in India: A vision for the twenty first century Select Publisher, New Delhi.
2. James, S.H and Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press,


**REFERENCES:**


1. Saferstein : Criminalistics (1976) Prentice Hall Inc., USA.
2. Deforest, Gansellen & Lee : Introduction to Criminalistics.
3. Sharma, B.R. (1974) Forensic Science in Criminal Investigation and Trials, Central Law Agency, Allahabad, 1974


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | | 3 | | 2 | 2 | | 2 | 2 | | |
| **CO2** | 2 | 3 | 3 | | | 3 | | 3 | 2 | | 3 | 3 | | |
| **CO3** | 3 | 3 | 2 | | 2 | 3 | | 3 | 3 | 2 | 3 | 2 | | |
| **CO4** | 3 | 3 | 3 | | 2 | 3 | | 3 | 3 | 2 | 3 | 3 | | |
| **CO5** | 2 | 2 | 2 | | 2 | 3 | | 2 | 2 | 2 | 3 | 2 | | |
| **Avg** | **2.40** | **2.60** | **2.40** | | **2.00** | **3.00** | | **2.60** | **2.40** | **2.00** | **2.80** | **2.40** | | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL II - SENSOR SYSTEM TECHNOLOGY**
**(B.E - BME)**

| BM24P07 | COMMUNICATION SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the analog modulation techniques.
- Analyzing the receiver characteristics and noise.
- Learning the information theory and source coding.
- Studying the digital bandpass signaling methods.
- Introducing the error control coding techniques.

**UNIT I ANALOG MODULATION 9**

**Amplitude Modulation Techniques** – Study of AM, DSBSC, SSBSC, and VSB generation, characteristics, and applications in communication systems. **Angle Modulation Methods** – Fundamentals and analysis of Phase Modulation (PM) and Frequency Modulation (FM) techniques.

**UNIT II RECEIVER CHARACTERISTICS 9**

Noise sources and types, noise figure, noise temperature, and noise analysis in cascaded systems. Single tuned and superheterodyne receiver architectures and operation.

**UNIT III INFORMATION THEORY 9**

Fundamentals of information theory including measure of information, entropy, source coding theorem, and discrete memoryless channels such as lossless, deterministic, noiseless, BEC, and BSC. Mutual information and channel capacity for analyzing communication efficiency and reliability. Source coding techniques including Shannon–Fano coding, Huffman coding and Run Length coding for efficient data compression.

**UNIT IV BANDPASS SIGNALING 9**

Signal space representation, correlator and matched filter concepts, and maximum likelihood (ML) detection techniques. PSD, and BER analysis of coherent BPSK, BFSK, and QPSK modulation schemes. Principles of QAM and structure of non-coherent receivers for BFSK and DPSK systems.

**UNIT V ERROR CONTROL CODING TECHNIQUES 9**

Channel coding theorem, Linear block codes, Hamming codes, Cyclic codes (CRC), Convolutional codes, Viterbi decoding (Soft/Hard decision decoding).

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain analog modulation techniques and their communication applications.

**CO2:** Analyze receiver characteristics, noise effects, and receiver applications.

**CO3:** Apply information theory and source coding methods in data communication applications.

**CO4:** Evaluate digital bandpass signaling schemes and their practical applications.

**CO5:** Analyze error control coding techniques and decoding methods.

**TEXT BOOKS:**

1. B.P.Lathi, "Modern Digital and Analog Communication Systems'', Oxford University Press, 3rd Edition, 2007
2. H Taub, D L Schilling, G Saha, "Principles of Communication Systems", TMH, 3rd Edition, 2007
3. 3. S. Haykin , "Digital Communications", John Wiley, 2005

**REFERENCES:**

1. H P Hsu, Schaum "Outline Series, Analog and Digital Communications", TMH, 2006
2. B.Sklar, "Digital Communications Fundamentals and Applications", Pearson Education, 2nd Edition, 2007.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | | | | | | | | 3 | |
| **CO2** | 3 | 3 | | 2 | 2 | 2 | | | 2 | | | | 3 | |
| **CO3** | 3 | 2 | | 2 | 2 | 2 | | | | | 2 | | 2 | |
| **CO4** | 3 | 3 | 2 | 2 | 2 | | | | 2 | | 2 | | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | | 2 | 3 |
| **Avg** | **3.00** | **2.60** | **2.50** | **2.25** | **2.20** | **2.00** | | | **2.00** | | **2.33** | | **2.40** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL II - SENSOR SYSTEM TECHNOLOGY**
**BM24P08 (Common to B.E - BME, ECE)**
**BM24903 (Common to B. Tech - AI&DS, IT, B.E - CSE, EEE)**

| BM24P08 / BM24903 | WEARABLE DEVICES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of wearable systems and sensors.
- Studying the signal processing and energy harvesting methods for wearable devices.
- Learning the wireless health monitoring systems and body area networks.
- Understanding the smart textile technologies and fabrication techniques.
- Exploring the medical and healthcare applications of wearable systems.

**UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9**

Introduction to wearable systems, need, applications, types, and components of wearable monitoring systems. Sensors for wearable systems including inertia movement sensors, respiration activity sensors, inductive and impedance plethysmography, pneumography, and wearable ground reaction force sensors.

**UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING 9**

Wearability issues, sensor placement, signal acquisition, sampling techniques, and rejection of irrelevant information. Energy harvesting methods: solar, vibration-based, thermal-based systems, hybrid thermoelectric photovoltaic harvesting, and thermopiles.

**UNIT III WIRELESS HEALTH SYSTEMS 9**

Need for wireless monitoring, body area networks (BAN) in healthcare, and BAN architecture. Technical challenges including system security, reliability, and wireless communication techniques.

**UNIT IV SMART TEXTILE 9**

Introduction to smart textiles: passive and active smart textiles. Fabrication techniques using conductive fibres, treated conductive fibres, conductive fabrics, and conductive inks. Case study on smart fabrics for monitoring biological parameters such as ECG and respiration.

**UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the principles, components, and sensors used in wearable systems.
**CO2:** Analyze signal processing techniques and energy harvesting methods for wearable devices.
**CO3:** Apply wireless communication and body area network concepts in healthcare monitoring applications.
**CO4:** Illustrate the smart textile technologies and fabrication methods for biomedical applications.
**CO5:** Compare the various wearable devices in healthcare system.

**TEXT BOOKS:**

1. B.P.Lathi, "Modern Digital and Analog Communication Systems'', Oxford University Press, 3rd Edition, 2007
2. H Taub, D L Schilling, G Saha, "Principles of Communication Systems", TMH, 3rd Edition, 2007
3. 3. S. Haykin , "Digital Communications", John Wiley, 2005

**REFERENCES:**

1. H P Hsu, Schaum "Outline Series, Analog and Digital Communications", TMH, 2006
2. B.Sklar, "Digital Communications Fundamentals and Applications", Pearson Education, 2nd Edition, 2007.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | | | | | | 2 | 3 | 2 | |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 2 | | | | 2 | 2 | 2 | 3 | 2 |
| **CO3** | 2 | 3 | 2 | 2 | 3 | | | | 2 | 2 | 2 | 2 | 3 | 3 |
| **CO4** | 2 | 2 | 3 | 2 | 3 | | | | 2 | 3 | 2 | 3 | 2 | 2 |
| **CO5** | 3 | 2 | 2 | | 2 | 2 | | | 2 | 3 | 3 | 3 | 3 | 3 |
| **Avg** | **2.60** | **2.40** | **2.25** | **2.00** | **2.60** | **2.00** | | | **2.00** | **2.50** | **2.20** | **2.60** | **2.60** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL II - SENSOR SYSTEM TECHNOLOGY**
**(B.E - BME)**

| EC24P38 | BODY AREA NETWORKS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of body area networks.
- Exploring the sensing and data acquisition in healthcare systems.
- Examining the communication techniques for BAN.
- Understanding the security and reliability issues.
- Applying the BAN concepts in healthcare applications.

**UNIT I BAN FUNDAMENTALS 9**

Introduction to Body Area Networks – Need and applications – Comparison with wireless sensor networks – BAN architecture – Components and design considerations.

**UNIT II BIOSENSORS AND DATA ACQUISITION 9**

Physiological sensors – ECG, EEG, EMG sensors – Wearable sensors – Signal acquisition – Sampling and preprocessing – Noise and artifact reduction.

**UNIT III WIRELESS COMMUNICATION IN BAN 9**

Short-range communication standards – Bluetooth, ZigBee, Wi-Fi – IEEE 802.15.6 – Data transmission techniques – Power-efficient communication..

**UNIT IV SECURITY AND RELIABILITY IN BAN 9**

Security requirements – Data privacy and authentication – Encryption techniques – Reliability issues – Fault tolerance and QoS in healthcare systems.

**UNIT V BAN APPLICATIONS AND ADVANCED SYSTEMS 9**

Healthcare monitoring systems – Remote patient monitoring – Telemedicine – Smart wearable systems – IoT integration – Future trends in BAN..

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the fundamentals and architecture of Body Area Networks (BAN).

**CO2:** Analyze sensing techniques and data acquisition methods in healthcare systems.

**CO3:** Illustrate communication protocols and technologies used in BAN.

**CO4:** Evaluate security, privacy, and reliability issues in BAN systems.

**CO5:** Apply BAN concepts in designing healthcare monitoring applications

**TEXT BOOKS:**

1. Atul Kumar, Shivam Verma, Somak Bhattacharyya (Eds.), Body Area Networks: BODYNETS 2024 Proceedings (Part I & II), Springer Nature, Lecture Notes in Computer Science (LNICST), 2026.
2. Mehmet R. Yuce, Jamil Y. Khan (Eds.), Wireless Body Area Networks: Technology, Implementation and Applications, Springer / Jenny Stanford Publishing, Revised recent editions (2023–2024).
3. Mehmet R. Yuce and Jamil Y. Khan, Wireless Body Area Networks: Technology, Implementation and Applications, Pan Stanford Publishing, 2021.

**REFERENCES:**

1. Springer LNICST Series, Body Area Networks: Smart IoT and Big Data for Healthcare (BODYNETS Proceedings), 2024.
2. IEEE / Elsevier, Wireless Body Area Network: Schemes, Protocols and Security Survey, 2022–2024.
3. Shiban Koul, Richa Bharadwaj, Wearable Antennas and Body Centric Communication, Springer, 2021–2022.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | 2 | 1 | | | | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 2 | 1 | | | | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 2 | 1 | | | | 2 | 2 | 3 | 2 |
| **CO4** | 3 | 2 | 2 | 3 | 2 | 2 | 2 | | | | 2 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 2 | 2 | | | | 2 | 3 | 3 | 2 |
| **Avg** | **3.00** | **2.40** | **2.00** | **2.20** | **2.20** | **2.00** | **1.40** | | | | **2.00** | **2.20** | **2.60** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL II - SENSOR SYSTEM TECHNOLOGY**
**(B.E - BME)**

| BM24P09 | VIRTUAL REALITY AND AUGMENTED REALITY IN HEALTHCARE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals and components of Virtual Reality systems.
- Studying the VR technologies used in healthcare environments and rehabilitation systems.
- Learning the principles, displays, and tracking methods of Augmented Reality systems.
- Exploring the AR technologies and interfaces used in healthcare systems.
- Analyzing the VR and AR case studies in medical training and patient care.

**UNIT I INTRODUCTION TO VIRTUAL REALITY 9**

The three I's of Virtual Reality, commercial VR technologies, and components of VR systems. Input devices - trackers, navigation and manipulation interfaces, gesture interfaces, and three-dimensional position trackers. Output devices - graphics displays, sound displays, and haptic feedback systems.

**UNIT II VIRTUAL REALITY IN HEALTHCARE 9**

Medical training environments, anatomy visualization, surgical simulation techniques, rehabilitation systems, pain management methods, neurological therapy, and mental health treatment using VR technologies.

**UNIT III INTRODUCTION TO AUGMENTED REALITY 9**

Introduction to Augmented Reality, Displays - Multimodal Displays, Visual Perception, Spatial Display Model, Tracking - Tracking, Calibration and Registration, Characteristics of Tracking Technology, Stationary Tracking systems, Sensors.

**UNIT IV AUGMENTED REALITY IN HEALTHCARE 9**

AR technologies in medical visualization, image-guided systems, wearable AR devices, tracking and registration methods, interactive healthcare interfaces, and real-time healthcare information systems.

**UNIT V CASE STUDIES 9**

Case studies on VR-based surgical simulators, AR-assisted surgery, VR rehabilitation systems, smart wearable healthcare devices, and immersive technologies for patient care and medical training.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the principles, components, and interaction devices of Virtual Reality systems.

**CO2:** Examine Virtual Reality technologies used in healthcare.

**CO3:** Illustrate the fundamentals, display technologies, and tracking methods of AR systems.

**CO4:** Interpret Augmented Reality technologies and interfaces used in healthcare applications.

**CO5:** Assess case studies of VR and AR systems in medical training, rehabilitation, and patient care.

**TEXT BOOKS:**


1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc.,2008.
2. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison-Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575
3. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability),Steve Aukstakalnis, Addison-Wesley Professional; 1 edition, 2016.
4. Jason Jerald. 2015. The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.


**REFERENCES:**


1. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, Robert Scoble & Shel Israel, Patrick Brewster Press; 1 edition, 2016.
2. Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, Tony Parisi, O'Reilly Media; 1 edition, 2015.
3. Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages, Tony Parisi, O'Reilly Media; 1 edition, 2014.
4. Learning Three.js: The JavaScript 3D Library for WebGL - Second Edition, Jos Dirksen, Packt Publishing - ebooks Account; 2nd Revised ed. Edition 2015.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | 3 | | | | | | 2 | 2 | 2 | 2 |
| **CO2** | 2 | 3 | 2 | | 3 | 3 | | | 3 | 2 | 2 | 3 | 3 | 2 |
| **CO3** | 2 | 2 | 2 | | 3 | | | | | | 2 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | | | | 2 | 3 | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 2 | 3 | | 2 | 2 | 3 | 3 | 3 | 3 | 2 |
| **Avg** | **2.40** | **2.60** | **2.20** | **3.00** | **2.80** | **3.00** | | | **2.33** | **2.67** | **2.20** | **2.60** | **2.60** | **2.40** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL II - SENSOR SYSTEM TECHNOLOGY**
**(B.E - BME)**

| BM24P10 | MEDICAL DEVICE REGULATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of medical device regulations and regulatory affairs.
- Studying the ISO standards and quality requirements for medical devices.
- Learning the US-FDA, IEC, and European regulatory frameworks for medical devices.
- Understanding the medical device regulatory system and guidelines in India.
- Exploring the regulatory requirements for clinical trials and digital alternatives..

**UNIT I MEDICAL DEVICE REGULATIONS 9**

History and fundamentals of medical device regulation, roles and competencies of regulatory affairs professionals. Medical device classification, risk-based classification, and practical examples of medical devices. Labeling requirements, risk management, clinical evaluation, and intended users of medical devices. Differentiation of medical devices, IVDs, combination products, and pharmaceuticals.

**UNIT II ISO STANDARDS 9**

ISO 13485:2016: Requirements for regulatory purposes: Quality Management Systems, certification process. ISO 14971: Application of Risk management to medical Devices.

**UNIT III IEC, REGULATORY SYSTEMS IN USA & EU 9**

IEC international standards and conformity assessment for medical devices, Good submission process, medical device regulatory system in the USA and European Union.

**UNIT IV INDIAN REGULATORY SYSTEM 9**

India: Medical device regulatory system, regulatory authorities, CDSCO guidelines, and roles of central and state regulatory bodies. Product registration, conformity assessment, quality system regulations, technical documentation, labeling requirements, and recent regulatory updates in India.

**UNIT V CLINICAL TRIALS AND DIGITAL REGULATIONS 9**

Regulatory strategies for medical devices, preclinical and clinical trial design, and FDA-approved devices. Post-market surveillance, digital health regulations, connected care systems, intelligent design control, and in-silico clinical trials.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the basic concepts of medical device regulations.

**CO2:** Examine the ISO standards from a regulatory perspective.

**CO3:** Illustrate the US-FDA, IEC and European regulations.

**CO4:** Describe the regulations in India.

**CO5:** Assess regulatory aspects of clinical trials and digital alternatives.

**TEXT BOOKS:**

1. Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products, 3rd Edition, Taylor & Francis Group, 2021

**REFERENCES:**

1. Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006
2. Medical Device Quality Assurance and Regulatory Compliance by Richard C Fries, CRC Press, 1998.
3. Product Safety in the European Union by GaborCzitan, Attila Gutassy, Ralf Wilde, TUVRheinlandAkademia, 2008.

**ONLINE RESOURCES**

1. Regulatory requirements for medical devices including in vitro diagnostics in India (Version 2.0), IIT Madras, Prof. Arun B.Ramteke, Prof. Aseem Sahu, Prof. Malay Mitra. https://nptel.ac.in/courses/127106136
2. World Health Organization. (2003). Medical device regulations : global overview and guiding principles. World Health Organization. https://apps.who.int/iris/handle/10665/42744
3. FOOD AND DRUG ADMINISTRATION USA, http://www.fda.gov/medicaldevices/deviceregulationandguidance/default.htm

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | | | 2 | 2 | 2 | | 2 | | 2 | 2 | 2 | |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 2 | 3 | | 2 | | 3 | 2 | 2 | |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 3 | 3 | | 2 | 2 | 3 | 2 | 3 | |
| **CO4** | 3 | 2 | 2 | | 2 | 3 | 3 | | 3 | 2 | 2 | 2 | 3 | |
| **CO5** | 3 | 2 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | |
| **Avg** | **3.00** | **2.40** | **2.50** | **2.00** | **2.20** | **2.60** | **2.80** | **2.00** | **2.40** | **2.00** | **2.60** | **2.20** | **2.60** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL II - SENSOR SYSTEM TECHNOLOGY**
**(B.E - BME)**

| BM24P11 | MEDICAL INFORMATICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the structure and functions of hospital information systems.
- Studying the computer applications in medical imaging and automated clinical laboratories.
- Learning the computerized patient record systems and healthcare information management.
- Understanding the decision support systems and artificial intelligence techniques in clinical diagnosis.
- Exploring the virtual reality and telehealth technologies in healthcare applications.

**UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9**

Introduction to Medical Informatics, structure of medical informatics, internet and medicine, and security issues in healthcare information systems. Computer-based medical information retrieval, hospital management and information systems, and functional capabilities of computerized hospital information systems. Overview of Health Informatics, Medical Informatics, and Bioinformatics.

**UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9**

Automated clinical laboratories and automated methods in hematology, cytology, and histology. Intelligent laboratory information systems, computerized ECG, EEG, and EMG systems. Computer-assisted medical imaging techniques including ultrasound, CT, nuclear medicine, radiation therapy planning, and MRI.

**UNIT III COMPUTERISED PATIENT RECORD 9**

Computer-based patient history and human–computer interaction in healthcare systems. Components and functionalities of computerized patient records (CPR), development tools, and intranet-based healthcare systems. Clinical information systems, CPR in radiology, application server providers, and computerized prescription systems.

**UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9**

Artificial neural networks and expert systems in healthcare applications. Computer-assisted decision support systems, production rule systems, and decision analysis in clinical medicine. Computers in critical patient care and assistive technologies for physically challenged individuals.

**UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9**

Virtual Reality applications in medicine, virtual endoscopy, computer-assisted surgery, and surgical simulation. Telemedicine, telesurgery, computer-assisted patient education, healthcare information systems, and computer-assisted instruction in medicine.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the structure and functional capabilities of Hospital Information System.

**CO2:** Describe the need of computers in medical imaging and automated clinical laboratory.

**CO3:** Analyze the functioning of information storage and retrieval in computerized patient record system.

**CO4:** Apply the suitable decision support system for automated clinical diagnosis.

**CO5:** Discuss the application of virtual reality and telehealth technology in medical industry.

**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.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | 3 | | | | 2 | | 2 | 2 | 3 | 2 |
| **CO2** | 2 | 3 | 2 | | 3 | | | | 2 | | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 2 | | 3 | 3 | | | 3 | 2 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | | 3 | | | | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 2 | | 3 | 3 | | | 2 | 2 | 3 | 2 | 3 | 3 |
| **Avg** | **2.40** | **2.60** | **2.20** | | **3.00** | **3.00** | | | **2.40** | **2.00** | **2.80** | **2.40** | **3.00** | **2.60** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL III - ADVANCED SIGNAL PROCESSING**
**(B.E - BME)**

| BM24P12 | BIOSIGNAL ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic biomedical signals such as ECG, EEG, EOG, and EMG.
- Exploring the filtering techniques to remove noise and artifacts in biomedical signals.
- Applying the engineering methods for ECG signal analysis.
- Implementing the engineering techniques for neurological signal analysis.
- Analysing the biomedical signals using advanced processing techniques.

**UNIT I INTRODUCTION TO BIOMEDICAL SIGNALS 9**

Biosignal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrogastrogram (EGG), Electroneurogram (ENG), Event related potentials (ERPs), Phonocardiogram (PCG), Speech signal, Objectives of Biomedical signal analysis, Difficulties in Biomedical signal analysis, Computer-aided diagnosis.

**UNIT II FILTERING FOR REMOVAL OF ARTIFACTS 9**

Time-domain Filters - synchronized averaging, Moving Average Filters, Derivative-based operators to remove low-frequency artifacts. Frequency-domain filters - Removal of High Frequency noise, Removal of low frequency noise, Removal of periodic artifacts, optimal filter- Wiener filter, Adaptive filters for removal of interference.

**UNIT III CARDIOVASCULAR APPLICATIONS 9**

Noise & Artifacts, ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection, Adaptive noise canceling in ECG, – structural features, Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis (PCA and ICA). Segmentation of PCG, intensity patterns, Spectral modeling and analysis of PCG signals.

**UNIT IV NEUROLOGICAL APPLICATIONS 9**

EEG rhythms & waveforms, EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models - Nonlinear modeling of EEG - artifacts in EEG & their characteristics and processing – Nonparametric spectral analysis, Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis - correlation analysis of EEG channels - coherence analysis of EEG channels.

**UNIT V SIGNAL PATTERN ANALYSIS AND RECOGNITION TECHNIQUES 9**

Modeling intramuscular EMG-Intramuscular signal decomposition-Fractal analysis of EMG signals. Statistical analysis of VAG signals. Analysis on amplitude and latency of MEG signals. Analysis of ERP effect. Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network-based classification.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Analyze biomedical signals and their spectral components.
**CO2:** Evaluate filters for biomedical signal processing.
**CO3:** Identify artifacts in ECG signals.
**CO4:** Compute EEG power and correlation spectra.
**CO5:** Develop algorithms for biomedical signal classification.

**TEXT BOOKS:**


1. Rangayyan, "Biomedical Signal Analysis", Wiley 2002.
2. Semmlow, "Biosignal and Biomedical Image Processing", Marcel Dekker, 2004


**REFERENCES:**


1. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida 1999.
2. D.C.Reddy, "Biomedical Signal Processing: Principles and techniques" , Tata McGraw Hill, New Delhi, 2005
3. Bruce, "Biomedical Signal Processing & Signal Modeling," Wiley, 2001
4. Sörnmo, "Bioelectrical Signal Processing in Cardiac & Neurological Applications", Elsevier 2005.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 1 | | | | | | 2 | | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 1 | 2 | | | | | | 2 | | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | | | | | 2 | | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | | | | | | 2 | | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | | | | | | 2 | | 3 | 3 |
| **Avg** | **3.00** | **2.80** | **2.40** | **1.80** | **2.00** | | | | | | **2.00** | | **3.00** | **2.60** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL III - ADVANCED SIGNAL PROCESSING**
**(Common to: B.E-BME, CSE, ECE & B.TECH-AI&DS, IT)**

| AD24P04 | COMPUTER VISION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of Computer Vision and image formation.
- Learning the image processing and feature extraction techniques.
- Exploring the object detection and pattern recognition methods.
- Studying the deep learning techniques in Computer Vision.
- Developing the real-world Computer Vision applications.

**UNIT I INTRODUCTION TO COMPUTER VISION 9**

Introduction to Computer Vision – Human vision vs computer vision – Digital image fundamentals – Image acquisition and representation – Image transformations – Color models – Image enhancement techniques – Applications of Computer Vision in healthcare, surveillance, robotics, and autonomous systems.

**UNIT II IMAGE PROCESSING AND FEATURE EXTRACTION 9**

Image filtering and smoothing – Edge detection techniques – Segmentation methods – Thresholding – Morphological operations – Feature extraction – Corner detection – Texture analysis – Shape representation – Feature descriptors.

**UNIT III OBJECT DETECTION AND PATTERN RECOGNITION 9**

Object detection fundamentals – Template matching – Motion detection – Face detection and recognition – Pattern recognition techniques – Classification methods – Optical Character Recognition (OCR) – Gesture recognition – Performance analysis.

**UNIT IV DEEP LEARNING FOR COMPUTER VISION 9**

Introduction to deep learning in Computer Vision – Convolutional Neural Networks (CNN) – Transfer learning – Object detection models – YOLO and R-CNN concepts – Image classification – Semantic segmentation – Instance segmentation – Real-time vision systems.

**UNIT V ADVANCED COMPUTER VISION APPLICATIONS 9**

3D vision and scene understanding – Image captioning – Video analytics – Autonomous navigation – Medical image analysis – Augmented Reality and Virtual Reality applications – Ethical issues and challenges – Future trends in Computer Vision.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After completion of this course, students will be able to:

**CO1:** Understand the basics of Computer Vision.
**CO2:** Apply image processing techniques.
**CO3:** Use object detection and pattern recognition methods.
**CO4:** Analyze deep learning models in Computer Vision.
**CO5:** Develop Computer Vision applications for real-world problems.

**TEXT BOOKS:**

1. V. Kishore Ayyadevara and Yeshwanth Reddy, "Modern Computer Vision with PyTorch", Packt Publishing, 2020 Edition, 2020.
2. Jagadeesh Kakarla, R. Balasubramanian, Subrahmanyam Murala, Santosh Kumar Vipparthi and Deep Gupta, "Computer Vision and Image Processing", Springer Nature, 2025 Edition, 2025.

**REFERENCES:**


1. Rajalingappaa Shanmugamani, "Deep Learning for Computer Vision", Packt Publishing, 2018 Edition, 2018.
2. Ahmed Fawzy Gad, "Practical Computer Vision Applications Using Deep Learning with CNNs", BPB Publications, 2021 Edition, 2021.
3. Satyabrata Roy, Deepak Sinwar, Nilanjan Dey and Thinagaran Perumal (Eds.), "Innovations in Computational Intelligence and Computer Vision", Springer, 2025 Edition, 2025.
4. Benjamin Planche and Eliot Andres, "Hands-On Computer Vision with TensorFlow 2", BPB Publications, 2020 Edition, 2020.
5. Nilanjan Dey, Amira Ashour and Suvojit Acharjee, "Artificial Intelligence and Computer Vision", Springer, 2021 Edition, 2021.


## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 2 | 1 | | | | | | 2 | 1 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 1 | | | | | | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | 1 | | | | | | 3 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | 1 | | | | | | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | | | | | | 3 | 3 | 3 |
| **Avg** | **3.00** | **2.80** | **2.40** | **2.20** | **2.80** | **1.20** | | | | | | **2.80** | **2.00** | **2.60** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL III - ADVANCED SIGNAL PROCESSING**
**(B.E - BME)**

| BM24P14 | SPEECH AND AUDIO SIGNAL PROCESSING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of speech production and hearing mechanisms.
- Learning the time-frequency analysis concepts in speech signals.
- Studying the audio coding and transform coding techniques.
- Applying the time and frequency domain methods in speech processing.
- Analysing the speech using linear predictive analysis methods.

**UNIT I MECHANICS OF SPEECH AND AUDIO 9**

Introduction - Review of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Absolute Threshold of Hearing - Critical Bands-Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- No simultaneous Masking.

**UNIT II TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS 9**

Introduction -Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters- Tree-Structured QMF and CQF M-band Banks - Cosine Modulated "Pseudo QMF" M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine Transform (MDCT) .

**UNIT III AUDIO CODING AND TRANSFORM CODERS 9**

Lossless Audio Coding-Lossy Audio Coding- ISO-MPEG-1A,2A,2A Advanced, 4AudioCoding - Optimum Coding in the Frequency Domain - Perceptual Transform Coder -Brandenburg-Johnston Hybrid Coder - CNET Coders - Adaptive Spectral Entropy Coding -Differential Perceptual Audio Coder - DFT Noise Substitution - DCT with Vector Quantization -MDCT with Vector Quantization.

**UNIT IV TIME AND FREQUENCY DOMAIN 9**

Time domain parameters of Speech signal – Methods for extracting the parameters: Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods, HOMOMORPHIC SPEECH ANALYSIS: Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders

**UNIT V LINEAR PREDICTIVE ANALYSIS 9**

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Analyze auditory models for audio quality.
**CO2:** Design speech perception models.
**CO3:** Develop speech and audio coding algorithms.
**CO4:** Extract speech signal parameters.
**CO5:** Implement pitch and formant analysis.

**TEXT BOOKS:**


1. Rabiner. L. R and Schaffer. R. W., "Digital Processing of Speech signals", Prentice Hall, 1978
2. Andreas Spanias, Ted Painter, Venkatraman AttiWayne Tomasi, "Audio signal processing and coding", John Wiley & Sons, 2007


**REFERENCES:**


1. Udo Zölzer , Digital Audio Signal Processing, A John Wiley& sons Ltd Publication, Second Edition, 2008.
2. Mark Kahrs, Karlheinz Brandenburg, "Applications of Digital Signal Processing to Audio And Acoustics", kluwer academic publishers new york, boston, dordrecht, london, moscow, 2002.
3. Martin S. Roden, "Analog and Digital Communication System", Prentice Hall of India, 3rd Edition, 2002.
4. Sklar. B, "Digital Communication Fundamentals and Applications" Pearson Education, 2nd Edition, 2007.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 1 | | | | | | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 1 | 2 | | | | | | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | | | | | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | | | | | | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | | | | | | 3 | 3 | 3 | 3 |
| **Avg** | **3.00** | **2.80** | **2.40** | **1.80** | **2.00** | | | | | | **2.20** | **3.00** | **2.60** | **2.40** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL III - ADVANCED SIGNAL PROCESSING**
**(B.E - BME)**

| BM24P15 | RAPID PROTOTYPING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the rapid prototyping fundamentals.
- Learning design and assembling of various parts.
- Studying the UV- and laser-based AM processes.
- Investigating the FDM and sheet lamination.
- Exploring the droplet and beam deposition processes.

**UNIT I INTRODUCTION 9**

Overview –Need -Development of Additive Manufacturing Technology -Principle – AM Process Chain-Classification –Rapid Prototyping-Rapid Tooling –Rapid Manufacturing – Applications-Benefits –Case studies.

**UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9**

Design tools: Data processing -CAD model preparation –Part orientation and support structure generation – Model slicing –Tool path generation-Design for Additive Manufacturing: Concepts and objectives-AM unique capabilities –DFAM for part quality improvement-Customized design and fabrication for medical applications.

**UNIT III PHOTO POLYMERIZATION AND POWDER BED FUSION 9**

Introduction to Photo polymerization: SLA-Photo curable materials –Process -Advantages and Applications. Powder Bed Fusion techniques and principles- SLS-Process description –powder fusion mechanism –Process Parameters – Typical Materials and Application. Electron Beam Melting- Typical Materials and Application**.**

**UNIT IV EXTRUSION BASED SYSTEMS AND SHEET LAMINATION 9**

Introduction to Extrusion Based System: FDM-Basic Principle –Materials –Applications and Limitations – Bio extrusion process and applications- Sheet Lamination Process: LOM-Gluing or Adhesive bonding – Thermal bonding-Applications.

**UNIT V DROPLET AND BEAM DEPOSITION PROCESSES 9**

Droplet formation technologies –Continuous mode –Drop on Demand mode –Three-Dimensional Printing – Advantages and Applications–Bio plotter -Beam Deposition Process: LENS-Process description –Material delivery –Process parameters –Materials –Benefits –Applications.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain fundamentals of Additive Manufacturing (AM).
**CO2:** Design and assemble parts for specific applications.
**CO3:** Describe laser- and UV-based AM processes.
**CO4:** Illustrate FDM and sheet lamination techniques.
**CO5:** Apply AM concepts in design, manufacturing, and mass customization.

**TEXT BOOKS:**


1. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, World Scientific Publishers, Third edition, 2010.
2. Liou L.W. and Liou F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2007.
3. Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and practice, Springer, 2006.


**REFERENCES:**


1. Ian Gibson, David W.Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. Tom Page Design for Additive Manufacturing, LAP Lambert Academic Publishing, 2012.
3. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 2 | 2 | | | | | 2 | 2 | 1 | |
| **CO2** | 2 | 3 | 3 | 2 | 3 | 3 | | | | | 2 | 3 | 2 | |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 3 | | | | | 2 | 3 | 2 | |
| **CO4** | 3 | 2 | 2 | 1 | 2 | 3 | | | | | 2 | 2 | 2 | |
| **CO5** | 3 | 3 | 2 | 2 | 2 | 2 | | | | | 3 | 3 | 3 | |
| **Avg** | **2.80** | **2.40** | **2.00** | **1.60** | **2.20** | **2.60** | | | | | **2.20** | **2.60** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL III - ADVANCED SIGNAL PROCESSING**
**(B.E - BME)**

| BM24P16 | BRAIN COMPUTER INTERFACE AND APPLICATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals and structure of BCI systems
- Studying the various signal acquisition methods
- Extracting linear and nonlinear features from EEG signals.
- Describing the regression and vector quantization techniques.
- Analysing the brain-controlled robotic systems through case studies.

**UNIT I INTRODUCTION TO BCI 9**

Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

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**UNIT II ELECTROPHYSIOLOGICAL SOURCES 9**

Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials-P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.

**UNIT III FEATURE EXTRACTION METHODS 9**

Time/Space Methods for BCI signal analysis– Fourier Transform, PSD – Wavelets – Parametric Methods – AR,MA,ARMA models – PCA – Linear and Non-Linear feature extraction methods.

**UNIT IV FEATURE TRANSLATION METHODS 9**

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization–Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

**UNIT V APPLICATIONS OF BCI 9**

Neuroprosthesis for functional restoration - Functional Electrical Stimulation, Visual Feedback and control mechanism- External device control, Case study: Brain actuated control of mobile Robot.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe BCI systems and applications.
**CO2:** Analyze event-related potentials (ERP) and sensorimotor rhythms (SMR).
**CO3:** Compute BCI signal features.
**CO4:** Design BCI classifier system.
**CO5:** Implement BCI for various applications.

**TEXT BOOKS:**

1. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.

**REFERENCES:**


1. R. Spehlmann, "EEG Primer", Elsevier Biomedical Press, 1981.
2. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida, 1986.
3. Bishop C.M., "Neural Networks for Pattern Recognition", Oxford, Clarendon Press, 1995.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 1 | 2 | | | | | 2 | 3 | 2 | 1 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 3 | | | | | 3 | 3 | 2 | 1 |
| **CO3** | 3 | 3 | 2 | 3 | 2 | 3 | | | | 2 | 3 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 3 | | | | 2 | 2 | 2 | 3 | 3 |
| **CO5** | 2 | 2 | 3 | 2 | 2 | 2 | | | | 2 | 3 | 2 | 3 | 3 |
| **Avg** | **2.80** | **2.40** | **2.20** | **2.00** | **2.00** | **2.60** | | | | **2.00** | **2.60** | **2.60** | **2.60** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL III - ADVANCED SIGNAL PROCESSING**
**(B.E - BME)**

| BM24P17 | BIOMETRIC SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the role of biometrics in modern technology.
- Learning the principles of biometric system design.
- Studying the fingerprint, iris, face, and speech recognition techniques.
- Analysing the performance of biometric systems.
- Exploring the biometric recognition and security techniques.

**UNIT I INTRODUCTION TO BIOMETRICS 9**

Introduction and back ground – biometric technologies – passive biometrics – active biometrics – Biometric characteristics, Biometric applications – Biometric Authentication systems- Taxonomy of Application Environment, Accuracy in Biometric Systems- False match rate- False non match rate-Failure to enroll rate-Derived metrics-Biometrics and Privacy

**UNIT II FINGERPRINT TECHNOLOGY 9**

History of fingerprint pattern recognition - General description of fingerprints- fingerprint sensors, fingerprint enhancement, Feature Extraction- Ridge orientation, ridge frequency, fingerprint matching techniques-correlation based, Minutiae based, Ridge feature based, fingerprint classification, Applications of fingerprints.

**UNIT III FACE RECOGNITION AND HAND GEOMETRY 9**

Introduction to face recognition, face recognition using PCA, LDA, face recognition using shape and texture, face detection in color images, 3D model based face recognition in video images, Neural networks for face recognition, Hand geometry – scanning – Feature Extraction – classification.

**UNIT IV IRIS RECOGNITION 9**

Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization-Daugman and Wilde‘s approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions.

**UNIT V VOICE SCAN AND MULTIMODAL BIOMETRICS 9**

Voice scan, speaker features, short term spectral feature extraction, Mel frequency cepstral coefficients, speaker matching, Gaussian mixture model, NIST speaker Recognition Evaluation Program, Introduction to multimodal biometric system – Integration strategies – Architecture – level of fusion – combination strategy, examples of multimodal biometric systems.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Understand biometric system principles.

**CO2:** Develop fingerprint recognition techniques.

**CO3:** Design face and hand geometry systems.

**CO4:** Implement iris recognition systems.

**CO5:** Formulate speech and multimodal biometric systems.

**TEXT BOOKS:**


1. James Wayman& Anil Jain, "Biometric Systems- Technology Design and Performance Evaluation", SPRINGER (SIE), 1st Edition, 2011
2. Paul Reid, "Biometrics for Network Security", Pearson Education, 2004
3. S.Y. Kung, S.H. Lin, M.W., "Biometric Authentication: A Machine Learning Approach", Prentice Hall, 2004


**REFERENCES:**


1. Nalini K Ratha, Ruud Bolle, "Automatic fingerprint recognition system'', Springer, 2003.
2. L C Jain, I Hayashi, S B Lee, U Halici, "Intelligent Biometric Techniques in Fingerprint and Face Recognition", CRC Press, 1st Edition, 1999.
3. John Chirillo, Scott Blaul, "Implementing Biometric Security", John Wiley & Sons, 2003


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | 3 | | | | 2 | | 2 | 2 | 3 | 2 |
| **CO2** | 2 | 3 | 2 | | 3 | | | | 2 | | 3 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | | | | 3 | 2 | 3 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | | 3 | | | | 3 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 2 | 2 | 2 | 3 | 3 | | | | 2 | 2 | 3 | 2 | 3 | 3 |
| **Avg** | **2.40** | **2.60** | **2.20** | **3.00** | **3.00** | | | | **2.40** | **2.00** | **2.80** | **2.40** | **3.00** | **2.60** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL IV - IMAGE PROCESSING AND BIO ENGINEERING**
**(B.E - BME)**

| BM24P18 | EMBEDDED SYSTEMS AND IoMT | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 2 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals, architecture, and design process of embedded systems.
- Exploring the peripheral interfacing techniques with embedded microcontrollers.
- Applying the software development tools and programming methods for embedded systems.
- Implementing the IoT systems using various hardware and software building blocks.
- Analysing the IoMT infrastructure and healthcare applications of embedded and IoT systems.

**UNIT I INTRODUCTION TO EMBEDDED SYSTEM DESIGN 6**

Introduction to embedded processors, Design Process, Introduction to Computer Architectures - Harvard, Von Neuman architectures, CISC & RISC Architectures, Memory Devices and their Characteristics - RAM, EEPROM, Flash Memory.

**UNIT II PERIPHERAL INTERFACING 6**

I/O Devices - Timers and Counters, Memory Interfacing - Direct Memory Access, Interfacing Protocols - Serial Peripheral Interface (SPI), Inter Integrated Circuit (I2C), Universal Serial Bus (USB), Controller Area Network (CAN), Ethernet/Wi-Fi (802.11), Bluetooth.

**UNIT III EMBEDDED SYSTEM SOFTWARE DESIGN 6**

Application Software, System Software, Design techniques, Model-based system engineering (MBSE), Integrated Development Environment tools – Editor, Compiler, Linker, Automatic Code Generators, Debugger, Board Support Library, Chip Support Library.

**UNIT IV DESIGN AND DEVELOPMENT OF IOT 6**

Definition and characteristics of IoT, Physical design of IoT - Things/Devices & Protocols, System building blocks - Sensors, Processors, Gateways, Applications and Database, Cybersecurity - vulnerability, penetration & Encryption technologies.

**UNIT V INTERNET OF MEDICAL THINGS 6**

Healthcare Monitoring system through Cyber-physical system, An loT Model for Neuro sensors, 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.

**TOTAL PERIODS: 30**

**LIST OF EXPERIMENTS**

1. Write Basic and arithmetic Programs Using Embedded C.
2. To interface LED with Aurdino and write an embedded C program to turn on / off LED with specified delay.
3. To interface Buzzer with Aurdino and write an embedded C program to turn on / off Buzzer with specified delay.
4. To interface DC/stepper motor using relay with Aurdino and write an embedded C program to turn on motor.

5. Develop simple application for testing infrared sensor using Aurdino.
6. Develop simple application to interface DHT11 sensor with Aurdino and write a program to display temperature humidity readings in LCD.
7. Develop IoMT Application using Aurdino and sensors such as temperature, ECG, Pulse etc.

**TOTAL PERIODS: 30**

**TOTAL PERIODS: 60**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe the embedded system design process and architectures.

**CO2:** Utilize the different peripheral interfacing devices with embedded microcontrollers.

**CO3:** Analyze the software design tools and embedded system design programming.

**CO4:** Implement the simple IoT systems using different building blocks.

**CO5:** Evaluate IoMT infrastructure for healthcare applications.

**TEXT BOOKS:**


1. Embedded Systems – A Contemporary Design Tool, James K Peckol, , John Weily, 2008, ISBN: 0-444-51616-6
2. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “loT Fundamentals: Networking Technologies, Protocols and Use Cases for lnternet of Things, Cisco Press, 2017.


**REFERENCES:**


1. Introduction to Embedded Systems, Shibu K V, Tata McGraw Hill Education Private Limited, 2009, ISBN: 10: 0070678790 3.
2. Embedded Software Primer, David E.Simon, ,Addison Wesley, ISBN-13: 978-0201615692
3. The Intel Microprocessors, Architecture, Programming and Interfacing” Barry B.Brey, 6th Edition, Pearson Education.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | | 2 | | | | | 3 | 2 | 3 | 3 |
| **CO2** | 2 | 3 | 2 | 2 | | 2 | | | | | 3 | 2 | 2 | 3 |
| **CO3** | 3 | 2 | 3 | 3 | | | | | | 2 | | 3 | 2 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | 2 | | | | | | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 2 | 3 | | | | | | | | 3 | 3 | 2 |
| **Avg** | **2.60** | **2.40** | **2.40** | **2.60** | **3.00** | **2.00** | | | | **2.00** | **3.00** | **2.60** | **2.60** | **2.60** |

**1 - Low, 2 - Medium, 3 – High**

## LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

| Sl. No. | Description of Equipment | Required numbers |
|---|---|---|
| 1 | Arduino board | 10 |
| 2 | WiFi module | 05 |
| 3 | DHT 11 sensors | 01 |
| 4 | Temperature sensor | 03 |
| 5 | ECG sensor | 03 |
| 6 | Infrared sensor | 03 |
| 7 | DC/Stepper motor | 10 Nos |
| 8 | Pulse sensor | 10 Nos |
| 9 | Buzzer | 1 No |
| 10 | Bread Board | 5 Nos |
| 11 | Personal System | 30 |
| 12 | Arduino Software (Open Source) | 10 |

**VERTICAL IV - IMAGE PROCESSING AND BIO ENGINEERING**
**(B.E - BME)**

| BM24P19 | TELEHEALTH TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 2 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals, benefits, and limitations of telemedicine systems.
- Learning the communication technologies and infrastructure used in telemedicine applications.
- Studying the ethical, legal, privacy, and security aspects of telemedicine practice.
- Applying the architecture and functioning of Picture Archiving and Communication Systems.
- Analysing the telemedicine applications in various medical specialties and healthcare service.

**UNIT I FUNDAMENTALS OF TELEMEDICINE 6**

History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.

**UNIT II TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE 6**

Audio, video, still images, text and data, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.

**UNIT III ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE 6**

Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues.

**UNIT IV PICTURE ARCHIVING AND COMMUNICATION SYSTEM 6**

Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.

**UNIT V APPLICATIONS OF TELEMEDICINE 6**

Teleradiology, telepathology, telecardiology, tele oncology, tele dermatology, telesurgery.

**TOTAL PERIODS: 30**

**LIST OF EXPERIMENTS:**

1. Porting sensor data on mobile devices
2. IoT for healthcare monitoring
3. Porting medical data on cloud platform
4. Cloud computing applications in health informatics
5. Study of telemedicine tools
6. Design of an application for mobile devices

**TOTAL PERIODS: 30**

**TOTAL PERIODS: 60**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the fundamentals, benefits and limitations of telemedicine.

**CO2:** Describe the types of communication technologies and infrastructure used in telemedicine

**CO3:** Evaluate the ethical, legal, and privacy issues in telemedicine practice.

**CO4:** Illustrate the architecture and technical functioning of PACS

**CO5:** Interpret practical applications of telemedicine in various medical specialties.

**TEXT BOOKS:**


1. Olga Ferrer Roca, Marcelo Sosa Iudicissa, "Handbook of Telemedicine", IOS Press, Netherland, 3. 2002
2. Khandpur R S, "TELEMEDICINE – Technology and Applications", PHI Learning Pvt Ltd., New Delhi, 2017.
3. Norris A C, "Essentials of Telemedicine and Telecare", John Wiley, New York, 2002


**REFERENCES:**


1. H K Huang, "PACS and Imaging Informatics: Basic Principles and Applications" Wiley, New Jersey, 2010.
2. Khandpur R S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003
3. Keith J Dreyer, Amit Mehta, James H Thrall, "Pacs: A Guide to the Digital Revolution", Springer, New York, 2002.
4. Garrett Grolemund, Hands–On Programming with R, O'Reilly, 1 edition, 2014.
5. Michael Dawson, Python Programming for the Absolute Beginner, Course Technology, 3rd edition ,2010
6. Magesh Jayakumar, Arduino and Android Using Mit App Inventor, Create space Independent Publishing Platform , 1.0 edition ,2016


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | 2 | | | 2 | | 3 |
| **CO2** | 3 | | 3 | | 3 | | | | 3 | | 3 | 2 | 2 | 3 |
| **CO3** | 2 | | 3 | | 3 | | 3 | | 3 | | 3 | 2 | 2 | 3 |
| **CO4** | 3 | | 3 | | 3 | | 3 | | 3 | 3 | 3 | 2 | 2 | 3 |
| **CO5** | 2 | | 3 | | 3 | | 3 | | 3 | 3 | 3 | 2 | 2 | 3 |
| **Avg** | **2.60** | | **3.00** | | **3.00** | | **3.00** | | **2.80** | **3.00** | **3.00** | **2.00** | **2.00** | **3.00** |

**1 - Low, 2 - Medium, 3 - High**

## LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

| Sl. No. | Description of Equipment | Required numbers |
|---|---|---|
| 1 | Arduino board | 10 |
| 2 | WiFi module | 05 |
| 3 | DHT 11 sensors | 01 |
| 4 | Temperature sensor | 03 |
| 5 | ECG sensor | 03 |
| 6 | Infrared sensor | 03 |
| 7 | Pulse sensor | 10 Nos |
| 8 | Bread Board | 5 Nos |
| 9 | Personal System | 30 |
| 10 | Arduino Software (Open Source) | 10 |

**VERTICAL IV - IMAGE PROCESSING AND BIO ENGINEERING**
**(B.E - BME)**

| BM24P20 | MEDICAL DEVICE DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the medical device standards and regulatory requirements.
- Learning the concepts and stages involved in medical device development.
- Studying the engineering design principles and project management metrics for medical devices.
- Investigating the testing, verification, and validation procedures for medical equipment.
- Exploring the design transfer processes and manufacturing methods for medical devices.

**UNIT I 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.

**UNIT II MEDICAL DEVICES STANDARDS AND REQUIREMENTS 9**

Medical devices classification, Medical Devices Directive Process – Harmonized Standards, ISO13485, ISO 14971, IEC60601-1, IEC 62304. Reliability, Concept of failure, Product Design and Development Process.

**UNIT III DESIGN ENGINEERING 9**

Hardware Design, Hardware Risk Analysis, Design and Project Metrics, Design for Six Sigma, Software Design, Software Coding, Software Risk Analysis, Software Metrics.

**UNIT IV TESTING AND VALIDATION 9**

Basis and Types of Testing, Hardware Verification and Data Analysis, Software Verification and Data Analysis.

**UNIT V DESIGN TRANSFER AND MANUFACTURING 9**

Hardware Manufacturing, Software Manufacturing, Configuration Management, Intellectual Property-Copy Rights-Trademarks-Trade Secrets.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should 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.

**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&D Handbook, Second Edition, CRC Press, 2012

**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.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | 1 | 2 | | | 2 | 1 | | 2 | 2 | 1 | |
| **CO2** | 2 | 3 | 3 | 2 | 3 | | | 3 | 3 | | 2 | 3 | 2 | |
| **CO3** | 3 | 2 | 2 | 2 | 2 | | | 2 | 2 | | 2 | 3 | 2 | |
| **CO4** | 3 | 2 | 2 | 1 | 2 | | | 2 | 2 | | 2 | 2 | 2 | |
| **CO5** | 3 | 3 | 2 | 2 | 2 | | | 3 | 2 | | 3 | 3 | 3 | |
| **Avg** | **2.80** | **2.40** | **2.00** | **1.60** | **2.20** | | | **2.40** | **2.00** | | **2.20** | **2.60** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL IV - IMAGE PROCESSING AND BIO ENGINEERING**
**(Common to B.E - BME, ECE)**

| BM24P21 | MEDICAL IMAGING SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the principles and physics of medical imaging systems.
- Learning the major imaging modalities used in diagnosis.
- Studying the concepts of image formation, reconstruction, and processing.
- Investigating the safety issues, artifacts, and system limitations.
- Exploring the AI-based and modern medical imaging techniques.

**UNIT I FUNDAMENTALS OF MEDICAL IMAGING 9**

Medical imaging systems, interaction of radiation with matter, image formation principles, biological effects of radiation, digital image acquisition systems.

**UNIT II X-RAY AND COMPUTED TOMOGRAPHY (CT) 9**

X- ray production and properties, imaging system components, CT principles, CT system architecture, image reconstruction techniques, CT artifacts and image quality improvement.

**UNIT III MAGNETIC RESONANCE IMAGING (MRI) 9**

Nuclear Magnetic Resonance principles, relaxation mechanisms (T1, T2), MRI system components, pulse sequences, MRI image reconstruction, MRI safety and artifacts.

**UNIT IV ULTRASOUND AND NUCLEAR IMAGING 9**

Ultrasound wave propagation in tissues, transducers, Doppler ultrasound, real-time imaging systems, gamma camera, SPECT, PET imaging and applications.

**UNIT V ADVANCED IMAGING AND IMAGE PROCESSING 9**

Medical image processing, enhancement and segmentation techniques, 3D reconstruction, hybrid imaging systems (PET-CT, SPECT-CT), AI in medical imaging, recent trends in biomedical imaging.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain fundamentals of medical imaging systems and radiation physics.
**CO2:** Analyze X-ray and CT imaging systems and reconstruction methods.
**CO3:** Apply MRI principles and understand system operation and safety.
**CO4:** Describe ultrasound and nuclear imaging systems and applications.
**CO5:** Apply image processing and AI techniques in medical imaging.

**TEXT BOOKS:**

1. R.S. Khandpur, Handbook of Biomedical Instrumentation, McGraw Hill, 4th Edition, 2023.
2. S. Webb, The Physics of Medical Imaging, CRC Press, Revised Edition, 2022.
3. William R. Hendee and E. Russell Ritenour, Medical Imaging Physics, 4th Edition, Wiley-Liss.

**REFERENCES:**

1. G. Z. Yang (Ed.), Body Sensor Networks and Medical Imaging Systems, Springer, 2023.
2. J.L. Prince & J. Links, Medical Imaging Signals and Systems, Pearson, 2022 (Reprint).

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | | 1 | | | | 2 | 2 | 2 | |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | 1 | | | | 2 | 2 | 2 | |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 2 | 1 | | | | 2 | 2 | 2 | |
| **CO4** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | | | | 2 | 2 | 2 | |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | | | | 2 | 3 | 3 | |
| **Avg** | **3.00** | **2.40** | **2.20** | **2.00** | **2.20** | **2.00** | **1.40** | | | | **2.00** | **2.20** | **2.20** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL IV - IMAGE PROCESSING AND BIO ENGINEERING**
**(B.E - BME)**

| BM24P22 | ARTIFICIAL ORGANS AND IMPLANTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of artificial organs and transplantation techniques.
- Learning the implant design parameters and methods for developing biomedical implant solutions.
- Studying the characteristics and performance of blood-interfacing implants.
- Investigating the soft tissue and hard tissue replacement techniques and materials.
- Exploring the compatibility and functional performance of artificial organs within living systems.

**UNIT I ARTIFICIAL ORGANS & TRANSPLANTS 9**

Artificial Organs: Introduction, outlook for organ replacements, design, evaluation process. Transplants: Overview, Immunological considerations, Blood transfusions, individual organs -kidney, liver, heart and lung, bone marrow, cornea.

**UNIT II PRINCIPLES OF IMPLANT DESIGN 9**

Principles of implant design, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, cells and regulators criteria for materials selection, Case study of organ regeneration.

**UNIT III IMPLANT DESIGN PARAMETERS AND ITS SOLUTION 9**

Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration.

**UNIT IV BLOOD INTERFACING IMPLANTS 9**

Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood.

**UNIT V IMPLANTABLE MEDICAL DEVICES AND ORGANS 9**

Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Describe adequate knowledge about artificial organs and transplants

**CO2:** Analyze implant design parameters and develop suitable solutions

**CO3:** Evaluate the characteristics and performance of blood-interfacing implants

**CO4:** Explain different types of soft tissue replacement and hard tissue replacement

**CO5:** Examine compatibility and functioning of artificial organs inside the living system

**TEXT BOOKS:**


1. Kopff W.J, Artificial Organs, John Wiley and sons, New York, 1st edition, 1976


**REFERENCES:**


1. J D Bronzino, Biomedical Engineering handbook Volume II, (CRC Press / IEEE Press), 2000.
2. R S Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, 2003
3. Yannas, I. V, "Tissue and Organ Regeneration in Adults", New York, NY: Springer, 2001.ISBN:9780387952147.
4. ohn Enderle, Joseph D.Bronzino, Susan M.Blanchard, ""Introduction to Biomedical Engineering", Elsevier, 2005.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 2 | | | 2 | | | | 3 | 3 | | 2 |
| **CO2** | 3 | 2 | 3 | 2 | | | 2 | | | | 2 | 3 | | 1 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | 2 | | | | 2 | 2 | | 3 |
| **CO4** | 2 | 3 | 2 | 2 | 2 | | 2 | | | | 3 | 3 | | 3 |
| **CO5** | 2 | 3 | 2 | 2 | | | 2 | | | | 3 | 2 | 2 | 3 |
| **Avg** | **2.40** | **2.60** | **2.60** | **2.00** | **2.00** | | **2.00** | | | | **2.60** | **2.60** | **2.00** | **2.40** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL IV - IMAGE PROCESSING AND BIO ENGINEERING**
**(B.E - BME)**

| BM24P23 | NEURAL ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the structure and functions of the human nervous system.
- Learning the diseases and degenerative disorders affecting the nervous system.
- Studying the visualization and radiological assessment techniques of the nervous system.
- Investigating the understand neural tissue engineering approaches for rehabilitation applications.
- Exploring the regeneration methods and repair mechanisms of the nervous system.

**UNIT I BASICS OF NEURON STRUCTURE AND FUNCTIONS 9**

Nervous system development. Trophic factors, extra cellular matrix components in nervous system development. Neuron: structure – function – classification. Glial cells – myelination. Neuro transmitter – types and functions. Synapses - Transport of materials and impulse in neurons.

**UNIT II BRAIN, BRAIN STEM AND SPINAL CORD 9**

Brain: structures – lobes – functional areas. Brain stem: structures – functional areas. Spinal cord: structure – functions. Concepts of nuclei – sensory and motor Tracts - Reticular formation. Blood supply to Brain and spinal cord.

**UNIT III NEURONAL DISEASES AND DISORDERS 9**

Neuro degeneration: Degenerative, Demyelinated and injury related disorders associated with nervous system. Wallerian Degeneration. Neuronal plasticity – CNS acting drugs and their pharmacokinetics. Alzheimer‘s, Parkinson‘s and Prion diseases

**UNIT IV NEUROPHYSIOLOGY & NEURORADIOLOGY 9**

Physiology of nerve conduction. Peripheral nerves – structure & Functions. Synaptic transmission and cellular signaling of Neurons. Electrical activity of the Brain and recording of brain waves. Evoked potentials. Visualization of nervous system. Neuromotor-machine interface: human voluntary motor control system.

**UNIT V NERVE RECONSTRUCTION AND REHABILITATION 9**

Neural plasticity; Neurological dysfunctions - Regeneration of the peripheral nervous system. Neural tissue engineering; Nerve graft; Drug delivery system in CNS. Rehabilitation: Mechanisms for Neuromotor rehabilitation; Robotics and virtual reality in physical therapy; Transcranial magnetic stimulation

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the basic structure and functions of human nervous system.

**CO2:** Understand diseases and degeneration related to nervous system.

**CO3:** Analyze visualization and radiological assessment of nervous system.

**CO4:** Apply neural tissue engineering for rehabilitation.

**CO5:** Discuss about Regeneration of nervous system.

**TEXT BOOKS:**


1. Mathews G.G., "Neurobiology", 2nd edition, Blackwell Science, UK, 2000
2. Malcom Carpenter, "Textbooks of Neuroanatomy", Mc. Graw hill Edition, 1996


**REFERENCES:**


1. W. Mark Saltzman, "Tissue Engineering – Engineering principles for design of replacement organs and tissue'', Oxford University Press Inc New York, 2004.
2. Park J.B., "ACS Biomaterials Science and Engineering", Plenum Press, 2014. Saunders, 2006


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | | | | 2 | 2 | | 3 | 3 | | 2 |
| **CO2** | 2 | 3 | 2 | 2 | | | | 2 | 2 | | 2 | 3 | 2 | 1 |
| **CO3** | 3 | 2 | 3 | 3 | | | | 2 | 2 | | 2 | 2 | 2 | 3 |
| **CO4** | 3 | 2 | 3 | 3 | 3 | | | 2 | 2 | | 3 | 3 | | 3 |
| **CO5** | 3 | 3 | 2 | 3 | | | | 2 | 2 | | 3 | 2 | 2 | 3 |
| **Avg** | **2.60** | **2.40** | **2.40** | **2.60** | **3.00** | | | **2.00** | **2.00** | | **2.60** | **2.60** | **2.00** | **2.40** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL V - MECHANICS**
**(B.E - BME)**

| BM24P24 | BIOMECHANICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamental concepts of the principles of mechanics.
- Analyzing the basics of biofluid mechanics.
- Learning the mechanical properties of musculoskeletal elements.
- Studying the biomechanics of joints and implants.
- Introducing the application of biomechanics into modelling and ergonomic design.

**UNIT I INTRODUCTION TO MECHANICS 9**

Introduction – Scalars and vectors, Statics –Resolution and composition of forces, Moments, couple, Resultant, equilibrium of coplanar forces, Dynamics – Linear motion, Newton's laws of motion, Velocity and acceleration, Kinematics – Models, Transducers Constitutive equations –non-viscous fluid, Newtonian Viscous fluid and Hookean Elastic solid.

**UNIT II BIOFLUID MECHANICS 9**

Intrinsic fluid properties, Rheological properties of blood, Pressure-flow relationship for Non- Newtonian Fluids, Fluid mechanics in straight tube, Structure of blood vessels, Material properties and modelling of Blood vessels, Heart – Cardiac muscle characterization, Native heart valves, Prosthetic heart valve fluid dynamics.

**UNIT III MUSCULOSKELETAL MECHANICS 9**

Constitutive equation of viscoelasticity – Maxwell, Voight and Kelvin models, anisotropy, Hard Tissues – Structure, viscoelastic properties, functional adaptation, Soft Tissues – Structure, functions, material properties and modelling of Soft Tissues – Cartilage, Tendons and Ligaments Skeletal Muscle, Bone fracture mechanics, Implants for bone fractures.

**UNIT IV BIOMECHANICS OF JOINTS AND IMPLANTS 9**

Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, Free body diagrams, Structure of joints, Types of joints, Biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle, Lubrication of synovial joints, Gait analysis, Motion analysis using video.

**UNIT V MODELLING AND ERGONOMICS 9**

Introduction to Finite Element Analysis, finite element analysis of lumbar spine; models for voice biomechanics, Ergonomics –Musculoskeletal disorders, Ergonomic principles contributing to good workplace design, Design of a Computer workstation, Whole body vibrations, Hand transmitted and whole-body vibrations.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the principles of mechanics, kinetics, and kinematics in biological systems.

**CO2:** Describe the basics of biofluid mechanics in heart valves and blood vessel models.

**CO3:** Explain the mechanical properties of musculoskeletal systems, joints, and implants.

**CO4:** Apply biomechanics principles in the analysis of human joints and movement.

**CO5:** Discuss the applications of biomechanics in healthcare, safety, and society.

**TEXT BOOKS:**


1. Y.C. Fung, Bio-Mechanics- Mechanical Properties of Tissues, Springer-Verlag, 1998.
2. Subrata Pal, Textbook of Biomechanics, Viva Books Private Limited, 2009
3. Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, Biofluid Mechanics: The Human Circulation, Taylor and Francis, 2007.
4. Özkaya, Nihat, Dawn Leger, David Goldsheyder, and Margareta Nordin. Fundamentals of biomechanics: equilibrium, motion, and deformation. Springer, 2016.


**REFERENCES:**


1. Sheraz S. Malik and Shahbaz S. Malik, Orthopaedic Biomechanics Made Easy, Cambridge University Press, 2015.
2. Jay D. Humphrey, Sherry De Lange, An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, Springer Science Business Media, 2004.
3. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press 2007.
4. Neil J. Mansfeild, Human Response to Vibration, CRC Press, 2005.
5. Carl J. Payton, Biomechanical Evaluation of movement in sports and Exercise, 2008.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | 3 | 2 | | | | 2 | 3 | 2 | |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 3 | 2 | | | | 2 | 3 | 2 | |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | | | | 2 | 3 | 2 | |
| **CO4** | 2 | 2 | 3 | 2 | 3 | 3 | 2 | | | | 2 | 3 | 2 | |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | | | | 2 | 3 | 2 | |
| **Avg** | **2.80** | **2.40** | **2.20** | **2.20** | **2.40** | **2.60** | **2.00** | | | | **2.00** | **3.00** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL V - MECHANICS**
**(B.E - BME)**

| BM24P25 | GENETIC ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of recombinant DNA technology and genetic engineering.
- Analyzing the construction and uses of DNA libraries and artificial chromosomes.
- Learning the DNA sequencing, PCR, and mutagenesis techniques.
- Studying the genome organization and modern sequencing methods.
- Introducing the applications of genomics in biotechnology and medicine.

**UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY 9**

Manipulation of DNA – Restriction and Modification enzymes - Design of linkers and adaptors - Characteristics of cloning and expression vectors - Introduction of recombinant DNA in to host cells and selection methods.

**UNIT II DNA LIBRARIES 9**

Construction of genomic and cDNA libraries, Artificial chromosomes – Bacteria, Yeast - Chromosomal walking.

**UNIT III SEQUENCING AND AMPLIFICATION OF DNA 9**

Maxam Gilbert's and Sanger's methods of DNA sequencing – PCR: Inverse PCR, Nested PCR, Allele specific PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

**UNIT IV ORGANIZATION AND STRUCTURE OF GENOMES 9**

Organization and structure of genomes - Genome sequencing methods: Conventional and shotgun genome sequencing methods, Next generation sequencing technologies - Ordering the genome sequence - Genetic maps and Physical maps, STS content-based mapping, Hybridization mapping, Optical mapping.

**UNIT V CURRENT STATUS OF GENOME SEQUENCING PROJECTS 9**

Introduction to Functional genomics – Microarrays - Serial Analysis of Gene expression (SAGE), Subtractive hybridization, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the basics of recombinant DNA technology and gene transfer methods.

**CO2:** Describe the construction and applications of DNA libraries and artificial chromosomes.

**CO3:** Apply DNA sequencing, PCR, and mutagenesis techniques in molecular biology.

**CO4:** Analyse genome organization and modern genome sequencing technologies.

**CO5:** Discuss functional genomics and the applications of genomics in biotechnology and healthcare.

**TEXT BOOKS:**

1. Old RW, Primrose SB, "Principles of Gene Manipulation, An Introduction to Genetic Engineering", Blackwell Science Publications, 1993.
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, 3rd Ed. (Blackwell Publishing).

**REFERENCES:**

1. Isil Aksan Kurnaz, "Techniques in Genetic Engineering", CRC Press, 2015.
2. Oksana Ableitner, "Introduction to Molecular Biology: Working with DNA and RNA (essentials)", Springer International, 2022.
3. Arun K. Shukla, "Proteomics in Biology", Academic Press, 2017.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | | | | | | | | 3 | |
| **CO2** | 3 | 3 | | 2 | 2 | 2 | | | 2 | | | | 3 | |
| **CO3** | 3 | 2 | | 2 | 2 | 2 | | | | | 2 | | 2 | |
| **CO4** | 3 | 3 | 2 | 2 | 2 | | | | 2 | | 2 | | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | 2 | | | | | 3 | | 2 | 3 |
| **Avg** | **3.00** | **2.60** | **2.50** | **2.25** | **2.20** | **2.00** | | | **2.00** | | **2.33** | | **2.40** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL V - MECHANICS**
**(B.E - BME)**

| BM24P26 | PHYSIOLOGICAL MODELLING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the application of Physiological models and vital organs.
- Analyzing the methods and techniques for analysis and synthesis of dynamic models.
- Learning the dynamic models, simulate and visualize, dynamic responses of physiological models.
- Studying the nonlinear models of physiological systems.
- Introducing the Simulation of physiological systems.

**UNIT I INTRODUCTION TO PHYSIOLOGICAL MODELING 9**

Approaches to modelling: The technique of mathematical modelling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modelling. Introduction to physiology (homeostasis, cell biology) Modelling physical systems.

**UNIT II MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM 9**

Dynamic systems and their control, modelling and block diagrams, the pupil control systems (Human Eye), general structure of control systems, the dynamic response characteristics of the pupil control system, open &close loop systems instability, automatic aperture control.

**UNIT III NONLINEAR MODELS OF PHYSIOLOGICAL SYSTEMS 9**

Nonparametric Modelling-Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modelling - Basic Parametric Model Forms and Estimation Procedures- Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.

**UNIT IV COMPARTMENTENTAL PHYSIOLOGICAL MODEL 9**

Modeling the body as compartments, behaviour in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modelling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation.

**UNIT V SIMULATION OF PHYSIOLOGICALSYSTEMS 9**

Simulation of physiological systems using Open CV / MATLAB software. Biological receptors: - Introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity. Neuromuscular model, Renal System, Drug Delivery Model.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the principles and applications of physiological models used in biomedical system analysis.

**CO2:** Analyze the methods and techniques used for the analysis and synthesis of linear and dynamic physiological systems.

**CO3:** Develop differential equation–based compartmental models to represent physiological systems and processes.

**CO4:** Evaluate nonlinear physiological models and their significance in biomedical system behavior.

**CO5:** Apply simulation techniques for modelling and analysis of physiological systems.

**TEXT BOOKS:**


1. Michel C Khoo, "Physiological Control Systems -Analysis, simulation and estimation", Prentice Hall of India, 2001.
2. Marmarelis, "Nonlinear Dynamic Modelling of Physiological Systems", Wiley-IEEE Press,2004.


**REFERENCES:**


1. Benjamin C Kuo, "Automatic control systems", Tenth Edition, McGraw-Hill Education, 2017.
2. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su, "Advanced Computational Methods in Life System Modelling and Simulation", Springer,2017
3. David T Westwick, Robert E. Kearney, Identification of Nonlinear Physiological Systems, Wiley-IEEE Press, 2003.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | | 2 | | | | 2 | 3 | 2 | |
| **CO2** | 3 | 2 | 2 | 2 | 2 | | 2 | | | | 2 | 3 | 2 | |
| **CO3** | 3 | 2 | 2 | 2 | 2 | | 2 | | | | 2 | 3 | 2 | |
| **CO4** | 3 | 2 | 2 | 2 | 2 | | 2 | | | | 2 | 3 | 2 | |
| **CO5** | 3 | 2 | 2 | 2 | 2 | | 2 | | | | 2 | 3 | 2 | 3 |
| **Avg** | **3.00** | **2.00** | **2.00** | **2.00** | **2.00** | | **2.00** | | | | **2.00** | **3.00** | **2.00** | **3.00** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL V - MECHANICS**
**BM24P27 (B.E - BME)**
**BM24901 (B.E - ECE)**

| BM24P27 / BM24901 | ASSISTIVE TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic principles of cardiac assist devices and their medical applications.
- Analyzing the working and monitoring of haemodialysis and artificial kidney systems.
- Learning the hearing tests and modern hearing aid technologies.
- Studying the design and function of prosthetic and orthotic devices.
- Introducing the recent trends in rehabilitation and assistive biomedical technologies.

**UNIT I CARDIAC ASSIST DEVICES 9**

Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves, AI-assisted cardiac monitoring systems, and smart biocompatible cardiac implants.

**UNIT II HEMODIALYSERS 9**

Artificial kidney, Dialysis action, hemodialyzer unit, membrane dialysis, portable dialyser monitoring and functional parameters, wearable and portable dialysis systems, nanotechnology-based dialysis membranes, IoT-enabled dialysis monitoring, and regenerative dialysis technologies.

**UNIT III HEARING AIDS 9**

Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids, cochlear implants, AI-enabled adaptive hearing aids, Bluetooth-enabled smart hearing systems, and tele-audiology technologies.

**UNIT IV PROSTHETIC AND ORTHOTIC DEVICES 9**

Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthotic system, functional electrical stimulation, sensory assist devices, myoelectric prostheses, brain–computer interface (BCI)-based prosthetic control, 3D-printed prosthetics, and smart wearable rehabilitation devices.

**UNIT V RECENT TRENDS 9**

Transcutaneous electrical nerve stimulator, biofeedback, robot-assisted rehabilitation, virtual reality-based physiotherapy, implantable neurostimulators, wearable biosensors, digital therapeutics, and AI-driven assistive healthcare technologies.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the principles and clinical applications of cardiac assist and circulatory support devices.

**CO2:** Describe the operation and monitoring of hemodialysis and artificial kidney systems.

**CO3:** Analyze hearing assessment techniques and the functioning of modern hearing aid systems.

**CO4:** Evaluate the design and performance of prosthetic, orthotic, and sensory assist devices.

**CO5:** Discuss recent advancements and emerging technologies in rehabilitation and assistive biomedical engineering.

**TEXT BOOKS:**


1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind,Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.


**REFERENCES:**


1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1stedition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323- 662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | | | 2 | | | | 2 | 3 | 2 | |
| **CO2** | 3 | 2 | 2 | 2 | | | 2 | | | | 2 | 3 | 2 | |
| **CO3** | 3 | 2 | 2 | 2 | 2 | | 2 | | | | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | 2 | | 2 | | | | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 2 | 2 | 2 | | 2 | | | | 2 | 3 | 2 | |
| **Avg** | **3.00** | **2.00** | **2.00** | **2.00** | **2.00** | | **2.00** | | | | **2.00** | **3.00** | **2.00** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL V - MECHANICS**
**(B.E - BME)**

| BM24P28 | ERGONOMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic concepts of ergonomics in human–machine systems.
- Analyzing the muscle physiology, posture, and workplace safety principles.
- Learning the design of ergonomic controls and display systems.
- Studying the anthropometry and workspace design concepts.
- Introducing the modern ergonomic applications and technologies in biomedical and industrial fields.

**UNIT I VISUAL AND AUDITORY ERGONOMICS 9**

Process of seeing – visual capabilities – factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display – process of hearing – principles of auditory display. eye-tracking technology.

**UNIT II MUSCLE PHYSIOLOGY 9**

Muscle physiology – muscle metabolism – respiratory response – joint motion study – measure of physiological in-efficiency and energy consumption – work rest cycles – aspects of manual and posture study, material handling (MMH) Bio-mechanical recommended limits of MMH.

**UNIT III CONTROLS AND DISPLAYS 9**

Spatial compatibility and physical arrangement of displays and controls - Design of displays and controls – movement capability – rotary controls and rotor displays movement of displays orientation of the operator and movement relationships control orders and control responses – human limitations in tracking task.

**UNIT IV ANTHROPOMETRY 9**

Anthropometry – anthropometric design principles – Physical workload and energy expenditure - work space envelope – factors in design of workspace surfaces – principles of seat design – principles of control panel. ergonomic implications. Organization classification of human errors theories of accident causation.

**UNIT V ERGONOMIC DESIGN APPLICATIONS 9**

Ergonomic principles in computer workstation design, medical equipment design optimization, healthcare ergonomics, human-cantered product design, ergonomic evaluation methods, safety-oriented equipment design, AI-assisted ergonomic analysis, wearable healthcare devices, telemedicine workstation ergonomics.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the basic principles of ergonomics and human factors.

**CO2:** Analyze posture, muscle activity, and biomechanical factors in workplace design.

**CO3:** Describe the design and function of ergonomic controls and displays.

**CO4:** Apply anthropometric principles in workspace and equipment design.

**CO5:** Examine recent ergonomic technologies and applications in healthcare and industry.

**TEXT BOOKS:**

1. Pascale Carayon, "Handbook of Human Factors and Engineering", Second Edition, CRC Press, 2011
2. Martin Helander, "Guide to Human Factors and Ergonomics", Second Edition, CRC Press,2005
3. Benjamin W.Niebel, "Motion and Time Study", Richard, D. Irwin Inc., Seventh Edition, 2002

**REFERENCES:**


1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press2007.
2. George Kanawaty, "Introduction to work study", ILO, 3rd edition, Oxford & IBH publishing, 2001
3. Stephen Pheasant, Christine M. Haslegrave, Body space: Anthropometry, Ergonomics and the Design of Work, CRC Press, 2005.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | | | 3 | | | | 2 | 3 | 2 | |
| **CO2** | 3 | 3 | 3 | 3 | | | 2 | | | | 2 | 3 | 2 | |
| **CO3** | 3 | 2 | 2 | 2 | 2 | | 3 | | | | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 2 | | 2 | | | | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 2 | 2 | 2 | 2 | | 3 | | | | 2 | 2 | 2 | |
| **Avg** | **3.00** | **2.20** | **2.40** | **2.20** | **2.00** | | **2.60** | | | | **2.00** | **2.80** | **2.00** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL V - MECHANICS**
**(B.E - BME)**

| BM24P29 | HAPTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of human haptics and sensory–motor systems.
- Analyzing the design principles of machine haptic devices and interfaces.
- Learning the haptic sensors, actuators, and smart tactile technologies.
- Studying the computational haptics and biomechanical modeling techniques.
- Introducing the medical applications of haptics in rehabilitation, telemedicine, and surgical simulation.

**UNIT I HUMAN HAPTICS 9**

Somatosensory System; Motor System, Muscle Physiology; Haptics Psychophysical experiments, neurohaptics, brain–computer interface (BCI) integration, wearable haptic feedback systems, AI-assisted sensory analysis, and virtual reality (VR)-based haptic interaction technologies.

**UNIT II MACHINE HAPTICS 9**

Design Haptic devices; Human factors involved, soft robotic haptic devices, wearable exoskeleton interfaces, smart tactile gloves, AI-enabled adaptive haptic systems, and Internet of Things (IoT)-based haptic communication technologies.

**UNIT III HAPTIC SENSORS AND ACTUATORS 9**

barriers in human haptics; Ergonomics, flexible tactile sensors, MEMS-based haptic actuators, piezoelectric and electroactive polymer actuators, smart materials for haptic systems, and nanotechnology-based tactile sensing technologies.

**UNIT IV COMPUTATIONAL HAPTICS 9**

Haptic Rendering; Rigid bodies, Deformable bodies, Stability rendering effects, Human performance and evaluation; Biomechanics of manipulation; Neuromuscular Models, digital twin technology.

**UNIT V HAPTICS FOR MEDICAL APPLICATIONS 9**

Applications: Telemedicine; Rehabilitation; Medical Simulations for education, robot-assisted surgery, telesurgery with force feedback, wearable rehabilitation robotics, AI-supported medical training simulators, and remote healthcare haptic technologies.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the basic principles of ergonomics and human factors.

**CO2:** Analyze posture, muscle activity, and biomechanical factors in workplace design.

**CO3:** Describe the design and function of ergonomic controls and displays.

**CO4:** Apply anthropometric principles in workspace and equipment design.

**CO5:** Discuss recent ergonomic technologies and applications in health care.

**TEXT BOOKS:**

1. Kay M.Stanney, Handbook of Virtual Environments: Design, Implementation, and Applications, Lawrence Erlbaum Associates, Publications. N. I. Durlach and A. S. Mavor, eds., Virtual Reality: Scientific and Technological Challenges, National Academy Press, Washington, D.C., 1994.
2. G.C. Burdea, Force and Touch Feedback for Virtual Reality, John Wiley & Sons, 1996.
3. Kandel, Eric R., et al., eds. Principles of neural science. Vol. 4. New York: McGraw-hill, 2000.

**REFERENCES:**

1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012.
2. Marc J. Madou, Fundamentals of Micro fabrication: the Science of miniaturization, CRC Press, 2002.
3. Nadim Maluf and Kirt Williams, An introduction to Microelectro Mechancial Systems Engineering, Second Edition, Artech House Inc, MA,2004.
4. Chang Liu, Foundations of MEMS, Pearson Education International, New Jersey, USA,2006.
5. Nitaigour Premch and Mahalik, MEMS, Tata McGraw Hill Publishing Company, New Delhi, 2007.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 2 | 3 | | | | | | 2 | 3 | 2 | |
| **CO2** | 3 | 2 | 2 | 2 | 3 | | 2 | | | | 2 | 3 | 2 | |
| **CO3** | 3 | 2 | 1 | 2 | | | 3 | | | | 2 | 3 | 2 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | | 2 | | | | 2 | 3 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | | | 3 | | | | 2 | 3 | 2 | |
| **Avg** | **2.80** | **2.40** | **2.20** | **2.00** | **3.00** | | **2.50** | | | | **2.00** | **3.00** | **2.00** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VI - ADVANCED HEALTHCARE**
**(B.E - BME)**

| BM24P30 | BIO MEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the semiconductors and solid mechanics for the fabrication of MEMS devices.
- Analyzing the mechanical and thermal sensors and actuators at the microscale level.
- Learning the electrostatic and piezoelectric sensors and actuators used in microscale applications.
- Studying the fundamentals of microfluidic systems.
- Introducing the applications of MEMS technology in various medical fields.

**UNIT I MEMS MATERIALS AND FABRICATION 9**

Semiconductor materials, photo lithography; doping; thin film growth and deposition; CVD and Ion Implantation, metallization; wet and dry etching; silicon micromachining; metal MEMS processes; electron beam lithography; soft lithography and printing.

**UNIT II MECHANICAL AND THERMAL SENSORS AND ACTUATORS 9**

Mechanical sensors and actuators – beam and cantilever –microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor.

**UNIT III ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATOR 9**

Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Piezoelectric sensor and actuator – inchworm motor, inertia & flow sensor.

**UNIT IV MICROFLUIDIC SYSTEMS 9**

Laminar flow in circular conduits, fluid flow in micro conduits, in sub micrometer and nanoscale. microfluidic components (filters, mixers, valves, and pumps)

**UNIT V APPLICATIONS OF BIOMEMS 9**

CAD for MEMS, DNA sensor, MEMS based drug delivery, Biosensors- sensors for glucose, uric acid, urea and triglyceride sensor. Introduction to the MATLAB tool for modelling/simulations of bioelectronics systems.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain various MEMS fabrication techniques.

**CO2:** Understand different mechanical and thermal sensors and actuators and their operating principles at the microscale level.

**CO3:** Describe electrostatic and piezoelectric sensors and actuators and their applications in MEMS systems.

**CO4:** Explain the fundamentals of microfluidic systems.

**CO5:** Illustrate the applications of MEMS in various fields of medicine.

**TEXT BOOKS:**


1. TaiRan Hsu,MEMS and Microsystems Design and Manufacture, Tata McGrawHill Publishing Company, New Delhi, 2017.
2. WanjunWang and Stephen A.Soper, BioMEMS:Technologies and Applications, CRC Press, NewYork, 2007.
3. P. Tabeling, S .Chen, Introduction to microfluidics, Oxford University Press, 2010.


**REFERENCES:**


1. Chang Liu, Foundations of MEMS, Pearson Education International, New Jersey, USA, 2011.
2. Ellis Meng, Biomedical Microsystems, CRC Press, Boca Raton, FL, 2011.
3. Alok Pandya ,Vijai Singh, Micro/Nanofluidics and Lab-on-Chip Based Emerging Technologies for Biomedical and Translational Research Applications - Part B, Academic Press, 2022.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | 2 | | | | | | 2 | 2 | |
| **CO2** | 3 | 2 | 2 | 2 | 1 | 2 | | | | | | 2 | 2 | |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 2 | | | | | | 2 | 2 | |
| **CO4** | 3 | 2 | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | |
| **CO5** | 3 | 2 | 2 | 2 | 2 | 3 | | | | | 2 | 2 | 3 | |
| **Avg** | **3.00** | **2.00** | **2.00** | **2.00** | **2.00** | **2.20** | | | | | **2.00** | **2.00** | **2.20** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VI - ADVANCED HEALTHCARE**
**(B.E - BME)**

| BM24P31 | CRITICAL CARE AND OPERATION THEATRE EQUIPMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the knowledge of various intensive care equipment and their working.
- Studying the working principles and applications of critical care equipment.
- Learning the necessity of different operation theatre equipment.
- Understanding the different dialyzers and ventilators.
- Exploring the patient safety, electrical hazards, grounding, patient isolation, and safety practices in operation theatres, ICCUs, and IMCUs.

**UNIT I INTENSIVE CARE UNIT EQUIPMENT 9**

Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and large units. ICU ventilators. Automated drug delivery systems, Infusion pumps, components of drug infusion system, closed loop control infusion system, implantable infusion system. BMD Measurements – SXA – DXA - Quantitative ultrasound bone densitometer

**UNIT II CRITICAL CARE EQUIPMENT 9**

Defibrillators, Hemodialysis Machine, Different types of Dialyzers, Membranes, Machine controls and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.

**UNIT III OPERATION THEATRE EQUIPMENT 9**

Craniotomy, Electrosurgical Machines, electrosurgical analyzers, surgical aspirator, Instruments for operation. Anesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy – Laparoscopy - Cryogenic Equipment - Anesthesia gas, Anesthesia gas monitor, - surgical microscope.

**UNIT IV CENTRALISED SYSTEMS 9**

Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting.

**UNIT V PATIENT SAFETY 9**

Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms, ICCU and IMCUs.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Apply biomedical knowledge to design monitoring devices for ICU and support medical staff during emergencies.

**CO2:** Select suitable surgical instruments and operating devices for medical applications.

**CO3:** Compare different techniques used in clinical diagnosis, therapy, surgery, and recent advancements.

**CO4:** Evaluate the performance and applications of operation theatre equipment.

**CO5:** Design medical devices for specific applications based on given specifications.

**TEXT BOOKS:**

1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd,New Delhi, 2015
2. Khandpur. R.S.,"Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003

**REFERENCES:**

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.
2. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
3. Antony Y.K.Chan,"Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
4. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | | 2 | | 2 | | 1 | 2 | 2 | |
| **CO2** | 3 | 2 | 2 | 1 | 2 | | 2 | | 1 | | 1 | 2 | 2 | |
| **CO3** | 3 | 2 | 3 | 2 | 2 | | 2 | | 1 | | 1 | 2 | 2 | |
| **CO4** | 3 | 3 | 2 | 3 | 2 | 2 | 2 | | 2 | | 2 | 2 | 2 | |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | | 2 | | 2 | 2 | 2 | |
| **Avg** | **3.00** | **2.40** | **2.60** | **2.00** | **2.40** | **2.00** | **2.00** | | **1.60** | | **1.40** | **2.00** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VI - ADVANCED HEALTHCARE**
**(Common To B.E - BME, ECE)**

| BM24P32 | HUMAN ASSIST DEVICES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of assistive technologies.
- Studying the mobility and rehabilitation systems.
- Learning the prosthetic and orthotic devices.
- Understanding the sensory and communication systems.
- Exploring the advanced assistive technologies.

**UNIT I ASSISTIVE TECHNOLOGY FUNDAMENTALS 9**

Introduction, need and classification of assistive technologies – Types of disabilities and functional limitations – Human factors and ergonomics – Standards and safety considerations – Overview of rehabilitation engineering.

**UNIT II MOBILITY AND REHABILITATION SYSTEMS 9**

Mobility aids – manual and powered wheelchairs, walkers, crutches, and canes – Design considerations and control strategies – Rehabilitation assistive systems.

**UNIT III PROSTHETICS AND ORTHOTIC SYSTEMS 9**

Upper and lower limb prostheses – Components and control – Myoelectric prostheses – Orthotic devices for limb and spine – Materials and fabrication.

**UNIT IV SENSORY AND COMMUNICATION SYSTEMS 9**

Hearing aids and cochlear implants – Visual aids and electronic travel aids – Braille systems – Speech assist devices – Augmentative and alternative communication systems.

**UNIT V ADVANCED ASSISTIVE TECHNOLOGIES 9**

Functional electrical stimulation – Rehabilitation robotics – Brain–computer interface – Smart assistive devices – Wearable and IoT-based assistive systems.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the fundamentals of assistive technologies and human factors.

**CO2:** Describe mobility and rehabilitation assistive systems.

**CO3:** Analyze prosthetic and orthotic devices and their working principles.

**CO4:** Evaluate sensory and communication assistive systems.

**CO5:** Apply advanced assistive technologies in healthcare application

**TEXT BOOKS:**

1. Janice M. Polgar, Albert M. Cook, Pedro Encarnaçao, Emma Smith, Assistive Technologies: Principles and Practice, 6th Edition, Elsevier, 2024.
2. Rory A. Cooper, Hisaichi Ohnabe, Douglas A. Hobson, An Introduction to Rehabilitation Engineering, CRC Press, 2020.
3. Joseph D. Bronzino, Biomedical Engineering Fundamentals, 4th Edition, CRC Press, 2019.

**REFERENCES:**

1. Rory A. Cooper, Hisaichi Ohnabe, Douglas A. Hobson, Rehabilitation Engineering Applied to Mobility and Manipulation, CRC Press, 2013.
2. John G. Webster, Amit J. Nimunkar, Medical Instrumentation: Application and Design, 5th Edition, Wiley, 2018.
3. Bin He, Neural Engineering, 2nd Edition, Springer, 2013.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | 2 | | | | | 1 | 2 | 2 | |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 2 | | | | | 1 | 2 | 2 | |
| **CO3** | 3 | 2 | 3 | 2 | 3 | 2 | | | | | 1 | 2 | 2 | |
| **CO4** | 3 | 2 | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | |
| **CO5** | 3 | 2 | 2 | 2 | 2 | 2 | | | | | 2 | 2 | 2 | |
| **Avg** | **3.00** | **2.00** | **2.20** | **2.00** | **2.20** | **2.00** | | | | | **1.40** | **2.00** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VI - ADVANCED HEALTHCARE**
**(B.E - BME)**

| BM24P33 | ADVANCEMENTS IN HEALTHCARE TECHNOLOGY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the importance of digital methods in managing and handling medical records.
- Studying the principles and applications of digital radiology in healthcare systems.
- Learning the tools, techniques, and workflow methods used in E-Health systems.
- Exploring the knowledge about wearable healthcare devices and their supporting technologies.
- Analyzing the interoperability, quality, and safety standards used in healthcare devices.

**UNIT I DIGITAL HEALTH 9**

Digital Health: Requirements and best practices, Laws and regulations in Digital health, Ethical issues, barriers and strategies for innovation.

**UNIT II DIGITAL RADIOLOGY 9**

Digital radiology for digital hospital, picture archiving and communication, system integration, digital history of radiology, medical image archives, storage and networks.

**UNIT III E-HEALTH 9**

E-Health: Healthcare networking, medical reporting through speech recognition, digital methods for physiological testing and functional diagnosis, and teleconsultation in medicine and radiology.

**UNIT IV M-HEALTH CARE AND WEARABLE DEVICES 9**

Introduction to mobile healthcare devices: healthcare economy, average hospital stay, outpatient care, healthcare costs, mobile phones, 4G technology, smart and wearable devices, adoption of e-health and m-health technologies, standards, system design, and case studies.

**UNIT V MODALITY AND STANDARDS FOR INTER-OPERABILITY 9**

Multimodality registration in daily clinical practice. Mobile healthcare. Selection and Implementation in e-Health project, design of medical equipment based on user needs. Security and privacy in digital health care. Case study

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the need for digital methods in handling medical records.

**CO2:** Describe the principles and applications of digital radiology.

**CO3:** Apply tools and methods used for workflow management in E-Health systems.

**CO4:** Identify technologies used in wearable healthcare devices.

**CO5:** Compare interoperability, quality, and safety standards used in developing healthcare systems.

**TEXT BOOKS:**


1. Christoph Thuemmler, Chunxue Bai, "Health 4.0: How Virtualization and Big Data are Revolutionizing Healthcare", Springer, 1st ed. 2017
2. Samuel A. Fricker, Christoph Thümmler, Anastasius Gavras, "Requirements Engineering For Digital Health", Springer, 2015.
3. Wlater Hruby, "Digital revolution in radiology – Bridging the future of health care, second edition, Springer, New York. 2006


**REFERENCES:**


1. Rick Krohn (Editor), David Metcalf, Patricia Salber, "Health-e Everything: Wearables and The Internet of Things for Health, ebook. 2013.
2. Khandpur,R.S,"Handbook of Biomedical Instrumentation", Second Edition. Tata Mc Graw Hill Pub. Co., Ltd. 2003
3. John, G. Webster. Medical Instrumentation: Application and Design. Second Edition. Wiley Publisher, New Delhi. 2013.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 2 | | 3 | | 2 | | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | | 2 | | 2 | | 2 | | 2 | 2 | 2 | |
| **CO3** | 2 | 2 | 3 | | 2 | | 2 | | 2 | | 2 | 2 | 2 | |
| **CO4** | 3 | 2 | 3 | 2 | 2 | | 2 | | 2 | | 2 | 2 | 2 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 2 | | 3 | | 3 | | 2 | 2 | 2 | 3 |
| **Avg** | **2.40** | **2.00** | **3.00** | **2.67** | **2.00** | | **2.40** | | **2.20** | | **2.00** | **2.00** | **2.00** | **1.80** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VI - ADVANCED HEALTHCARE**
**(B.E - BME)**

| BM24P34 | ROBOTICS IN MEDICINE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of robotics and position analysis.
- Studying the parallel robots, different types of motion, and force analysis.
- Learning the basics of trajectory planning, motion control systems, and actuators.
- Understanding the knowledge of sensors and vision systems used in robotics.
- Exploring the fuzzy control and applications of robotics in medicine.

**UNIT I FUNDAMENTALS AND POSITION ANALYSIS 9**

Basics of robotics: classification, advantages and disadvantages, components, degrees of freedom, joints, coordinates, reference frames, programming modes, workspace, programming languages, and collaborative robots. Position analysis of robots, transformations, forward and inverse kinematics, Denavit–Hartenberg representation, articulated robots.

**UNIT II PARALLEL ROBOTS, DIFFERENTIAL MOTIONS AND FORCE ANALYSIS 9**

Parallel robots: physical characteristics, forward and inverse kinematics, planar and spatial robots, Jacobian analysis, robot motions, screw-based and parallel robots, Lagrangian mechanics, dynamic equations, static force analysis, transformation of forces and moments.

**UNIT III TRAJECTORY PLANNING, MOTION CONTROL SYSTEMS AND ACTUATORS 9**

Path and trajectory planning, joint space and Cartesian space, trajectory recording, basics of control systems, block diagrams, transfer functions, PID controllers, Bode plots, state-space and digital control, nonlinear systems, hydraulic, pneumatic and electric actuators, and speed reduction techniques.

**UNIT IV SENSORS, IMAGE PROCESSING AND ANALYSIS WITH VISION SYSTEMS 9**

Sensor characteristics, position, velocity, acceleration, force, pressure, and torque sensors, microswitches, touch and proximity sensors, vision systems, Fourier and Hough transforms, image processing, segmentation, object recognition, depth analysis, image compression, colour images, and heuristics.

**UNIT V FUZZY CONTROL AND APPLICATIONS IN MEDICINE 9**

Fuzzy control, fuzzy sets, inference rules, defuzzification, simulation, applications in biomedical engineering and rehabilitation, nanobots in medicine, robotic surgery, teleoperated robots, cooperative robots, and case studies.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the fundamentals of robotics and position analysis.

**CO2:** Describe the working of parallel robots, different types of motion, and force analysis.

**CO3:** Explain the basics of trajectory planning, motion control systems, and actuators.

**CO4:** Identify and describe various sensors and vision systems used in robotics.

**CO5:** Apply fuzzy control techniques and robotics applications in medicine.

**TEXT BOOKS:**


1. S. B. Niku, Introduction to Robotics, Analysis, Control, Applications, Pearson Education, 2020
2. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India, 2003.
3. J Craig, Introduction to Robotics, Pearson Education, 2005.


**REFERENCES:**


1. Grover, Wiess, Nagel and Oderey, Industrial Robotics, McGraw Hill, 2012
2. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications, 2003.
3. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robotics and Automation Sensor – Based integration, Academic Press, 1999.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 3 | | | | 2 | 2 | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | | | 2 | 2 | 3 | 3 | 2 | 3 |
| **CO3** | 3 | 2 | 2 | 1 | 2 | | | | 2 | 1 | 3 | 3 | 3 | 3 |
| **CO4** | 3 | 2 | 2 | 2 | 3 | | | | 2 | 2 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | | | | 2 | 2 | 3 | 2 | 2 | 2 |
| **Avg** | **3.00** | **2.40** | **2.00** | **1.80** | **2.60** | | | | **2.00** | **1.80** | **2.80** | **2.60** | **2.40** | **2.60** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VI - ADVANCED HEALTHCARE**
**(B.E - BME)**

| BM24P35 | MEDICAL DEVICE TROUBLESHOOTING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding equipment testing and electrical safety.
- Developing testing and troubleshooting skills.
- Learning operation and maintenance of medical equipment.
- Applying troubleshooting and quality assurance practices.
- Exploring maintenance management and documentation.

**UNIT I INTRODUCTION 9**

Causes of Equipment Failure, testing of electrical equipment: 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.

**UNIT II TESTING AND TROUBLESHOOTING 9**

Testing of electronic components: Troubleshooting of PCB boards, Calibration of analog and digital sensor probes, Display interface, DC Power supply design, testing, Safe electrical practice, Cables, and standard, Fuse.

**UNIT III TESTING OF MEDICAL EQUIPMENT 9**

Testing of Surgical Equipment: Functions and operating procedure-Testing and maintenance of Heart lung machine, surgical lights, ventilator, patient monitor, anesthesia machine, dialyzer, and surgical tools.

**UNIT IV TROUBLESHOOTING OF MEDICAL EQUIPMENT 9**

Troubleshooting of equipments: X-ray machines, Troubleshooting of ECG recorders, Ultrasound machines incubator, baby warmer, infusion pumps, Patient Monitors, annual maintenance, contract requirements, vendor services, quality and safety standards.

**UNIT V MAINTENANCE MANAGEMENT 9**

Objectives, Maintenance Policy, Contracts and Provisions, Essentials of a Good Equipment Program, Installation Procedures, Service and Maintenance laboratory, Documentation, Professional Qualities, and Work Habits.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain equipment testing and safety practices.

**CO2:** Apply electronic testing and troubleshooting methods.

**CO3:** Analyze testing and maintenance of medical equipment.

**CO4:** Evaluate troubleshooting and quality standards in healthcare devices.

**CO5:** Develop maintenance management and documentation skills.

**TEXT BOOKS:**

1. Shakti Chatterjee, Aubert Miller, "Biomedical Equipment Repair", Cengage Learning Technology & Engineering, 2018.
2. David Herres, "Troubleshooting and Repairing Commercial Electrical Equipment", McGraw Hill Professional edition, 2016.

**REFERENCES:**

1. Rao S, "Testing, Commissioning, Operation and Maintenance of Electrical Equipment", Khanna Publishers, New Delhi, 2014.
2. Francis Hegarty, John Amoore, "Health care technology management – A systematic approach" CRC Press, USA, 2017.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | 2 | 2 | 2 | | | | | 2 | 2 | 2 | |
| **CO2** | 3 | 3 | 2 | 2 | 3 | 3 | | | | | 2 | 3 | 3 | |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 3 | | | | | 2 | 3 | 3 | |
| **CO4** | 2 | 3 | 2 | 3 | 3 | 3 | | | | | 2 | 2 | 3 | |
| **CO5** | 2 | 2 | | | 2 | 2 | | | | | 2 | 2 | 2 | |
| **Avg** | **2.60** | **2.40** | **2.00** | **2.40** | **2.40** | **2.60** | | | | | **2.00** | **2.40** | **2.60** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VII - MEDICAL DEVICE INNOVATION AND DEVELOPMENT**
**(B.E - BME)**

| BM24P36 | FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the problem identification and analysis techniques in engineering applications.
- Analyzing the effective problem-solving skills through individual and team-based approaches.
- Learning the knowledge of innovation, entrepreneurship, and product development processes.
- Studying the individual and collaborative teamwork skills in multidisciplinary environments.
- Introducing the project planning, organization, and management techniques for successful project execution.

**UNIT I BASICS OF PRODUCT DEVELOPMENT 9**

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development.

**UNIT II REQUIREMENTS AND SYSTEM DESIGN 9**

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

**UNIT III DESIGN AND TESTING 9**

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification. High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing.

**UNIT IV SUSTENANCE ENGINEERING AND PRODUCT END-OF-LIFE SUPPORT 9**

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL - Obsolescence Management – Configuration Management - EoL Disposal.

**UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES 9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems. Intellectual Property Rights and Confidentiality – Security and Configuration Management.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Identify, formulate, and critically analyze engineering and real-world problems.

**CO2:** Develop effective solutions to specific problems individually and collaboratively within a team.

**CO3:** Gain knowledge of innovation and product development in business.

**CO4:** Work effectively individually and in teams.

**CO5:** Plan, organize, and manage projects effectively from initiation to completion.

**TEXT BOOKS:**


1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.


**REFERENCES:**


1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | | 2 | 2 | 1 | | | 2 | 2 | | |
| **CO2** | 3 | 3 | 3 | 2 | | 3 | 2 | 2 | | | 2 | 2 | | |
| **CO3** | 2 | 2 | 3 | 2 | | 3 | 2 | 2 | | | 2 | 2 | | |
| **CO4** | 2 | 2 | 2 | 2 | | 3 | 2 | 2 | | | 2 | 2 | | |
| **CO5** | 2 | 2 | 3 | 2 | | 2 | 2 | 2 | | | 3 | 2 | | |
| **Avg** | **2.40** | **2.40** | **2.60** | **2.00** | | **2.60** | **2.00** | **1.80** | | | **2.20** | **2.00** | | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VII - MEDICAL DEVICE INNOVATION AND DEVELOPMENT**
**(B.E - BME)**

| BM24P40 | PATIENT SAFETY, STANDARDS AND ETHICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the importance of patient safety against electrical hazards in healthcare systems.
- Studying the patient safety laws, regulations, and healthcare standards.
- Learning the standards and testing procedures related to patient safety.
- Understanding the patient safety practices and specialties in clinical environments.
- Exploring the knowledge about healthcare organizations and their role in patient safety management.

**UNIT I EFFECTS OF ELECTRICITY 9**

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development.

**UNIT II PATIENT SAFETY LAWS AND REGULATIONS 9**

Mandatory Reporting systems. Anatomy of a patient safety Law: Compliance Tips, Federal patient safety Legislation Initiatives, Medical Device Reporting, Clinical trials and Adverse-Event Reporting, Patient safety Goals and standards, The Quality Assessment and performance Improvement rule.

**UNIT III STANDARDS AND TESTING 9**

Guidelines and safety practices to improve patient safety, Electrical safety codes and standards - IEC 60601-1 2005 standard, Basic Approaches to protection against shock, protection equipment design, Electrical safety analyser - Testing the electric system.

**UNIT IV PATIENT SAFETY IN MAIN CLINICAL SPECIALITIES 9**

Intensive care and Anesthesiology, safety surgery save lives, Emergency department clinical risk, Obstetric safety patient, Patient safety in internal medicine, Patient safety in Radiology.

**UNIT V MEDICAL ETHICS 9**

Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor And Society, Case Studies.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Outline the importance of patient safety against electrical hazards.

**CO2:** Brief out the patient safety laws and regulations.

**CO3:** explain the standards and testing of patient.

**CO4:** Understand the concept of the patient safety specialities in clinical.

**CO5:** know about various health care organization.

**TEXT BOOKS:**

1. John G.Webster, "Medical Instrumentation Application and design", 4th edition, Wiley India PvtLtd, New Delhi, 2015.
2. Liam Donaldson,Walter Ricciardi, "Textbook of patient safety and clinical Risk management", Springer.
3. Fay A. Rozovsky, James R. Woods, Jr, " The Handbook of Patient Safety Compliance", 2016

**REFERENCES:**

1. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education, 4th Edition, Pearson Education, 2001.
2. Sukhmeet Panesar, Andrew Carson-Stevens, Sarah Salvilla, Aziz Sheikh, Patient Safety and Healthcare Improvement at a Glance, Wiley-Blackwell, 1st Edition, 2014.
3. Khandpur R.S., Handbook of Biomedical Instrumentation, McGraw Hill Education. 3 rd Edition, 2024.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 3 | | 2 | | | 2 | 2 | 2 | 2 | |
| **CO2** | 3 | 2 | 2 | 1 | 2 | | 2 | | | 1 | 2 | 2 | 2 | |
| **CO3** | 3 | 2 | 3 | 2 | 2 | | 2 | | | 1 | 2 | 2 | 2 | |
| **CO4** | 3 | 3 | 2 | 3 | 2 | | 2 | | | 2 | 2 | 2 | 2 | |
| **CO5** | 3 | 3 | 3 | 2 | 3 | | 2 | | | 2 | 2 | 2 | 2 | |
| **Avg** | **3.00** | **2.40** | **2.60** | **2.00** | **2.40** | | **2.00** | | | **1.60** | **2.00** | **2.00** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VII - MEDICAL DEVICE INNOVATION AND DEVELOPMENT**
**(B.E - BME)**

| BM24P41 | PRINCIPLES OF TISSUE ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals and principles of tissue engineering.
- Studying the multidisciplinary teamwork and collaborative skills in biomedical applications.
- Learning the ethical and professional practices related to stem cell and gene therapy applications.
- Understanding the design and selection of biomaterials for tissue engineering applications.
- Exploring the knowledge of tissue repair techniques and clinical engineering applications.

**UNIT I 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 II FUNDAMENTALS OF TISSUE ENGINEERING 9**

Introduction and scope of tissue engineering – Organization and classification of tissues: epithelial and connective tissues – Vascularization and angiogenesis – Wound healing process – Extracellular matrix: matrix components and ligand interactions – Basics of tissue culture – Materials used in tissue engineering.

**UNIT III STEM CELLS 9**

Definition and classification of stem cells – Concepts of differentiation, dedifferentiation, maturation, proliferation, pluripotency, and immortalization – Sources of stem cells: hematopoietic, fetal, cord blood, placental, bone marrow, primordial germ cells, cancer stem cells, and induced pluripotent stem cells.

**UNIT IV ENGINEERING METHODS AND DESIGN 9**

Soft lithography techniques – Self-assembled monolayers, microcontact printing, and microfluidic patterning – Laminar flow patterning – Cell interactions with polymer scaffolds and gels – Fabrication of polymer scaffolds using electrospinning, solvent casting, and particulate leaching methods.

**UNIT V APPLICATION OF TISSUE ENGINEERING 9**

Replacement engineering of bone, cartilage, skin, blood, pancreas, kidney, heart valve, and liver – Regenerative engineering for peripheral nerve, cardiac tissue, and muscle regeneration – Regulation, commercialization, and patenting in tissue engineering.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Understand the fundamentals of tissue engineering.

**CO2:** Develop multidisciplinary teamwork skills.

**CO3:** Apply ethical and professional practices in stem cell and gene therapy applications.

**CO4:** Design biomaterials for tissue engineering applications.

**CO5:** Gain knowledge of tissue repair and clinical engineering applications.

**TEXT BOOKS:**

1. Robert P lanza, Robert Langer, Joseph Vacanti, "Principles of Tissue Engineering", Academic Press, United States, 2020.
2. Donglu Shi, Qing Liu, “Tissue Engineering and Nanotheranostics”, World Scientific Publications, Singapore, 2018.

**REFERENCES:**

1. Gary E. Wnek, Gary L Browlin, “Encyclopedia of Biomaterials and Biomedical Engineering”, Marcel Dekker Inc, New York, 2008.
2. R. Lanza, Anthony Atala (Eds), “Essential of Stem Cell Biology”, Academic Press, USA, 2013.
3. R. Lanza, Anthony Atala,“Handbook of Stem Cells’’, Academic Press, USA, 2012.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | | | 2 | | | 2 | 2 | 2 | |
| **CO2** | 3 | 2 | 2 | 2 | 2 | | | 2 | | | 2 | 2 | 2 | |
| **CO3** | 3 | 2 | 3 | 2 | 3 | | | 2 | | | 2 | 2 | 2 | |
| **CO4** | 3 | 2 | 2 | 2 | 2 | | | 2 | | | 2 | 2 | 2 | |
| **CO5** | 3 | 2 | 2 | 2 | 2 | | | 2 | | | 2 | 2 | 2 | |
| **Avg** | **3.00** | **2.00** | **2.20** | **2.00** | **2.20** | | | **2.00** | | | **2.00** | **2.00** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VII - MEDICAL DEVICE INNOVATION AND DEVELOPMENT**
**(B.E - BME)**

| BM24P42 | MEDICAL INNOVATION AND ENTREPRENEURSHIP | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the role of biomedical engineers in entrepreneurship and innovation.
- Studying the fundamentals of entrepreneurship in biomedical engineering.
- Learning the innovation, creativity, and entrepreneurial skills for technology development.
- Exploring the resources, funding agencies, and market opportunities for biomedical products.
- Analyzing the entrepreneurial opportunities and challenges in the healthcare industry.

**UNIT I CREATIVITY, INNOVATION AND IPR 9**

Role of creativity and innovation – Innovation process – Sources and methods of generating new ideas – Creative problem-solving techniques – Entrepreneurial process – Intellectual property rights: patents, copyrights, trademarks, and geographical indications – Ethical, social responsibilities, and challenges.

**UNIT II SCOPE FOR BIOMEDICAL ENGINEERING ENTREPRENEURSHIP 9**

Definition, characteristics, and functions of an entrepreneur – Common myths of entrepreneurship – Fundamentals and models of entrepreneurship – Advancements in the biomedical field – Supporting societies and professional activities – Impact of innovation in medical devices – Case studies.

**UNIT III NEW VENTURE 9**

Developing an effective business model – Importance and components of a business model – Establishing a small-scale industry – Venture assessment and venture creation – Market research – Preparation and presentation of a business plan – Case studies.

**UNIT IV FUNDING NEW VENTURES AND GLOBALIZATION 9**

Evaluation of investment options and future funding – Incentives and subsidies for medical device entrepreneurship – Assessment of financial requirements and sources of finance – Impact of globalization on medical product manufacturing, marketing, leadership, and quality management – Case studies.

**UNIT V MARKETING FUNCTION 9**

Industry and competitor analysis – Marketing research for new ventures – Defining objectives – Collection of data from primary and secondary sources – Analysis and interpretation of results – Marketing process – Case studies.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the role of biomedical engineers in entrepreneurship.

**CO2:** Understand entrepreneurship fundamentals for biomedical engineers.

**CO3:** Develop innovation and entrepreneurial skills.

**CO4:** Identify resources, funding agencies, and market-driven products.

**CO5:** Analyze entrepreneurial opportunities and challenges.

**TEXT BOOKS:**

1. Jen-Shih Lee "Biomedical Engineering Entrepreneurship", World Scientific Publishing, USA. 2010
2. Vasant Desai, ―The Dynamics of Entrepreneurial Development and Management‖, Himalaya Publishing House, 2010.
3. Brant Cooper, Patrick Vlaskovits, "The Lean Entrepreneur", Wiley, 2nd edition, New Jersy, 2016.

**REFERENCES:**

1. Nathan Furr, Jeff Dyer, "The Innovator's Method: Bringing the Lean Start-up into Your Organization", Harvard Business Press, Boston, 2014.
2. Donald F.Kuratko and Richard M. Hodgetts, "Entrepreneurship", South-Western.
3. Gupta S.L., Arun Mittal, "Entrepreneurship Development", International Book House, 2012.
4. Prasanna Chandra, "Projects- Planning, Analysis, Financing, Implementation and review‖, TATA McGraw Hill, 2012.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 3 | 3 | 2 | | | 3 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 3 | | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | |
| **CO3** | 2 | 2 | 3 | | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | |
| **CO4** | 3 | 2 | 3 | 2 | 2 | | | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO5** | 3 | 2 | 3 | 3 | 2 | | | 3 | 3 | 3 | 2 | 2 | 2 | 3 |
| **Avg** | **2.40** | **2.00** | **3.00** | **2.67** | **2.00** | | | **2.40** | **2.20** | **2.20** | **2.00** | **2.00** | **2.00** | **1.80** |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VII - MEDICAL DEVICE INNOVATION AND DEVELOPMENT**
**(B.E - BME)**

| BM24P43 | BIOMATERIALS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the characteristics and classification of biomaterials.
- Studying the metals, ceramics, and nanomaterials used as biomaterials.
- Learning the polymeric biomaterials and their applications in tissue replacement implants.
- Gaining the knowledge of nanoscience and nanotechnology concepts.
- Exploring the biocompatibility and biomaterial testing methods.

**UNIT I INTRODUCTION TO BIO-MATERIALS 9**

Definition and classification of biomaterials – Mechanical properties and viscoelasticity – Biomaterial performance – Biological response to implants – Wound healing and blood compatibility – Nanoscale phenomena in biomaterials.

**UNIT II METALLIC AND CERAMIC MATERIALS 9**

Metallic implants - Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics.

**UNIT III POLYMERIC IMPLANT MATERIALS 9**

Polymerization and factors affecting polymer properties – Polymers as biomaterials – Biodegradable polymers – Biopolymers: collagen, elastin, and chitin – Medical textiles – Materials used in ophthalmology, including contact lenses and intraocular lenses.

**UNIT IV TISSUE REPLACEMENT IMPLANTS 9**

Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair – Extracellular matrix-based biomaterials – Soft tissue replacements, sutures, surgical tapes, and adhesives – Vascular grafts and joint replacements – Tissue scaffolding and engineering using nano biomaterials.

**UNIT V TESTING OF BIOMATERIALS 9**

Biocompatibility, blood compatibility, and tissue compatibility testing – Toxicity, sensitization, carcinogenicity, mutagenicity, and special tests – In vitro and in vivo evaluation methods – Sterilization of implants and medical devices using ethylene oxide (ETO), gamma radiation, and autoclaving – Effects of sterilization on biomaterials and devices.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Analyze biomaterials classification and nanotechnology applications.

**CO2:** Identify challenges and advancements in metallic and ceramic biomaterials.

**CO3:** Examine challenges and advancements in polymeric biomaterials.

**CO4:** Develop material combinations for tissue replacement implants.

**CO5:** Understand biomaterial testing standards.

**TEXT BOOKS:**


1. Sujata V. Bhatt, “Biomaterials”, Second Edition, Narosa Publishing House, 2005.
2. JoonB.Park Joseph D. Bronzino, “Biomaterials - Principles and Applications”, CRC press, 2003.
3. Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, “Biomaterials: A Nano Approach”, CRC Press, 2010.


**REFERENCES:**


1. Monika Saini, Yashpal Singh, Pooja Arora, Vipin Arora, and KratiJain. “Implant biomaterials: A comprehensive review”, World Journal of Clinical Cases, 2015.
2. Biomaterials- Basic Theory with Engineering Applications C.Mauli Agarwal, Joo L.Ong, Mark R. Appleford, Gopinath Mani. Cambrige University Press, New York- 2016.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | | 2 | | | | | | 2 | 2 | | |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | | | | | 3 | 2 | | |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | | | | | 3 | 2 | | |
| **CO4** | 3 | 2 | 2 | | 2 | | | | | | 2 | 2 | | |
| **CO5** | 3 | 3 | 2 | 2 | 2 | | | | | | 3 | 3 | | |
| **Avg** | **3.00** | **2.60** | **2.40** | **2.00** | **2.00** | | | | | | **2.60** | **2.20** | | |

**1 - Low, 2 - Medium, 3 - High**

**VERTICAL VII - MEDICAL DEVICE INNOVATION AND DEVELOPMENT**
**(B.E - BME)**

| BM24P44 | BIOMEDICAL OPTICS AND PHOTONICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the physical properties of light and optical properties of tissues.
- Studying the design and working principles of optical components.
- Learning the principles and applications of optical biosensors.
- Gaining the knowledge of optical engineering in diagnostic and surgical applications.
- Exploring the laser–tissue interaction and the therapeutic applications of optics.

**UNIT I OPTICAL PROPERTIES 9**

Basic principles of light: reflection, refraction, absorption, polarization, interference, and coherence. Basic laws of light including Beer–Lambert law and Snell's law. Optical properties of tissues such as absorption, scattering, and anisotropy.

**UNIT II OPTICAL INSTRUMENTATION 9**

Working principle of light sources - Lasers - LEDs, Working principle of optical detectors - Photodiode - Spectrometer - CMOS and CCD cameras - Lens - Optical filters - Optical fibers.

**UNIT III OPTICAL BIOSENSORS 9**

Principles of optical biosensing, immobilization of biorecognition elements, types of optical biosensors such as fiber optic, planar waveguide, evanescent, interferometric, and surface plasmon resonance biosensors, advantages, disadvantages, and applications.

**UNIT IV APPLICATIONS OF LASERS 9**

Diagnostic - Optical coherence tomography, Fluorescence, Photoacoustic tomography, Laser induced breakdown spectroscopy, Hyperspectral imaging. Surgical - Lasers in dentistry, Dermatology, Ophthalmology**.**

**UNIT V LASER TISSUE INTERACTION 9**

Laser tissue interactions via photochemical, Photothermal, Photomechanical techniques, Photodynamic therapy (PDT) - Oncological and non-oncological applications, Low level laser therapy (LLLT) - Biostimulation applications.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the optical properties of light and tissues.

**CO2:** Understand the working principles of optical components.

**CO3:** Discuss biomedical applications of biosensors.

**CO4:** Summarize diagnostic and surgical laser applications.

**CO5:** Interpret laser–tissue interaction and therapeutic laser applications.

**TEXT BOOKS:**

1. Tuan Vo Dinh, "Biomedical Photonics –Handbook, CRC Press, Bocaraton, 2014.
2. Jurgen Popp, Valery V. Tuchin, Arthur Chiou and Stefen Heinemann, Handbook of Biophotonics, Vol 2: Photonics for Healthcare, John Wiley and Sons, 1st Edition, 2011.

**REFERENCES:**


1. Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications" Springer, 2007.
2. Splinter R and Hooper B. A., "An Introduction to Biomedical Optics", Taylor and Francis, 2006.
3. Mark E. Brezinski, "Optical Coherence Tomography: Principles and Applications", Academic Press, 2006.
4. Paras N. Prasad, "Introduction to Biophotonics", A. John Wiley and sons, Inc. Publications, 2003.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 3 | | 2 | | | | 2 | 2 | 2 | |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | 2 | | | | 3 | 3 | 2 | |
| **CO3** | 3 | 2 | 2 | 1 | 2 | | 2 | | | | 3 | 3 | 3 | |
| **CO4** | 3 | 2 | 2 | 2 | 3 | | 2 | | | | 3 | 3 | 3 | |
| **CO5** | 3 | 3 | 2 | 2 | 3 | | 2 | | | | 3 | 2 | 2 | |
| **Avg** | **3.00** | **2.40** | **2.00** | **1.80** | **2.60** | | **2.00** | | | | **2.80** | **2.60** | **2.40** | |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE I**
**(Common to B.E – BME, B. Tech - AI&DS)**

| AS24901 | SPACE SCIENCE | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Learning the basics of space science and space environment.
- Studying how the universe was formed.
- Understanding about galaxies and their types.
- Exploring the stars and their life cycle.
- Analyzing the solar system and planets.

**UNIT I INTRODUCTION 9**

Introduction to space science and applications – historical development – Space Environment Vacuum and its Effects, Plasma & Radiation Environments and their Effects, Debris Environment and its Effects - Newton's Law of gravitation .

**UNIT II ORIGIN OF UNIVERSE 9**

Early history of the universe – Big-Bang and Hubble expansion model of the universe – cosmic microwave background radiation – dark matter and dark energy.

**UNIT III GALAXIES 9**

Galaxies, their evolution and origin – Types of galaxies- active galaxies and quasars – Galactic rotation – Stellar populations – galactic magnetic field and cosmic rays- Dark matter in galaxies.

**UNIT IV STARS 9**

Stellar spectra and structure – stellar evolution – Nucleo-synthesis and formation of elements – Classification of stars – Harvard classification system – Hertsprung-Russel diagram – Luminosity of star – variable stars – composite stars (white dwarfs, Neutron stars, black hole, star clusters).

**UNIT V SOLAR SYSTEM 9**

Nebular theory of formation of our Solar System – Solar wind and nuclear reaction as the source of energy – Sun and Planets: Brief description about shape size – period of rotation about axis and period of revolution .

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Summarize space science and gravitation fundamentals.

**CO2:** Explain Big Bang theory and universe expansion.

**CO3:** Identify types of galaxies and their features.

**CO4:** Describe star classification and evolution.

**CO5:** Analyze solar system formation and constituents.

**TEXT BOOKS:**

1. Hess, Wilmot N. Introduction to Space Science. Updated ed., Springer, 2021.
2. Krishnaswami, K. S. Astrophysics: A Modern Perspective. Revised ed., New Age International, 2020.
3. Fraknoi, Andrew, David Morrison, and Sidney C. Wolff. Astronomy. 2nd ed., OpenStax, 2022.

**REFERENCES:**


1. Choudhuri, Arnab Rai. Astrophysics for Physicists. 2nd ed., Cambridge University Press, 2023.
2. Krishnaswami, K. S. Understanding Cosmic Panorama. Revised ed., New Age International, 2021.
3. Bennett, Jeffrey O., et al. The Cosmic Perspective. 10th ed., Pearson, 2023.
4. Karttunen, Hannu, et al. Fundamental Astronomy. 7th ed., Springer, 2024.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | 1 | | | | | | | 3 | |
| **CO2** | 3 | 2 | | 1 | | | | | | | | 2 | 3 | |
| **CO3** | 3 | 2 | | 1 | | | | | | | | 2 | 2 | |
| **CO4** | 3 | 2 | | 2 | | | | | | | | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 1 | 1 | | 1 | 1 | | | | 2 | 3 | 2 | 3 |
| **Avg** | **3.00** | **2.00** | **1.00** | **1.25** | | **1.00** | **1.00** | | | | **2.00** | **2.25** | **2.40** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE I**
**(Common to B.E – BME, ECE & B. Tech - AI&DS)**

| IE24901 | INTRODUCTION TO INDUSTRIAL ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the productivity and ways to measure it.
- Learning the basics of facilities planning and plant location.
- Using the work study and ergonomics to design better workplaces.
- Gaining the skills to apply Statistical Process Control in industries.
- Recognizing how Production and Operations Management builds competitive advantage.

**UNIT I INTRODUCTION 9**

Concepts of Industrial Engineering – History and development of Industrial Engineering – Roles of Industrial Engineer – Applications of Industrial Engineering – Production System – Input Output Model – Productivity – Factors affecting Productivity – Increasing Productivity of resources – Kinds of Productivity measures.

**UNIT II PLANT LOCATION AND LAYOUT 9**

Factors affecting Plant location –of Plant Layout – Principles of Plant Layout – Types of Plant Layout – Methods of Plant and Facility Layout – Storage Space requirements – Plant Layout procedure – Line Balancing methods.

**UNIT III WORK SYSTEM DESIGN& ERGONOMICS 9**

Need – Method Study procedure – Principles of Motion Economy – Work Measurement procedures – Time Study –Work sampling- Ergonomics and its areas of application in the work system - Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing.

**UNIT IV STATISTICAL QUALITY CONTROL 9**

Definition and Concepts – Fundamentals – Control Charts for variables – Control Charts for attributes – Acceptance Sampling –Single sampling plan – Double sampling plan.

**UNIT V PRODUCTION PLANNING AND CONTROL 9**

Forecasting – Qualitative and Quantitative forecasting techniques – Types of production – Process planning – Economic Batch Quantity– Loading – Scheduling and control of production – Dispatching–Progress control.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Define productivity concepts and measurement methods.
**CO2:** Evaluate facility location models and design layouts.
**CO3:** Conduct method and time studies for efficiency.
**CO4:** Apply control charts to manage process quality.
**CO5:** Formulate planning strategies and MRP.

**TEXT BOOKS:**

1. O. P. Khanna, 2010, Industrial Engineering and Management, Dhanpat Rai Publications. recent publications, 17th Edition, 2021.

**REFERENCES:**


1. Salvendy, G. (Ed.), Handbook of Industrial Engineering and Management, Wiley, 2021.
2. Dr. Navin Kumar Dev, Production and Operations Management, Khanna Publishing House, 2026 Edition.
3. Ravi Shankar, Industrial Engineering and Management, Galgotia Publications, 2009
4. Martand Telsang, Industrial Engineering and Production Management, S. Chand & Company, 2006


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 2 | | | | 2 | | 2 | | | |
| **CO2** | 3 | 3 | 3 | 2 | 2 | | | | 2 | | 2 | 2 | | |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | | | 2 | | 2 | 2 | | |
| **CO4** | 3 | 3 | 3 | 2 | 2 | | | | 2 | | 2 | 2 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | | | | 2 | | 2 | 3 | 2 | 3 |
| **Avg** | **3.00** | **3.00** | **2.80** | **2.00** | **2.00** | | | | **2.00** | | **2.00** | **2.25** | **2.00** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE I**
**(Common To B. Tech - AI&DS, B. E - BME, ECE)**

| FD24901 | FOOD, NUTRITION AND HEALTH | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding different food resources from plants, animals and microbes.
- Understanding digestion, absorption and utilization of nutrients.
- Learning the steps involved in food product development.
- Understanding preventive and remedial measures for health problems.
- Studying the role of regulatory agencies and case studies related to GM foods.

**UNIT I FOOD AND MICROBIOLOGY OF HEALTH 9**

Food resources (plant, animal, microbes); Overview of current production systems; constraints and necessity of novel strategies. Functional and "Super" Foods - role in optimal nutrition. Sugar, protein and fat substitutes. Food and behaviour- physiological disturbances in alcoholism, drug abuse and smoking. Food Related Laws: Inspection – Microbial Indicators of product quality – Indicators of food safety – 229 Microbiological safety of foods - control strategies – Hazard Analysis Critical Point System (HACCP concept)- Microbiological criteria.

**UNIT II NUTRIENTS AND FOOD ADDITIVES: 9**

Macro nutrients- carbohydrates, proteins and lipids. Micronutrients-Minerals: Calcium, Magnesium, Iron, Zinc, Copper and Selenium; Vitamins. Nutritional Physiology: Digestion, absorption, and utilization of major and minor nutrients. Biotechnology of food additives- Bioflavors and colors, microbial polysaccharides, recombinant enzymes in food sector.

**UNIT III NANO FOOD TECHNOLOGY 9**

Nano materials as food components, food packaging and nano materials, policies on usage of nanomaterials in foods. Food product development: steps involved in food product development, shelf-life assessment.

**UNIT IV FOOD RELATED NUTRITIONAL DISORDERS AND ENERGY CALCULATION 9**

Type I Disorders-Causes of life style and stress related diseases. Cardio-vascular diseases, hypertension, obesity. Type-II Disorders: Cancer, diabetics, ulcers, electrolyte and water imbalance. Health indices. Preventive and remedial measures. Energy balance and methods to calculate individual nutrient and energy needs. Planning a healthy diet.

**UNIT V CONSUMERS ON GM FOODS AND CONTEMPORARY ISSUES 9**

Global perspective of consumers on GM foods; Major concerns of transgenic, foods GM ingredients in food products. (labeling, bioavailability, safety aspects); regulatory agencies involved in GM foods, Case studies-GM foods.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the nutritional value and health importance of different foods.

**CO2:** Describe the role of nutrients and food additives in human health and metabolism.

**CO3:** Understand the applications of nanotechnology in food processing and packaging.

**CO4:** Identify nutritional disorders, calculate energy needs and plan healthy diets.

**CO5:** Evaluate food safety laws, HACCP principles and issues related to GM foods.

**TEXT BOOKS:**


1. P.J. Fellows.2009. Food Processing Technology -Principles and Practice (Third Edition). A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition.
2. Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto, Robert E. Levin. 2015. Food Biotechnology. CRC Press. Second edition.


**REFERENCE BOOKS:**


1. Understanding Nutrition. 2010. Ellie Whitney, Sharon Rady Rolfes, 11e. Thompson Wadsworth.
2. Nutritional Sciences- From Fundamentals to Food.2013. Michelle McGuire, Kathy A. Beerman, 2 nd e. Thompson Wadsworth.
3. Yasmine Motarjemi, Huub Lelieveld, Food Safety Management - A Practical Guide for the Food Industry (2014), 1st Edition, Academic Press, London, UK


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | 3 | 2 | 2 | 2 | 2 | 2 | | 2 | 3 | 2 | | |
| **CO2** | 3 | | 3 | 2 | 2 | 2 | 2 | 2 | | 2 | 3 | 2 | | |
| **CO3** | 3 | | 3 | 2 | 2 | 2 | 2 | 2 | | 2 | 3 | 2 | | |
| **CO4** | 3 | | 3 | 2 | 2 | 2 | 2 | 2 | | 2 | 3 | 2 | | |
| **CO5** | 3 | | 3 | 2 | 2 | 2 | 2 | 2 | | 2 | 3 | 2 | | |
| **Avg** | **3.00** | | **3.00** | **2.00** | **2.00** | **2.00** | **2.00** | **2.00** | | **2.00** | **3.00** | **2.00** | | |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE I**
**(Common to B.E – BME, B. Tech - AI&DS)**

| CE24902 | ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Imparting the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects.
- Familarizing with various ESIA tools, techniques, and methodologies.

**UNIT I INTRODUCTION TO EIA 9**

Impacts of Development on Environment – Rio Principles of Sustainable Development Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework.

**UNIT II ENVIRONMENTAL ASSESSMENT 9**

Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction.

**UNIT III ENVIRONMENTAL MANAGEMENT PLAN 9**

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Public Hearing-Environmental Clearance.

**UNIT IV SOCIO ECONOMIC ASSESSMENT 9**

Baseline monitoring of Socio-economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis.

**UNIT V SOCIAL IMPACT CASE STUDIES 9**

EIA case studies pertaining to Infrastructure Projects – Roads, Mining and Bridges – Mass Rapid Transport Systems - Airports - Dams and Irrigation projects - Power plants.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Carry out scoping and screening of developmental projects for environmental and social assessments.

**CO2:** Explain different methodologies for environmental impact prediction and assessment.

**CO3:** Plan environmental impact assessments and environmental management plans.

**CO4:** Valuate socio-economic impacts, identify affected persons, and analyze rehabilitation plans and cost-benefit of environmental effects.

**CO5:** Evaluate environmental impact assessment reports.

**TEXT BOOKS:**


1. Canter, R.L, "Environmental impact Assessment ", 2nd Edition, McGraw Hill Inc, New Delhi,1995.
2. Lohani, B., J.W. Evans, H. Ludwig, R.R. Everitt, Richard A. Carpenter, and S.L. Tu, "Environmental Impact Assessment for Developing Countries in Asia", Volume 1 – Overview, Asian Development Bank,1997.
3. Peter Morris, Riki Therivel "Methods of Environmental Impact Assessment", Routledge Publishers,2009.


**REFERENCES:**


1. Becker H. A., Frank Vanclay,"The International handbook of social impact assessment" conceptual and methodological advances, Edward Elgar Publishing,2003.
2. Barry Sadler and Mary McCabe, "Environmental Impact Assessment Training Resource Manual", United Nations Environment Programme,2002.
3. Judith Petts, "Handbook of Environmental Impact Assessment Vol. I and II", Blackwell Science New York, 1998.
4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | | 2 | 2 | | 2 | | 2 | | 3 | |
| **CO2** | | | | | 2 | 3 | 3 | | 2 | | 2 | | 3 | |
| **CO3** | | | | | 2 | 2 | 2 | | 2 | | 2 | | 2 | |
| **CO4** | | | | | | 3 | 3 | | 2 | | 2 | | 2 | 2 |
| **CO5** | | | | | 3 | 3 | 3 | | 3 | | 3 | | 2 | 3 |
| **Avg** | | | | | **2.33** | **2.60** | **2.60** | | **2.20** | | **2.20** | | **2.40** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE I**
**(Common To B. Tech - AI&DS, B. E - BME)**

| EE24901 | RENEWABLE ENERGY SYSTEM | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Providing the knowledge on renewable energy technologies.
- Enabling the solar energy and design of PV system.
- Understanding the wind energy system.
- Familiarizing with various possible hybrid energy systems.
- Imparting knowledge on application of various renewable energy technologies.

**UNIT I INTRODUCTION 6**

Primary energy sources – Classification - renewable vs. non-renewable energy sources - renewable energy scenario in India and word. Current usage and future potential of renewable energy sources in India - development of renewable energy technologies.

**UNIT II SOLAR ENERGY 12**

Solar Radiation and solar energy measurements - Solar Thermal power plants: Solar Collectors - types and its applications - Central receiver power plants – solar pond – Thermal energy storage system with Phase Changing Materials (PCM). Photovoltaic energy generation – Solar cell - types of solar cells and its application – Solar PV power generation schemes: Standalone power system, Grid connected system and Hybrid system.

**UNIT III WIND ENERGY 9**

Introduction on Wind energy, Factors influencing wind, site selection of windmills - Wind energy conversion systems (WECS): Wind turbine components, Classification – Horizontal Axis Wind Turbine (HAWT), Vertical Axis Wind Turbine (VAWT) and types – Wind turbine control systems – Challenges in grid integration.

**UNIT IV BIO-ENERGY 9**

Energy from biomass, Principle of biomass conversion technologies/process and their classification, Biogas generation - types of biogas plants, selection of site for biogas plant, Advantage and disadvantages of biogas generation, Thermal gasification of biomass - biomass gasifies, Application of biomass and biogas plants and their economics – Environmental effects of Biomass.

**UNIT V OTHER TYPES OF ENERGY 9**

Energy conversion from Hydrogen and Fuel cells, Geo thermal energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini- hydel power plants and their economics.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Summarize the importance, classification, future potential of renewable energy and its technologies.

**CO2:** Interpret the operating principles and applications of solar thermal and photovoltaic systems.

**CO3:** Analyze different wind turbine systems, site selection criteria, and grid integration challenges.

**CO4:** Evaluate biomass and biogas conversion technologies along with their environmental and economic impacts.

**CO5:** Explain the concepts and applications of hydrogen energy, geothermal, OTEC, tidal, wave, and mini-hydel power systems.

**TEXT BOOKS:**


1. D. P. Kothari, K. C. Singhal, "Renewable energy sources and emerging technologies", PHI Learning, 2022.
2. Twidell & Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2015.


**REFERENCE BOOKS:**


1. D. S. Chauhan, S. K. Srivastava, "Non – Conventional Energy Resources", New Age International Publishers, 4th Edition 2021.
2. G. N. Tiwari and M. K. Ghosal, "Renewable energy resources: Basic Principles and Applications", Alpha Science International, 2005.
3. B. H. Khan, "Non – Conventional Energy Resources", Tata Mc Graw Hill, 3rd Edition 2017.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | | | | 3 | | | | | 2 | | 3 | |
| **CO2** | 3 | 3 | 3 | 2 | 2 | 3 | | | | | 2 | | 3 | |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 3 | | | | | 2 | | 3 | |
| **CO4** | 3 | 3 | 2 | 2 | 2 | 3 | | | | 2 | 2 | | 3 | |
| **CO5** | 3 | 3 | 2 | 2 | 2 | 3 | | | | 2 | 2 | | 3 | |
| **Avg** | **3.00** | **3.00** | **2.50** | **2.00** | **2.00** | **3.00** | | | | **2.00** | **2.00** | | **3.00** | |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE I**
**(Common To B. Tech - AI&DS, B. E - BME)**

| EI24901 | INTRODUCTION TO INDUSTRIAL INSTRUMENTATION AND CONTROL | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the unit operations involved in process industries and transport systems.
- Studying the evaporators, crystallizers, dryers, distillation, refrigeration, and chemical reactors.
- Learning the unit operations used in the petrochemical industry.
- Understanding the unit operations and processes in thermal power plants.
- Studying the unit operations in the paper and pulp industry.

**UNIT I COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -I 9**

Unit Operation, Measurement and Control -Transport of solid, liquid and gases - Evaporators – Crystallizers- Dryers.

**UNIT II COMMON UNIT OPERATIONS IN PROCESS INDUSTRIES -II 9**

Unit Operation, Measurement and Control: - Distillation – Refrigeration processes – Chemical reactors.

**UNIT II PROCESS MEASUREMENT AND CONTROL IN PETROCHEMICAL INDUSTRY 9**

Process flow diagram of Petro Chemical Industry - Gas oil separation in production platform – wet gas processing – Fractionation Column – Catalytic Cracking unit – Catalytic reforming unit.

**UNIT IV PROCESS MEASUREMENT AND CONTROL IN THERMAL POWER PLANT INDUSTRY 9**

Process flow diagram of Coal fired thermal Power Plant– Coal pulverizer - Deaerator – Boiler drum - Superheater – Turbines.

**UNIT V PROCESS MEASUREMENT AND CONTROL IN PAPER & PULP INDUSTRY 9**

Process flow diagram of paper and pulp industry – Batch digestor – Continuous sulphate digestor –Control problems on the paper machine.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the basic unit operations used in process industries such as transport systems, evaporators, crystallizers, and dryers.

**CO2:** Explain the basic unit operations used in process industries including distillation, refrigeration processes, and chemical reactors.

**CO3:** Identify and understand the working dynamics of important unit operations in the petrochemical industry.

**CO4:** Identify and understand the working dynamics of important unit operations in Thermal power plant industry.

**CO5:** Identify and understand the working dynamics of important unit operations in paper & pulp industry.

**TEXT BOOKS:**


1. Balchen ,J.G., and Mumme, K.J., " Process Control structures and applications", Van Nostrand Reinhold Co., New York, 1988
2. Warren L. McCabe, Julian C. Smith and Peter Harriot, "Unit Operations of Chemical Engineering", McGraw-Hill International Edition, New York, Sixth Edition, 2001.


**REFERENCE BOOKS:**


1. Liptak B.G., "Instrument and Automation Engineers' Handbook: Process Measurement and Analysis", Fifth Edition, CRC Press, 2016.
2. James R.couper, Roy Penny, W., James R.Fair and Stanley M.Walas, "Chemical Process Equipment: Selection and Design", Gulf Professional Publishing, 2010.
3. Austin G.T and Shreeves, A.G.T., "Chemical Process Industries", McGraw–Hill International student, Singapore, 1985.
4. Luyben W.C., "Process Modeling, Simulation and Control for Chemical Engineers",
5. McGraw-Hill International edition, USA, 1989.
6. K. Krishnaswamy, Process Control, new age publishers, 2009.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | | | | | 3 | 2 | | 2 | | 3 | 2 | |
| **CO2** | 3 | 3 | | | | | 3 | 2 | | 2 | | 3 | 2 | |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | | 2 | 2 | 3 | 2 | |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | | 2 | 2 | 3 | 2 | |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | | 2 | 2 | 3 | 2 | |
| **Avg** | **3.00** | **3.00** | **2.00** | **3.00** | **3.00** | **2.00** | **3.00** | **2.00** | | **2.00** | **2.00** | **3.00** | **3.00** | |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE I**
**(Common to B.E – BME, CSE, ECE & B. Tech - AI&DS, IT)**

| MA24901 | GRAPH THEORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the graph models and basic concepts of graphs.
- Studying the characterization and properties of trees and graph connectivity.
- Providing an exposure to the Eulerian and Hamiltonian graphs.
- Introducing Graph colouring and explain its significance.
- Describing the Optimization Graph Algorithms.

**UNIT I INTRODUCTION TO GRAPHS 9**

Graphs and Graph Models – Connected graphs – Common classes of graphs – Multi graphs and Digraphs – Degree of a vertex – Degree Sequence – Graphs and Matrices – Isomorphism of graphs.

**UNIT II TREES AND CONNECTIVITY 9**

Bridges – Trees – Characterization and properties of trees – Cut vertices – Cut edges – Connectivity.

**UNIT III TRAVERSABILITY 9**

Eulerian graphs – Characterization of Eulerian graphs – Hamiltonian graphs – Necessary condition for Hamiltonian graphs – Sufficient condition for Hamiltonian graphs.

**UNIT IV PLANARITY AND COLOURING 9**

Planar Graphs – The Euler Identity – Non planar Graphs – Vertex Colouring – Lower and Upper bounds of chromatic number.

**UNIT V OPTIMIZATION GRAPH ALGORITHMS 9**

Dijkstra's shortest path algorithm – Kruskal's and Prim's minimum spanning tree algorithms – Transport Network – The Max-Flow Min-Cut Theorem – The Labeling Procedure – Maximum flow problem.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Apply graph models for solving real world problem.

**CO2:** Explain the importance the natural applications of trees and graph connectivity.

**CO3:** Demonstrate the characterization study of Eulerian graphs and Hamiltonian graphs.

**CO4:** Analyze the graph colouring concepts in partitioning problems.

**CO5:** Explore the standard optimization graph algorithms in solving application problems.

**TEXT BOOKS:**

1. Bondy, J. A. and Murty, U.S.R., "Graph Theory with Applications", North Holland Publication,2008.
2. Gary Chatrand and Ping Zhang, “Introduction to Graph Theory”, Tata McGraw – Hill companies Inc., New York, 2006.

**REFERENCES:**

1. Ralph P. Grimaldi, “Discrete and Combinatorial Mathematics, An applied introduction" Fifth edition, Pearson Education, Inc, S
2. Balakrishnan R. and Ranganathan K., “A Text Book of Graph Theory”, Springer – Verlag, New York, 2012. 225.
3. Douglas B. West, “Introduction to Graph Theory”, Pearson, Second Edition, New York, 2018.
4. Diestel, R, "Graph Theory", Springer,3rd Edition,2006.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | | | | | | | | | | 3 | |
| **CO2** | | 2 | 2 | | 2 | | | | | | | | 3 | |
| **CO3** | | 2 | 2 | 2 | | | | | 3 | | | | 2 | |
| **CO4** | 3 | 2 | 2 | | | | | | | | | | 2 | 2 |
| **CO5** | | 3 | 2 | 2 | | | | | 3 | | | | 2 | 3 |
| **Avg** | **3.00** | **2.40** | **2.20** | **2.00** | **2.00** | | | | **3.00** | | | | **2.40** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE I**
**(Common to: B.E-BME, ECE)**

| AD24906 | NEURAL NETWORKS AND DEEP LEARNING | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 2 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamental concepts of deep neural networks.
- Comprehending associative memory models and unsupervised learning networks.
- Applying Convolutional Neural Network (CNN) architectures for solving real-world problems.
- Analyzing core computations in deep learning and utilize them to design and train neural networks for various applications.
- Implementing autoencoders and generative models for practical use cases.

**UNIT I INTRODUCTION 6**

Neural Networks- Artificial Neural Network: An Introduction Evolution of Neural Networks-Basic Models of Artificial Neural Network- Important Terminologies of ANNs.

**UNIT II ASSOCIATIVE MEMORY AND UNSUPERVISED LEARNING NETWORKS 6**

Training Algorithms for Pattern Association-Autoassociative and Heteroassociative Memory Network-Bidirectional Associative Memory (BAM)-Hopfield Networks-Temporal Associative Memory Network-Fixed Weight Competitive Nets-Kohonen Self-Organizing Feature Maps-Learning Vector Quantization.

**UNIT III THIRD-GENERATION NEURAL NETWORKS 6**

Spiking Neural Networks-Convolutional Neural Networks-Deep Learning Neural Networks-Extreme Learning Machine Model-Convolutional Neural Networks: The Convolution Operation – Motivation – Pooling – Variants of the basic Convolution Function – Structured Outputs – Data Types– Efficient Convolution Algorithms.

**UNIT IV DEEP FEEDFORWARD NETWORKS 6**

History of Deep Learning- A Probabilistic Theory of Deep Learning- Gradient Learning – Chain Rule and Backpropagation – Optimization Techniques – Regularization – Dropout – Batch normalization.

**UNIT V RECURRENT NEURAL NETWORKS 6**

Recurrent Neural Networks: Introduction – Recursive Neural Networks – Bidirectional RNNs – Deep Recurrent Networks – Applications: Image Generation, Image Compression, Natural Language Processing.

**TOTAL PERIODS: 30**

**LIST OF EXPERIMENTS**

1. (a) Implement simple vector operations (addition, multiplication) in TensorFlow.
   (b) Implement a regression model in Keras.
2. Implement a perceptron in TensorFlow/Keras Environment.
3. (a) Implement a Feed-Forward Network in TensorFlow/Keras.
   (b) Implement an Image Classifier using CNN in TensorFlow/Keras.

4. (a) Improve the Deep learning model by fine tuning hyper parameters.
   (b) Implement a Transfer Learning concept in Image Classification.
5. Using a pre trained model on Keras for Transfer Learning.
6. Implement an LSTM based Autoencoder in TensorFlow/Keras.
7. Image generation using GAN.

**TOTAL PERIODS: 30**
**TOTAL PERIODS: 60**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Apply Convolutional Neural Networks for image processing tasks.
**CO2:** Explain the principles of associative memory and unsupervised learning networks.
**CO3:** Utilize CNN architectures and their variants for real-world applications.
**CO4:** Analyze fundamental computations in deep learning and develop models for various tasks.
**CO5:** Implement autoencoders and generative models for practical applications.

**TEXT BOOKS:**


1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", Alanna Maldonado, 2023.
2. Francois Chollet, Matthew Watson, "Deep Learning with Python", Manning Publications, Third Edition, 2025.


**REFERENCES:**


1. Aurélien Géron, "Hands-On Machine Learning with Scikit-Learn and TensorFlow", O'Reilly, 3rd Edition, 2022.
2. Josh Patterson, Adam Gibson, "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.
3. Charu C. Aggarwal, "Neural Networks and Deep Learning: A Textbook", Springer International Publishing, 1st Edition, 2018.
4. Jojo Moolayil, "Learn Keras for Deep Neural Networks", Apress,2018.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 3 | | | | | | | 3 | 3 | 2 |
| **CO2** | 3 | 2 | 1 | 2 | 2 | | | | | | | 2 | 2 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | | | | 1 | 1 | | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | | | | 1 | | | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | | | | | | | 3 | 3 | 3 |
| **Avg** | **3.0** | **2.8** | **2.2** | **2.4** | **2.8** | | | | **1.0** | **1.0** | | **2.8** | **2.8** | **2.4** |

**1 - Low, 2 - Medium, 3 – High**

**LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS**

| Sl. No. | Description of Equipment | Required numbers |
|---|---|---|
| 1 | Personal System | 30 |
| 2 | Python (V 3.8+) and Anaconda Distribution | 30 |
| 3 | VS Code (coding + debugging alternative) | 30 |
| 4 | Open-Source Python Libraries (NumPy, SciPy, Matplotlib, Scikit-learn) | |

**OPEN ELECTIVE I**
**(Common To B. E - BME, ECE)**

| CS24901 | DIGITAL MARKETING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of online and digital marketing.
- Learning SEO, SEM, and digital advertising techniques.
- Gaining knowledge of email marketing and campaign management.
- Exploring the social media and customer engagement strategies.
- Analyzing the digital marketing trends and web analytics.

**UNIT I INTRODUCTION TO ONLINE MARKET 9**

Online Market space- Digital Marketing Strategy- Components - Opportunities for building Brand Website - Planning and Creation - Content Marketing.

**UNIT II SEARCH ENGINE OPTIMISATION 9**

Search Engine Optimization (SEO) – Keyword Strategy – SEO Planning and Strategy – SEO Success Factors – On-Page Optimization Techniques – Off-Page Optimization Techniques – Search Engine Marketing (SEM) – Working of Search Engines – SEM Components – Pay Per Click (PPC) Advertising – Display Advertising.

**UNIT III E- MAIL MARKETING 9**

E- Mail Marketing - Types of E- Mail Marketing - Email Automation - Lead Generation - Integrating Email with Social Media and Mobile- Measuring and maximizing email campaign effectiveness

**UNIT IV SOCIAL MEDIA MARKETING 9**

Social Media Marketing - Social Media Channels- Leveraging Social media for brand conversations and buzz. Successful /benchmark Social media campaigns. Engagement Marketing- Building Customer relationships - Creating Loyalty drivers - Influencer Marketing.

**UNIT V DIGITAL TRANSFORMATION 9**

Digital Transformation & Channel Attribution- Analytics- Ad-words, Email, Mobile, Social Media, Web Analytics - Changing your strategy based on analysis- Recent trends in Digital marketing.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Understand digital marketing concepts and strategies.
**CO2:** Apply SEO and SEM techniques for online promotion.
**CO3:** Use email marketing tools for campaigns and lead generation.
**CO4:** Analyze social media marketing and customer engagement.
**CO5:** Evaluate digital marketing trends and analytics.

**TEXT BOOKS:**

1. Digital Marketing Strategy: An Integrated Approach to Online Marketing (3rd Edition) – Simon Kingsnorth, Kogan Page, 2022.
2. Digital Marketing Excellence: Planning, Optimizing and Integrating Online Marketing (7th Edition) – Dave Chaffey & PR Smith, Routledge, 2022.

**REFERENCE BOOKS:**

1. SEO 2024: Learn Search Engine Optimization – Adam Clarke, Independently Published, 2024.
2. Email Marketing Rules (4th Edition) – Chad S. White, Wiley, 2023.
3. Jab, Jab, Jab, Right Hook – Gary Vaynerchuk, HarperBusiness, 2022 reprint edition.
4. Marketing 5.0: Technology for Humanity – Philip Kotler, Hermawan Kartajaya & Iwan Setiawan, Wiley, 2021 (latest reprints 2023–2025).
5. Digital Marketing Analytics – Chuck Hemann & Ken Burbary, Que Publishing, 2023 reprint edition. Fundamentals of Digital Marketing – Puneet Singh Bhatia, Pearson India, 2023.
6. Social Media Marketing: Principles and Practice – Puneet Singh Bhatia, Pearson India, 2022

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 1 | 3 | | | | 1 | 2 | 3 | 3 | 3 | 3 |
| **CO2** | 2 | 2 | 2 | 1 | 3 | | | | 1 | 2 | 3 | 3 | 3 | 3 |
| **CO3** | 1 | 1 | 1 | 2 | 2 | | | | 1 | 2 | 1 | 3 | 2 | 1 |
| **CO4** | 3 | 2 | 2 | 3 | 1 | | | | 1 | 3 | 2 | 2 | 3 | 2 |
| **CO5** | 2 | 3 | 1 | 3 | 3 | | | | 2 | 3 | 1 | 1 | 2 | 1 |
| **Avg** | **2.20** | **2.20** | **1.60** | **2.00** | **2.40** | | | | **1.20** | **2.40** | **2.00** | **2.40** | **2.60** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE II**
**(Common to: B.E-BME, CSE & B.Tech-AI&DS, IT)**

| IE24902 | RESOURCE MANAGEMENT TECHNIQUES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Formulating the linear programming problems and solve LPP using simple algorithm.
- Solving the networking problems.
- Formulating and solving integer programming problems.
- Solving the Non-Linear programming problems.
- Understanding and solving the project management problems.

**UNIT I LINEAR PROGRAMMING 9**

LP formulation and graphic solution – Resource allocation problems – simplex method – sensitivity analysis.

**UNIT II DUALITY AND NETWORKS 9**

Definition of dual problems – primal – Dual relationships – Dual simplex method –post optimality analysis – Transportation and assignment model – Shortest route problem.

**UNIT III INTEGER PROGRAMMING 9**

Cutting plan algorithm – Branch and bound methods, Multistage (Dynamic) programming.

**UNIT IV CLASSICAL OPTIMIZATION THEORY 9**

Unconstrained external problems, Newton – Raphson method – Equality constraints –Jacobean methods – Lagrangian method – Kuhn – Tucker conditions – Simple problems.

**UNIT V OBJECT SCHEDULING 9**

Network diagram representation – Critical path method – Time charts and resource levelling – PERT.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

**CO1:** Use Simplex method to solve optimization problems
**CO2:** Solve the problems to find minimum cost and shortest route.
**CO3:** Apply integer programming to solve real-life applications.
**CO4:** Apply the methods to solve Non-linear programming problems.
**CO5:** Use PERT &CPM for project management.

**TEXT BOOKS:**

1. H.A. Taha, “Operation Research”, Prentice Hall of India, 2002.

**REFERENCES:**


1. Paneer Selvam, „Operations Research", Prentice Hall of India, 2002.
2. Anderson "Quantitative Methods for Business", 8th Edition, Thomson Learning, 2002.
3. Winston "Operation Research", Thomson Learning, 2003.
4. Vohra, "Quantitative Techniques in Management", Tata Mc Graw Hill, 2002.
5. Anand Sarma, "Operation Research", Himalaya Publishing House, 2003.


## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | 2 | 2 | | | | | | 1 | 2 | 1 | 2 | 2 | 3 |
| **CO2** | 1 | 2 | 2 | | | | | | 1 | | 2 | 2 | 3 | 2 |
| **CO3** | 2 | 3 | 1 | | | | | | 1 | 1 | 1 | 1 | 3 | 2 |
| **CO4** | 2 | 1 | | | | | | | 1 | | 1 | 2 | 3 | 2 |
| **CO5** | 1 | 2 | 1 | | | | | | | 1 | | 2 | 3 | 3 |
| **Avg** | **1.40** | **2.00** | **1.50** | | | | | | **1.00** | **1.33** | **1.25** | **1.80** | **2.80** | **2.40** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE II**
**(Common to: B.E-BME, ECE & B.TECH-AI&DS)**

| MG24901 | FINTECH REGULATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of FinTech and the role of financial regulations.
- Introducing the concepts and regulatory aspects of Financial Technology
- Understanding the crowdfunding models, digital assets, and cryptocurrency regulations.
- Exploring the digital lending systems and consumer protection laws.
- Examining the cybersecurity, anti-money laundering practices, and compliance requirements in Fintech.

**UNIT I INTRODUCTION 9**

The Role of the Regulators, Equal Treatment and Competition, Need for a regulatory assessment of Fintech, India Regulations, The Risks to Consider, Regtech and SupTech, The rise of TechFins, Regulatory sandboxes, compliance and whistleblowing.

**UNIT II INNOVATION AND REGULATION 9**

The technology, market and the law, Regulation and Innovation in Banking and Finance, Regulations of Fintech Firms and their role in Market-Based Chains, Current Regulatory Approach, Fintech Innovations in Banking, Asset Management, Insurance, Pensions and Healthcare Schemes, Patentability of FinTech inventions.

**UNIT III CROWDFUNDING AND DIGITAL ASSETS 9**

Types of crowdfunding, The Jobs Act, Regulation crowdfunding, Regulation A+, Regulation D crowdfunding, Intrastate offerings, Digital Assets – Three uses of Digital Assets, A world of Altcoins, Stablecoins, Digital Asset Forks, Initial Coin Offerings, Regulatory Framework for Digital and Crypto Assets, Central Bank Digital Currencies.

**UNIT IV MARKETPLACE LENDING AND MOBILE PAYMENTS 9**

Online Lending Business Models, Payday Loans, Consumer Protection Laws, Debt Collection, Equal Credit Opportunity Act, Contract Formation and the E-Sign Act, Military Lending Act, Securities Laws Considerations, Mobile Devices, Payment Cards and the Law, Truth in Lending Act and Regulation Z, Card Act, Electronic Fund Transfer Act and Regulation E, Fair Credit Reporting Act, Federal Bank Secrecy Act, State Money Transmitter Laws.

**UNIT V ANTI-MONEY LAUNDERING AND CYBERSECURITY 9**

Reporting requirements under the Bank Secrecy Act, Patriot Act, Penalties for violating the BSA, Virtual currencies and the Bank Secrecy Act, Cybersecurity Frameworks, Cybersecurity Act of 2015, Contractual and Self-Regulatory obligations.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

**CO1:** Explain FinTech regulations, compliance, and associated risks.
**CO2:** Analyze innovation and regulatory aspects in digital finance systems.
**CO3:** Interpret crowdfunding, digital assets, and crypto regulations.
**CO4:** Examine lending platforms, mobile payments, and transaction laws.
**CO5:** Apply AML regulations and cybersecurity frameworks in FinTech environments.

**TEXT BOOKS:**


1. Gupta, C. M., and Gagandeep Kaur, editors. "E-Banking, FinTech, & Financial Crimes: The Current Economic and Regulatory Landscape", Springer, 2024.
2. Joshi, V. C., "Changing Dimensions of Financial Services and Banking Regulation: Cases and Perspectives from India within an International Context", Palgrave Macmillan, 2025.


**REFERENCES:**


1. Kevin C. Taylor," FinTech Law: A Guide to Technology Law in the Financial Services Industry", BNA Books, 2014.
2. Jelena Madir, "FinTech 3 Law and Regulation", Edward Elgar Publishing Limited, 2019.
3. Valerio Lemma, "Fintech Regulation: Exploring New Challenges of the Capital Markets Union", Palgrave Macmillan, 2020.
4. Chris Brummer, "Fintech Law in a Nutshell", West Academic Publishing, 2020.
5. Bernardo Nicoletti, "The Future of Fintech, Integrating Finance and Technology in Financial Services", Springer Nature, 2017.


## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | 2 | 3 | | 3 | | 2 | 2 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 2 | | 2 | | 2 | 2 | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | 3 | 2 | | 2 | | 1 | 2 | 1 | 3 | 2 |
| **CO4** | 2 | 3 | 2 | 2 | 3 | 3 | | 2 | | 2 | 3 | 2 | 3 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | 3 | 3 |
| **Avg** | **2.80** | **2.60** | **2.00** | **2.00** | **2.60** | **2.60** | **2.00** | **2.40** | **1.00** | **1.80** | **2.20** | **1.80** | **2.80** | **2.40** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE II**
**(Common To B. TECH - AI&DS, B.E - BME)**

| FD24903 | HOLISTIC NUTRITION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of nutrition, metabolism, and essential nutrients.
- Learning the holistic and Ayurvedic principles in diet and lifestyle planning.
- Analyzing the role of nutrition, environment, and food safety in health.
- Studying different dietary approaches for health and wellness.
- Exploring the preventive nutrition, nutraceuticals, and antioxidants in managing lifestyle diseases.

**UNIT I NUTRITION AND HEALTH 9**

Introduction to the principles of nutrition; Basics of nutrition including; micronutrients (vitamins and minerals), the energy-yielding nutrients (Carbohydrates, Lipids and Proteins), metabolism, digestion, absorption and energy balance. Lipids: their functions, classification, dietary requirements, digestion & absorption, metabolism and links to the major fatal diseases, heart disease and cancer.

**UNIT II AYURVEDA – MIND/BODY HEALING 9**

Philosophy of Holistic Nutrition with spiritual and psychological approaches towards attaining optimal health; Principles and practical applications of Ayurveda, the oldest healing system in the world. Three forces – Vata, Pitta and Kapha, that combine in each being into a distinct constitution. Practical dietary and lifestyle recommendations for different constitutions will also be explored in real case studies.

**UNIT III NUTRITION AND ENVIRONMENT 9**

Based on an underlying philosophy that environments maintain and promote health and that individuals have a right to self-determination and self-knowledge, Nutrition principles which promote health and prevent disease. Safety of our food supply, naturally occurring and environmental toxins in foods, microbes and food poisoning.

**UNIT IV COMPARATIVE DIETS 9**

Evaluating principles of food dynamics, nutrient proportions, holistic individuality, the law of opposites, food combining, and more. Therapeutic benefits and limitations of several alternative diet approaches, including: modern diets (intermittent fasting), food combining (colour-therapy/rainbow diet), high protein diets (Paleo), Vegetarian approaches (plant-based/vegetarian/vegan variations, fruitarian), as well as cleansing and detoxification diets (caffeine, alcohol, and nicotine detoxes, juice fasts).

**UNIT V PREVENTIVE HEALTH CARE 9**

Proper nutrition protection against, reverse and/or retard many ailments including osteoporosis, diabetes, atherosclerosis and high blood pressure, arthritis, cancer, anemia, kidney disease and colon cancer. Current research developments on phytochemicals, antioxidants and nutraceuticals will be explored.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain nutrition principles, metabolism, and the role of macro- and micronutrients.

**CO2:** Apply holistic and Ayurvedic concepts for dietary and lifestyle recommendations.

**CO3:** Analyze the role of nutrition, environment, and food safety in disease prevention.

**CO4:** Evaluate modern and alternative dietary approaches.

**CO5:** Assess preventive nutrition, nutraceuticals, and antioxidants in lifestyle disorders.

**TEXT BOOKS:**


1. Desai, B. B., Handbook of Nutrition and Diet. Marcel Dekker, New York. 2000
2. Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press


**REFERENCES:**


1. Modern Nutrition in Health & Disease by Young & Shils.
2. Food, Nutrition and Diet Therapy – by Krause and Mahan 1996, Publisher- W.B. Saunders, ISBN: 0721658350
3. Nutritive Value of Indian Foods.- by C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian Published by National Institute of Nutrition, Indian Council of Medical Research, 1989


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | | 2 | | 2 | | | | | 2 | 2 | | 2 |
| **CO2** | 2 | 3 | 3 | 2 | | 3 | | | | | 2 | 2 | | 3 |
| **CO3** | 2 | 3 | 3 | 2 | | 3 | | | | | 2 | 2 | | 3 |
| **CO4** | 2 | 3 | 3 | 2 | | 3 | | | | | 2 | 2 | | 3 |
| **CO5** | 2 | 3 | 3 | 2 | | 2 | | | | | 2 | 2 | | 3 |
| **Avg** | **2.00** | **2.80** | **3.00** | **2.00** | | **2.60** | | | | | **2.00** | **2.00** | | **2.80** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE II**
**(Common to: B.E-BME, CSE, ECE, EEE & B.TECH-AI&DS, IT)**

| AI24902 / AI24903 | IT IN AGRICULTURAL SYSTEM | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Introducing the precision agriculture technologies and their role in improving farm productivity.
- Understanding the environment control systems used in greenhouse and controlled farming.
- Developing the knowledge in agricultural systems management and optimization techniques.
- Analyzing the weather prediction models and their application in agricultural planning.
- Familiarizing the students with e-governance, ICT tools, and digital systems in agriculture.

**UNIT I PRECISION FARMING 9**

Introduction to Precision Agriculture, Agricultural Management using Technology, Ground-Based Sensors, Remote Sensing in Agriculture, GPS Technology in Farming, GIS and mapping software, Yield mapping systems, Crop production modeling.

**UNIT II ENVIRONMENT CONTROL SYSTEMS 9**

Artificial lighting systems for controlled plant growth, Management of crop growth in greenhouse environments, Simulation of $CO_2$ consumption in greenhouses, Online measurement and monitoring of plant growth, Models of plant production in controlled environments, Introduction to expert systems in horticulture.

**UNIT III AGRICULTURAL SYSTEMS MANAGEMENT 9**

Overview of agricultural systems and management principles, Reliability and performance of agricultural systems, Simulation of crop growth and field operations, Optimization of resources (water, fertilizers, labor), Basics of linear programming in agriculture, Project scheduling techniques, Role of artificial intelligence and decision support systems.

**UNIT IV WEATHER PREDICTION MODELS 9**

Importance of climate variability in agriculture, Basics of seasonal forecasting, Understanding global climate systems, Introduction to global climate models, Application of climate forecasts in agriculture, Systems approach for using seasonal predictions.

**UNIT V E-GOVERNANCE IN AGRICULTURAL SYSTEMS 9**

Introduction to expert systems and decision support systems, Agricultural and biological databases, Concepts of e-commerce and e-business in agriculture, Technology-enhanced learning systems (e-learning), Role of ICT in rural development, Information society and digital agriculture initiatives.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

**CO1:** Demonstrate precision agriculture technologies (sensors, GPS, GIS, modeling) for farm management.

**CO2:** Analyze controlled environment systems for greenhouse-based crop production.

**CO3:** Optimize agricultural systems using management and decision-making techniques.

**CO4:** Evaluate climate data and forecasting models for agricultural planning.

**CO5:** Implement ICT tools and digital platforms in agricultural applications.

**TEXT BOOKS:**


1. National Research Council, "Precision Agriculture in the 21st Century", National Academies Press, Canada, 1997.
2. H. Krug, Liebig, H.P. "International Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation", 1989.


**REFERENCES:**


1. Peart, R.M., and Shoup, W. D., "Agricultural Systems Management", Marcel Dekker, New York, 2004.
2. Hammer, G.L., Nicholls, N., and Mitchell, C., "Applications of Seasonal Climate", Springer, Germany, 2000.


## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 3 | | 2 | | | | | 2 | 3 | |
| **CO2** | 2 | 3 | 2 | 2 | 2 | | 3 | | | | | 1 | 2 | |
| **CO3** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | | | | 2 | 2 | 3 | 2 |
| **CO4** | 2 | 3 | 1 | 3 | 2 | 2 | 3 | | | | 2 | 2 | 2 | 3 |
| **CO5** | 2 | 2 | 2 | 2 | 3 | 2 | 2 | | | | 2 | 3 | 3 | |
| **Avg** | **2.40** | **2.60** | **2.00** | **2.20** | **2.40** | **2.00** | **2.40** | | | | **2.00** | **2.00** | **2.60** | **2.50** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE II**
**(Common to: B.E-BME, ECE & B.TECH-AI&DS)**

| EE24903 | PLC AND SCADA | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of PLC and safety standards used in industrial automation.
- Developing the knowledge of PLC programming concepts and languages for automation applications.
- Acquiring the knowledge on the basic concepts, components and functions of SCADA systems used for industrial monitoring and control.
- Learning the industrial communication protocols and their applications in process automation systems.
- Analyzing the designing and implementing PLC programs for industrial control applications.

**UNIT I INTRODUCTION TO PLC AND SAFETY 9**

Introduction to Programmable Logic Controller (PLC) – PLC block diagram and working – PLC programming languages and basic instructions – Alarm and interlock design – PLC networking basics – Safety concepts in PLC with examples – Process safety using PLC – Introduction to IEC 61131-3 standards and their role in safety control.

**UNIT II PLC PROGRAMMING USING IEC61131-3 9**

Basic PLC programming concepts: rails, rungs, relay logic and latch switch – Timers and counters – Boolean logic and mathematical instructions – Data handling instructions – PLC communication and PLC-to- computer communication – Introduction to Function Block Diagram (FBD), Ladder Logic (LL), Instruction List (IL), Sequential Function Chart (SFC) and Structured Text (ST).

**UNIT III INTRODUCTION TO SCADA 9**

Overview of SCADA system – Elements and history of SCADA – Remote Terminal Unit (RTU) – Discrete and analog control systems – Master Terminal Unit (MTU) – Operator interface and monitoring functions.

**UNIT IV HART AND FIELD BUS COMMUNICATION 9**

Introduction to industrial communication standards – HART communication protocol and working – Communication modes, networks and commands in HART – HART and OSI model basics – Introduction to Field Bus, architecture, standards, topology, interoperability and interchangeability.

**UNIT V PLC PROGRAMMING APPLICATIONS 9**

PLC programming exercises using IEC61131-3 languages – Traffic light control (two-way and four-way) – Water level control – Automatic material sorting and bottle filling systems – Code converters – DC motor control – Alarm circuit design.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

**CO1:** Explain PLC architecture and safety standards used in industrial automation.

**CO2:** Develop simple PLC programs using IEC61131-3 programming languages and instruction sets.

**CO3:** Describe SCADA components and apply basic monitoring and control concepts in industrial systems.

**CO4:** Explain HART and Field Bus communication concepts and their role in industrial automation.

**CO5:** Design PLC-based control programs for selected industrial applications.

**TEXT BOOKS:**


1. Frank D.Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw-Hill, New York, 2019.
2. Stuart Boyer A, "SCADA: Supervisory control and data Acquisition", ISA - The Instrumentation, Systems, and Automation Society, 4th Edition, 2010.


**REFERENCES:**


1. Frank D.Petruzella, "Programmable Logic Controllers", 5th Edition, 2020.
2. John W. Webb and Ronald A. Reis, "Programmable Logic Controllers: Principles and Applications", 6th Edition, 2019.
3. W.Bolton, "Programmable Logic Controllers", 6th Edition, 2015.
4. Stuart A.Boyer, "SCADA: Supervisory Control and Data Acquisition", 5th Edition, 2018.
5. Bela G.Liptak, "Instrument Engineers' Handbook: Process Control and Optimization", 5th Edition, 2018.
6. William Stallings, "Data and Computer Communications", 11th Edition, 2020.


## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | | | | | 2 | | 3 | 2 | 2 | 3 |
| **CO2** | 2 | 2 | 2 | 2 | | | | | 2 | | 3 | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | | | | | 2 | | 3 | 1 | 3 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | | | | | 2 | | 3 | 2 | 3 | 2 |
| **CO5** | 3 | 2 | 2 | 2 | | | | | 2 | | 3 | 2 | 3 | 3 |
| **Avg** | **2.60** | **2.00** | **2.00** | **2.00** | | | | | **2.00** | | **3.00** | **1.80** | **2.80** | **2.40** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE II**
**(Common to: B.E-BME, ECE)**

| CS24904 | DEVOPS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of DevOps principles and practices.
- Learning continuous integration, deployment, and automation.
- Exploring the containerization, orchestration, and DevOps tools.
- Studying the monitoring and infrastructure automation.
- Building the DevOps pipelines for software development.

**UNIT I INTRODUCTION 9**

Introduction to DevOps – Evolution of software development practices – Agile and DevOps culture – DevOps lifecycle – Continuous Integration (CI) and Continuous Deployment (CD) – Version control systems – DevOps architecture – Benefits and challenges of DevOps – Overview of DevOps tools.

**UNIT II VERSION CONTROL AND CONTINUOUS INTEGRATION 9**

Git fundamentals – Repository management – Branching and merging – Git workflows – Build automation – Jenkins architecture and configuration – Continuous Integration pipelines – Automated testing – Dependency management – Source code quality analysis.

**UNIT III CONTAINERIZATION AND ORCHESTRATION 9**

Introduction to containerization – Docker architecture – Docker images and containers – Dockerfile creation – Container networking and storage – Kubernetes architecture – Pod, deployment, and service management – Container orchestration concepts – Scaling and load balancing.

**UNIT IV CONFIGURATION MANAGEMENT AND CLOUD DEVOPS 9**

Infrastructure as Code (IaC) – Configuration management tools – Ansible fundamentals – Terraform basics – Cloud computing concepts – DevOps in AWS/Azure/GCP – Deployment automation – Serverless computing – Security practices in DevOps.

**UNIT V MONITORING, LOGGING, AND ADVANCED DEVOPS PRACTICES 9**

Monitoring and logging concepts – Prometheus and Grafana basics – ELK stack overview – Incident management – CI/CD pipeline optimization – DevSecOps principles – Site Reliability Engineering (SRE) concepts – AI for DevOps (AIOps) – Future trends in DevOps.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

**CO1:** Understand DevOps principles and SDLC practices.
**CO2:** Use version control and continuous integration.
**CO3:** Apply containerization and orchestration tools.
**CO4:** Study infrastructure automation and cloud DevOps.
**CO5:** Build and manage CI/CD pipelines.

**TEXT BOOKS:**

1. Varghese Chacko, "DevOps with Python: Automating Infrastructure and CI/CD Pipelines", BPB Publications, 2025.
2. Len Bass, "DevOps: A Software Architect's Perspective", Pearson India, 2016.

**REFERENCES:**


1. Sricharan Vadapalli, "Hands-on DevOps: Explore Continuous Delivery and Integration", Packt Publishing India, 2017.
2. Chinmaya Kumar Dehury and Satish Narayana Srirama, "Mastering DevOps: A Cloud Engineering Perspective", Elsevier, 2026.
3. Aruna Ravichandran, Kieran Taylor and Peter Waterhouse, "DevOps for Digital Leaders", Springer, 2016.
4. Sricharan Vadapalli, "Continuous Integration, Delivery and Deployment Practices", Packt, 2018.
5. Abhinav Krishna Kaiser and Vamshi Meda, "AI Integration in DevOps and Software Operations", Springer, 2024.
6. Adarsh Saxena et al., "DevOps Automation Pipeline with Infrastructure as Code (IaC)", 2025.


## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | 1 | | | | – | 1 | 2 | 2 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | 1 | 1 | 2 | 3 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | | | | 1 | 1 | 2 | 3 | 3 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 3 | 1 | | | 1 | 1 | 3 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 1 | | | 2 | 2 | 3 | 3 | 3 | 3 |
| **Avg** | **3.00** | **2.80** | **2.40** | **2.00** | **2.60** | **1.00** | | | **1.20** | **1.20** | **2.40** | **2.80** | **3.00** | **2.60** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE II**
**(Common to: B.E-BME, ECE)**

| RA24901 | ROBOTIC PROCESS AUTOMATION | L | T | P | C |
|---|---|---|---|---|---|
| | | 2 | 0 | 2 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamental concepts and principles of Robotic Process Automation.
- Gaining the knowledge of RPA design approaches, development strategies, and methodologies.
- Learning the basic logic, workflow structure, and functioning of RPA systems.
- Exploring the exception handling, debugging, and logging techniques in RPA applications.
- Understanding the process of deployment, monitoring, and maintenance of software bots.

**UNIT I INTRODUCTION TO ROBOTIC PROCESS AUTOMATION 6**

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Core Components of RPA, RPA Platforms.

**UNIT II AUTOMATION PROCESS ACTIVITIES 6**

Sequence, Flowchart & ControlFlow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making.

**UNIT III APP INTEGRATION, RECORDING AND SCRAPING 6**

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, scraping data from website and writing to CSV.

**UNIT IV EXCEPTION HANDLING 6**

Exception handling, Common exceptions, Logging- Debugging techniques, collecting crash dumps, Error reporting.

**UNIT V DEPLOYMENT AND MAINTENANCE 6**

Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates

**TOTAL: 30 PERIODS**

**LIST OF EXPERIMENTS:**

**Setup and Configure a RPA tool and understand the user interface of the tool:**

1. Create a Sequence to obtain user inputs display them using a message box.
2. Create a Flowchart to navigate to a desired page based on a condition.
3. Create a State Machine workflow to compare user input with a random number.
4. Build a process in the RPA platform using UI Automation Activities.
5. Create an automation process using key System Activities, Variables and Arguments.
6. Also implement Automation using System Trigger.
7. Automate login to (web) Email account.

**TOTAL PERIODS: 30**

**TOTAL PERIODS: 60**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

**CO1:** Explain the concepts, evolution, benefits, applications, core components, and platforms of Robotic Process Automation (RPA).

**CO2:** Develop automation workflows using sequence, flowchart, activities, and control flow constructs for decision-making processes.

**CO3:** Implement application integration, recording, scraping, selectors, and workflow activities to automate data extraction and operational tasks.

**CO4:** Analyze exceptions, logging mechanisms, debugging techniques, and error-reporting methods to improve the reliability of RPA solutions.

**CO5:** Deploy and maintain software robots using publishing tools, orchestration servers, licensing mechanisms, and update management techniques.

**TEXT BOOKS:**


1. Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool – UiPath by Alok Mani Tripathi, Packt Publishing, 2018.
2. Tom Taulli , —The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems, Apress publications, 2020.
3. Randall Boyle , Raymond Panko, —Corporate Cybersecurity ‖ , Pearson, 2025.


**REFERENCES:**


1. Frank Casale (Author), Rebecca Dilla (Author), Heidi Jaynes (Author), Lauren Livingston (Author), Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation, Amazon Asia-Pacific Holdings Private Limited, 2018.
2. Richard Murdoch, Robotic Process Automation: Guide to Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant, Amazon Asia-Pacific Holdings Private Limited, 2018.
3. A Gerardus Blokdyk, —Robotic Process Automation A Complete Guide , 2020.


## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 3 | 2 | 1 | 1 | 2 | | | | | 2 | 2 | 2 | 3 |
| **CO2** | 1 | 3 | 2 | 3 | 2 | 2 | | | | | 2 | 2 | 3 | 2 |
| **CO3** | 1 | 2 | 3 | 1 | 1 | 2 | | | | | 2 | 3 | 3 | 2 |
| **CO4** | 2 | 3 | 3 | 2 | 2 | 2 | | | | | 2 | 2 | 3 | 2 |
| **CO5** | 2 | 2 | 3 | 3 | 3 | 2 | | | | | 3 | 3 | 3 | 3 |
| **Avg** | **1.60** | **2.60** | **2.60** | **2.00** | **1.80** | **2.00** | | | | | **2.20** | **2.40** | **2.80** | **2.40** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE II**
**(Common To B. E – BME, ECE)**

| IP24901 | INTELLECTUAL PROPERTY RIGHTS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding basics of IPR and its types.
- Explaining procedures for obtaining IPR.
- Analyzing national and international IPR laws.
- Evaluating strategies for IP protection, innovation, and traditional knowledge.
- Applying IP valuation and commercialization methods

**UNIT I INTRODUCTION 9**

Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

**UNIT II PROCESS 9**

New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.

**UNIT III STATUTES 9**

International Treaties and conventions on IPRs, The TRIPs Agreement, PCT Agreement, The Patent Act of India, Patent Amendment Act (2005), Design Act, Trademark Act, Geographical Indication Act, Bayh- Dole Act and Issues of Academic Entrepreneurship.

**UNIT IV STRATEGIES IN INTELLECTUAL PROPERTY 9**

Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies

**UNIT V MODELS 9**

The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Understanding of intellectual property and appreciation of the need to protect it
**CO2:** Awareness about the process of patenting
**CO3:** Interpreting of the statutes related to IPR
**CO4:** Applying strategies to protect intellectual property
**CO5:** Analyzing models for making strategic decisions related to IPR

**REFERENCES:**


1. Bently, Lionel, and Brad Sherman. Intellectual Property Law. 6th ed., Oxford University Press, 2026.
2. Reddy, S. V. Damodar. Text Book of Intellectual Property Rights. 9th ed., Asia Law House, 2025.
3. Narayanan, P. Intellectual Property Law. 3rd rev. ed., Eastern Law House, 2025.
4. Law Relating to Intellectual Property Rights. 7th ed., Central Law Publications, 2024.
5. Gervais, Daniel J. Intellectual Property: The Law in a Global Context. 4th ed., Oxford University Press, 2019.
6. N. Nagpal, M. Arora, M.R.D. Usman, S. Rahar, "Intellectual Property Rights" Edu creation Publishing, New Delhi, 2017.
7. S. Lakshmana Prabu, TNK. Suriyaprakash, "Intellectual Property Rights", 1st ed., In Tech open access, Croatia, 2017.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | 2 | | | | 2 | | |
| **CO2** | 2 | 2 | 2 | 2 | 2 | | | 2 | | 2 | | 2 | 2 | |
| **CO3** | 2 | 3 | 2 | 3 | | | | 2 | | | | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | | | | 3 | 2 | 2 |
| **CO5** | 2 | 2 | 3 | 2 | 3 | | | 2 | 2 | 2 | 3 | 3 | 3 | 2 |
| **Avg** | **2.20** | **2.20** | **2.20** | **2.00** | **2.33** | **2.00** | **2.00** | **2.00** | **2.00** | **2.00** | **3.00** | **2.40** | **2.25** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE II**
**(Common to: B.E-BME, ECE)**

| CE24901 | CLIMATE CHANGE AND ITS IMPACT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of climate change and global warming.
- Studying the causes and impacts of climate variability.
- Analyzing the greenhouse gases and their effects on the environment.
- Exploring the mitigation and adaptation strategies for climate change.
- Evaluating the policies and sustainable approaches for climate resilience.

**UNIT I FUNDAMENTALS OF CLIMATE CHANGE 9**

Introduction to climate change – Weather and climate – Global warming – Greenhouse effect – Greenhouse gases – Causes of climate change – Natural and anthropogenic factors

**UNIT II CLIMATE SYSTEM AND VARIABILITY 9**

Earth's climate system – Carbon cycle – Energy balance – Climate variability – El Nino and La Nina – Climate models – IPCC reports and climate scenarios

**UNIT III IMPACTS OF CLIMATE CHANGE 9**

Impact on water resources – Agriculture and food security – Ecosystems and biodiversity – Sea level rise – Human health impacts – Extreme weather events

**UNIT IV MITIGATION AND ADAPTATION STRATEGIES 9**

Climate change mitigation – Renewable energy sources – Carbon capture and storage – Sustainable development – Adaptation strategies – Disaster risk reduction and resilience

**UNIT V CLIMATE POLICIES AND SUSTAINABILITY 9**

International climate agreements – Kyoto Protocol – Paris Agreement – Climate governance – Environmental policies – Sustainable practices and green technologies

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

**CO1:** Explain the fundamentals of climate change and global warming.
**CO2:** Analyze climate systems and variability.
**CO3:** Evaluate the impacts of climate change on environment and society.
**CO4:** Apply mitigation and adaptation strategies.
**CO5:** Assess climate policies and sustainable development approaches.

**TEXT BOOKS:**

1. John Houghton, Global Warming: The Complete Briefing, Cambridge University Press, 2018.
2. William James Burroughs, Climate Change: A Multidisciplinary Approach, Cambridge University Press, 2017.

**REFERENCES:**

1. IPCC Assessment Reports, Intergovernmental Panel on Climate Change, Latest Edition.
2. Joseph Romm, Climate Change: What Everyone Needs to Know, Oxford University Press, 2020.
3. Stephen H. Schneider, Global Warming and Climate Change, Wiley Publications, 2019.

## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | 2 | 3 | | | | 2 | | | |
| **CO2** | 3 | 3 | 2 | 2 | | 2 | 3 | | | | 2 | | | |
| **CO3** | 3 | 3 | 2 | 2 | | 3 | 3 | | | | 2 | | | |
| **CO4** | 3 | 3 | | 2 | | 3 | 3 | | | | 2 | | | |
| **CO5** | 3 | 3 | | 2 | | 3 | 3 | | | | 2 | | | |
| **Avg** | **3.00** | **2.80** | **2.00** | **2.00** | | **2.60** | **3.00** | | | | **2.00** | | | |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE III**
**(Common To B.E - BME, ECE)**

| SF24901 | FIRE SAFETY ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Providing basic knowledge of Fire and Safety Engineering.
- Studying fire effects on construction materials and fire resistance tests.
- Understanding the fire zones, fire-stopped areas, and fire-resistant doors.
- Learning the fire protection and repair methods for structural members.
- Developing skilled safety professionals with technical and management knowledge.

**UNIT I INHERENT SAFETY CONCEPTS 9**

Compartment fire-factors controlling fire severity, ventilation controlled and fuel-controlled fires; Spread of fire in rooms, within building and between buildings. Effect of temperature on the properties of structural materials- concrete, steel, masonry and wood; Behavior of non-structural materials on fire- plastics, glass, textile fibres and other house hold materials.

**UNIT II PLANT LOCATIONS 9**

Compartment temperature-time response at pre-flashover and post flashover periods; Equivalence of fire severity of compartment fire and furnace fire; Fire resistance test on structural elements-standard heating condition, Indian standard test method, performance criteria.

**UNIT III WORKING CONDITIONS 9**

Fire separation between building- principle of calculation of safe distance. Design principles of fire resistant walls and ceilings; Fire resistant screens- solid screens and water curtains; Local barriers; Fire stopped areas- in roof, in fire areas and in connecting structures; Fire doors- Low combustible, Non-combustible and Spark-proof doors - method of suspension of fire doors.

**UNIT IV FIRE SEVERITY AND REPAIR TECHNIQUES 9**

Fabricated fire proof boards-calcium silicate, Gypsum, Vermiculite, and Perlite boards; Fire protection of structural elements - Wooden, Steel and RCC. Reparability of fire damaged structures- Assessment of damage to concrete, steel, masonry and timber structures, Repair techniques- repair methods to reinforced concrete Columns, beams and slabs, Repair to steel structural members, Repair to masonry structures.

**UNIT V WORKING AT HEIGHTS 9**

Safe Access - Requirement for Safe Work Platforms- Stairways - Gangways and Ramps-Fall Prevention & Fall Protection - Safety Belts - Safety nets - Fall Arrestors- Working on Fragile Roofs - Work Permit Systems- Accident Case Studies.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Understand the effects of fire on construction materials.

**CO2:** Understand fire resistance and non-combustibility tests and select suitable structural elements for fire safety.

**CO3:** Understand fire walls, fire screens, barriers, and fire doors to prevent fire spread.

**CO4:** Learn fire protection and repair methods for RCC, steel, and wooden structures.

**CO5:** Understand safety techniques and develop decision-making skills during emergencies.

**TEXT BOOKS:**


1. Jain, V.K, "Fire safety in buildings" (2nd edn.). New Age International(P) Ltd., New Delhi,2010.
2. John A. Purkiss, "Fire safety engineering design of structures" (2nd edn.), Butterworth Heinemann, Oxford, UK,2009.


**REFERENCES:**


1. Smith, E.E. and Harmathy, T.Z. (Editors), "Design of buildings for fire safety". ASTM Special Publication 685, American Society for Testing and Materials, Boston, U.S.A,1979.
2. Butcher, E. G. and Parnell, A. C, "Designing of fire safety". JohnWiley and Sons Ltd., New York, U.S.A.1983.
3. Roytman, M. Y, "Principles of fire safety standards "for building construction". Amerind Publishing Co. Pvt. Ltd., New Delhi,1975.
4. Hazop & Hazan, "Identifying and Assessing Process Industry Hazards", Fourth Edition ,1999
5. Frank R. Spellman, Nancy E. Whiting, "The Handbook of Safety Engineering: Principles and Applications", 2009.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 2 | 1 | | | | | | 1 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 1 | | | | | | 1 | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 3 | 2 | 1 | | | | | | 1 | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | 1 | 2 | | | | | 1 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 3 | 1 | | | | | | 2 | 3 | 3 | 2 |
| **Avg** | **3.00** | **2.20** | **3.00** | **2.20** | **1.00** | **2.00** | | | | | **1.20** | **2.60** | **2.80** | **2.20** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE III**
**(Common To B.E - BME, CSE & B. Tech - IT)**

| MR24901 | MECHATRONICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the principles and selection of sensors and transducers.
- Analyzing the fundamentals and design concepts of mechatronics systems.
- Learning the architecture and programming of programmable logic controllers.
- Studying the real-time interfacing and data acquisition systems.
- Interpreting the case studies of industrial mechatronics systems and applications.

**UNIT I SENSORS AND TRANSDUCERS 9**

Sensors and Transducers, Performance Terminology, Displacement, Position, Proximity sensors, Velocity and Motion, Force, Fluid Pressure, Liquid Flow, Liquid Level, Temperature Sensors, Light Sensors, Selection of Sensors.

**UNIT II INTRODUCTION TO MECHATRONICS 9**

Introduction to Mechatronics, Systems, Need for Mechatronics, Emerging areas of Mechatronics, Classification of Mechatronics, Design Process of Mechatronics, Examples of Mechatronics Systems.

**UNIT III PROGRAMMABLE LOGIC CONTROLLERS 9**

Basic PLC Structure, Architecture, I/O Processing, Programming with Timers and Counters, Instruction Lists, Latching and Internal Relays, Master and jump Controls, Data Handling, Selection of PLC.

**UNIT IV REAL TIME INTERFACING 9**

Introduction to real-time interfacing, interfacing standards, and elements of data acquisition and control systems. Overview of I/O processes, general-purpose I/O cards, data conversion techniques, application software, and man–machine interface systems.

**UNIT V CASE STUDIES ON DESIGN OF MECHATRONICS SYSTEM 9**

Motion control using DC motors, AC motors, and servo motors, Temperature control systems, pick-and-place robots, car parking barrier systems, washing machine control systems, and auto-focus and exposure control in cameras.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain the operating principles and characteristics of sensors and transducers.

**CO2:** Describe the fundamentals, classification, and design process of mechatronics systems.

**CO3:** Apply PLC architecture and programming techniques for automation systems.

**CO4:** Analyze real-time interfacing methods and data acquisition systems used in mechatronics.

**CO5:** Evaluate mechatronics system applications involving motion and temperature control systems.

**TEXT BOOKS:**


1. Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015.
2. Devdas Shetty, Richard A. Kolk, “Mechatronics System Design”, 2ndEdition,Cengage Learning 2012.
3. Georg pelz, "Mechatronic Systems: Modeling and simulation" with HDL’s, John wiley and sons Ltd, 2003.


**REFERENCES:**


1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., “Mechatronics”, Chapman and Hall, 1993.
2. Davis G. Alciatore and Michael B. Histand, “Introduction to Mechatronics and Measurement systems”, McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
5. Smaili. A and Mrad. F, “Mechatronics Integrated Technologies for Intelligent Machines”, Oxford University Press, 2007.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | | 3 | | | | | | 2 | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 3 | 2 | 2 | | | | 2 | | 2 | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | | | | 2 | | 2 | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | | | | 2 | | 3 | 2 | 3 | 3 |
| **CO5** | 3 | 2 | 3 | 2 | 2 | 3 | | | 2 | | 3 | 3 | 3 | 2 |
| **Avg** | **3.00** | **2.40** | **2.60** | **2.25** | **2.60** | **3.00** | | | **2.00** | | **2.40** | **2.60** | **2.80** | **2.20** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE III**
**(B.E - BME)**

| EC24902 | VLSI DESIGN | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of MOS transistor principles and CMOS technology.
- Learning the design of combinational logic circuits.
- Studying sequential circuits and clocking strategies.
- Understanding arithmetic circuits, memory architecture, and programmable devices.
- Learning ASIC design flow, testing methods, and Verilog HDL basics.

**UNIT I MOS TRANSISTOR PRINCIPLES 9**

Introduction to NMOS and CMOS logic families, Ideal and Non-ideal I-V Characteristics, MOS(FET) Transistor Characteristic under Static and Dynamic Operation, Technology Scaling.

**UNIT II COMBINATIONAL LOGIC CIRCUITS 9**

Propagation Delay, Stick diagrams, CMOS Static Logic Gates, CMOS Dynamic Logic Circuits, Pass Transistor Logic, NMOS Elmore Delay Model, and Low-Power Design Techniques.

**UNIT III SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES 9**

Static and Dynamic Registers, Pipelines, Timing Classification, Synchronous Design and Self-Timed Circuit Design.

**UNIT IV INTERCONNECT, MEMORY ARCHITECTURE AND ARITHMETIC CIRCUITS 9**

Interconnect Parameters – Capacitance, Resistance, and Inductance, Sequential digital circuits: adders, comparators, shift registers. Logic Implementation using Programmable Devices (PLA, FPGA) and Memory Architecture.

**UNIT V ASIC DESIGN AND TESTING 9**

Introduction to wafer to chip fabrication process flow. embedded cores and SOCs, Fault models, ASIC Design Flow, Introduction to test benches, Scan design: Test interface and boundary scan.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Understand MOS transistor operation and power consumption concepts.
**CO2:** Design basic combinational logic circuits using CMOS logic.
**CO3:** Analyze sequential circuits and clocking methods.
**CO4:** Describe arithmetic circuits, memory architecture, and programmable logic devices.
**CO5:** Understand ASIC design, testing techniques, and develop simple Verilog test benches.

**TEXT BOOKS:**

1. R. Jacob Baker, CMOS: Circuit Design, Layout, and Simulation (4th Edition), Wiley- IEEE Press, 2019.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective (2nd Edition), Pearson, 2017.
3. Sung-Mo Kang and Yusuf Leblebici, CMOS Digital Integrated Circuits: Analysis and Design (4th Edition), McGraw-Hill, 2018.

**REFERENCES:**

1. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis (3rd Edition), Pearson, 2019.
2. Phillip E. Allen and Douglas R. Holberg, CMOS Analog Circuit Design (4th Edition), Oxford University Press, 2020.
3. M. L. Bushnell and V. D. Agrawal, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Springer, 2020.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | | 2 | | | | | 2 | 3 | 2 | 2 |
| **CO2** | 2 | 3 | 2 | 2 | | 1 | | | | | 2 | 3 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 3 | 2 | 3 | | | | | 2 | 2 | 2 | 2 |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 3 | | | | | 2 | 2 | 2 | 3 |
| **CO5** | 2 | 2 | 1 | 2 | 3 | 3 | | | | | 3 | 2 | 2 | 2 |
| **Avg** | **2.40** | **2.40** | **1.80** | **2.20** | **2.30** | **2.40** | | | | | **2.20** | **2.40** | **2.00** | **2.20** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE III**
**(B. E - BME)**

| BT24903 | BIOTECHNOLOGY FOR WASTE MANAGEMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding biological treatment and fermentation processes.
- Studying waste biomass and value addition methods.
- Learning waste-to-energy conversion techniques.
- Gaining knowledge of chemical and enzyme production from wastes.
- Interpreting composting processes and waste management technologies.

**UNIT I BIOLOGICAL TREATMENT PROCESS 9**

Fundamentals of biological process - Anaerobic process – Pretreatment methods in anaerobic process – Aerobic process, Anoxic process, Aerobic and anaerobic digestion of organic wastes - Factors affecting process efficiency - Solid state fermentation – Submerged fermentation – Batch and continuous fermentation.

**UNIT II WASTE BIOMASS AND ITS VALUE ADDITION 9**

Types of waste biomass – Solid waste management - Nature of biomass feedstock – Biobased economy/process – Value addition of waste biomass – Biotransformation of biomass – Biotransformation of marine processing wastes.

**UNIT III BIOCONVERSION OF WASTES TO ENERGY 9**

Perspective of biofuels from wastes - Bioethanol production – Biohydrogen Production – dark and photo fermentative process - Biobutanol production – Biogas and Biomethane production - Single stage anaerobic digestion, Two stage anaerobic digestion - Biodiesel production.

**UNIT IV CHEMICALS AND ENZYME PRODUCTION FROM WASTES 9**

Production of lactic acid, succinic acid, citric acid – Biopolymer synthesis – Production of Amylases - Lignocellulolytic enzymes - Pectinolytic enzymes - Proteases – Lipases.

**UNIT V BIOCOMPOSTING OF ORGANIC WASTES 9**

Overview of composting process - Benefits of composting, Role of microorganisms in composting - Factors affecting the composting process - Waste Materials for Composting, Fundamentals of composting process - Composting technologies, Composting systems – Non-reactor Composting, Reactor composting - Compost Quality.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain biological treatment and fermentation processes.

**CO2:** Describe waste biomass utilization and value addition techniques.

**CO3:** Apply waste-to-energy conversion methods for biofuel production.

**CO4:** Interpret the production of chemicals and enzymes from wastes.

**CO5:** Summarize composting technologies and organic waste management methods.

**TEXT BOOKS:**

1. Antoine P. T., (2017) "Biofuels from Food Waste Applications of Saccharification Using Fungal Solid State Fermentation", CRC press.
2. Joseph C A., (2019)"Anaerobic Waste-Wastewater Treatment and Biogas Plants-A Practical Handbook", CRC Press.

**REFERENCES:**


1. Palmiro P. and Oscar F.D'Urso, (2016) 'Biotransformation of Agricultural Waste and By-Products',The Food, Feed, Fibre, Fuel (4F) Economy, Elsevier.
2. Kaur Brar S., Gurpreet Singh D. and Carlos R.S., (Eds), (2014)'Biotransformation of Waste Biomass into High Value Biochemicals', Springer.
3. Keikhosro K, Editor, (2015) 'Lignocellulose-Based Bioproducts', Springer.
4. John P, (2014) 'Waste Management Practices-Municipal, Hazardous, and Industrial', Second Edition, CRC Press, 2014.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | | | 2 | 3 | 2 | |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 3 | 2 | 2 | | | 2 | 3 | 2 | |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | 2 | 3 | 2 | |
| **CO4** | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | | | 2 | 3 | 2 | |
| **CO5** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | | | 2 | 3 | 2 | |
| **Avg** | **2.80** | **2.40** | **2.00** | **2.00** | **2.00** | **2.60** | **2.00** | **2.00** | | | **2.00** | **3.00** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE III**
**(Common To B. TECH - AI&DS, IT & B. E - BME, CSE)**

| FD24902 | FOOD SAFETY AND QUALITY REGULATIONS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding food safety, sanitation practices, and food contaminants.
- Learning food quality assessment and evaluation techniques.
- Gaining knowledge of food safety management systems and HACCP principles.
- Exploring the national and international food safety regulation.
- Studying the Codex standards and food regulatory administration systems.

**UNIT I FUNDAMENTALS OF FOOD SAFETY AND SANITATION 9**

Introduction to food safety and security: Hygienic design of food plants and equipments, Food Contaminants (Microbial, Chemical, Physical), Food Adulteration (Common adulterants), Food Additives (functional role, safety issues), Food Packaging & labeling. Sanitation in warehousing, storage, shipping, receiving, containers and packaging materials.

**UNIT II FOOD QUALITY ASSESSMENT TECHNIQUES 9**

Food quality and quality attributes – Instrumental, chemical, and microbial quality control methods – Sensory evaluation of food and statistical analysis – Water quality and other utility requirements in food processing.

**UNIT III FOOD SAFETY MANAGEMENT AND REGULATORY SYSTEMS 9**

Critical quality control points at various stages of food production, including raw and processing materials – Food quality assurance and quality control with HACCP principles – Food inspection and food laws – Risk assessment methods including microbial risk assessment, dose–response – Risk management and implementation of food surveillance systems for monitoring food safety.

**UNIT IV FOOD SAFETY GOVERNANCE AND GLOBAL REGULATORY SYSTEMS 9**

Indian and international food regulations – Role of FAO in India and its technical cooperation programs – Biosecurity in food and agriculture – Functions of the World Health Organization (WHO), World Organization for Animal Health (OIE), and International Plant Protection Convention (IPPC).

**UNIT V FOOD STANDARDS AND CODEX ADMINISTRATION 9**

Codex Alimentarius Commission and Codex India – Role of the Codex Contact Point – National Codex Contact Point (NCCP) – National Codex Committee of India: terms of reference (ToR), functions, and shadow committees.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Understand food safety, sanitation, and contaminants.
**CO2:** Apply food quality assessment and evaluation techniques.
**CO3:** Analyze food safety management and HACCP systems.
**CO4:** Explain national and international food safety regulations.
**CO5:** Interpret Codex standards and food regulatory administration.

**TEXT BOOKS:**

1. Handbook of food toxicology by S. S. Deshpande, 2002.
2. The food safety information handbook by Cynthia A. Robert, 2009.
3. Nutritional and safety aspects of food processing by Tannenbaum SR, Marcel Dekker Inc., New York 1979.

**REFERENCES:**

1. Microbiological safety of Food by Hobbs BC, 1973.
2. Food Safety Handbook by Ronald H. Schmidt, Gary E. Rodrick, A John Wiley & Sons Publication, 2003.

## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | 2 | 2 | | | | 2 | 2 | 2 | |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | | | | 2 | 2 | 2 | |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 2 | 2 | | | | 2 | 2 | 2 | |
| **CO4** | 2 | 2 | | 1 | | 2 | 2 | | | | 2 | 2 | 2 | |
| **CO5** | 2 | 3 | | 1 | | 2 | 2 | | | | 2 | 2 | 2 | |
| **Avg** | **2.60** | **2.60** | **2.00** | **1.50** | **2.00** | **2.00** | **2.00** | | | | **2.00** | **2.00** | **2.00** | |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE III**
**(Common to B. E - BME, CSE, ECE, B. Tech - IT)**

| AU24901 | BATTERIES AND MANAGEMENT SYSTEM | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basics of battery technologies and battery characteristics.
- Learning the structure, functions, and requirements of Battery Management Systems (BMS).
- Studying battery state estimation methods such as SOC and SOH.
- Understanding the battery modeling and simulation techniques for energy storage applications.
- Gaining knowledge of BMS design and applications in electric vehicles and renewable energy systems.

**UNIT I INTRODUCTION TO BATTERY TECHNOLOGIES 9**

Introduction to Battery Management Systems (BMS) – Cells and batteries – Battery parameters: nominal voltage, capacity, C-rate, energy and power density – Series and parallel connection of cells – Electrochemical cells and Lithium-ion batteries – Rechargeable batteries – Charging and discharging characteristics – Overcharging and undercharging effects – Charging methods and modes of charging.

**UNIT II BATTERY MANAGEMENT SYSTEM REQUIREMENTS 9**

Introduction and functions of BMS – Battery pack architecture and topology – Voltage, temperature and current sensing techniques – High-voltage contactor control – Isolation monitoring – Thermal management and protection systems – Communication interfaces in BMS – Range estimation – State of Charge estimation overview.

**UNIT III BATTERY STATE ESTIMATION TECHNIQUES 9**

Basic definitions of battery state parameters – Battery State of Charge (SOC) estimation methods – Voltage-based and model-based SOC estimation techniques – Battery State of Health (SOH) estimation – Battery degradation and aging mechanisms – Aging characteristics of lithium-ion battery electrodes – Performance evaluation.

**UNIT IV BATTERY MODELLING AND SIMULATION 9**

Battery modeling concepts – Equivalent Circuit Models (ECM) – Physics-based and empirical modeling approaches – Simulation of battery systems – Electric vehicle battery simulation – Vehicle range estimation – Constant power and voltage simulation – Battery pack simulation techniques.

**UNIT V DESIGN AND APPLICATIONS OF BMS 9**

Design principles of Battery Management Systems – Battery pack design considerations – Effect of operating conditions on battery life – Multi-battery systems and energy balancing – Battery management in electric vehicles – Renewable energy storage applications – Recent trends and future developments in BMS.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

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

**CO1:** Explain the fundamentals of batteries, their characteristics, and charging/discharging methods.

**CO2:** Describe the functions and components of Battery Management Systems (BMS).

**CO3:** Apply SOC and SOH estimation techniques to assess battery performance.

**CO4:** Analyze battery models and simulate battery systems for electric vehicle applications.

**CO5:** Design and evaluate Battery Management Systems for electric vehicles and energy storage systems.

**TEXT BOOKS:**


1. Davide Andrea, Battery Management Systems for Large Lithium-Ion Battery Packs, Artech House, Reprint 2021.
2. S. R. Paranjothi and R. Prakash, Electric Vehicle Technology and Battery Management Systems, Charulatha Publications, First Edition, 2022.


**REFERENCES:**


1. Shunli Wang and Ping Liu, Lithium-Ion Batteries: Fundamentals and Applications, Wiley, 2020.
2. Ru-Shi Liu, Leif Nyholm and Guoyao Zheng, Rechargeable Batteries: Materials, Technologies and New Trends, Wiley-VCH, 2020.
3. James Larminie and John Lowry, Electric Vehicle Technology Explained, 2nd Edition, Wiley, Reprint 2021.
4. Arun Kumar Bansal and Sanjeevikumar Padmanaban, Battery Management Systems and Applications in Electric Vehicles, Springer, 2022.
5. Gianfranco Pistoia, Electric and Hybrid Vehicles: Power Sources, Models, Sustainability, Infrastructure and the Market, Elsevier, 2021.


## CO-PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | 2 | | | | | 1 | 2 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | 2 | | | | | 2 | 3 | 2 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | | | | | | | 2 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 3 | 3 | | | | | | | 3 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 3 | 2 | 2 | | | | | 3 | 3 | 2 |
| **Avg** | **3.00** | **2.80** | **2.50** | **2.50** | **2.80** | **2.00** | **2.00** | | | | | **2.20** | **2.80** | **2.20** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE III**
**(Common To B.E - BME, CSE, ECE, EEE & B. Tech – IT, AI&DS)**

| RA24903 | FOUNDATION OF ROBOTICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Studying the kinematics, drive systems and programming of robots.
- Studying the basics of robot laws and transmission systems.
- Exploring the concepts and techniques of robot manipulator, its kinematics.
- Analyzing the various Programming and Machine Vision application in robots.
- Building confidence among students to evaluate, choose and incorporate robots in engineering systems.

**UNIT I FUNDAMENTALS OF ROBOT 9**

Robot – Definition – Robot Anatomy – Co-ordinate systems, Work Envelope, types and classification – specifications – Pitch, yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and their functions.

**UNIT II ROBOT KINEMATICS 9**

Forward kinematics, inverse kinematics and the difference: forward kinematics and inverse Kinematics of Manipulators with two, three degrees of freedom (in 2 dimensional), four degrees of freedom (in 3 dimensional) – derivations. Homogeneous transformation matrices, translation and rotation matrices.

**UNIT III ROBOT DRIVE SYSTEMS AND END EFFECTORS 9**

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of All These Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic grippers, vacuum grippers, internal grippers and external grippers, selection and design considerations of a gripper

**UNIT IV SENSORS IN ROBOTICS 9**

Force sensors, touch and tactile sensors, proximity sensors, non-contact sensors, proximity sensors, fail safe hazard sensor systems, and compliance mechanism. Machine vision system - camera, frame grabber, sensing and digitizing image data – signal conversion, image storage, lighting techniques, image processing and analysis – data reduction, segmentation, feature extraction, object recognition, other algorithms, applications – Inspection, identification, visual serving and navigation.

**UNIT V PROGRAMMING AND APPLICATIONS OF ROBOT 9**

Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion Commands, Sensors commands, End-Effector Commands, and simple programs - Role of robots in inspection, assembly, material handling, underwater, space and medical fields.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Interpret the features of robots and technology involved in the control.

**CO2:** Apply the basic engineering knowledge and laws for the design of robotics.

**CO3:** Explain the basic concepts like various configurations, classification and parts of end effectors compare various end effectors and grippers and tools and sensors used in robots.

**CO4:** Explain the concept of kinematics, degeneracy, dexterity and trajectory planning.

**CO5:** Demonstrate the image processing and image analysis techniques by machine vision system.

**TEXT BOOKS:**


1. S. Ganesh Hegde, A Textbook of Industrial Robotics, Laxmi Publications Pvt. Ltd., Revised Edition, 2019. ISBN: 9789380386867.
2. Mikell P. Groover, Industrial Robotics: Technology, Programming and Applications, McGraw-Hill Education, 2nd Edition, Reprint Edition, 2017. ISBN: 9780070265097.


**REFERENCES:**


1. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill Education, Reprint Edition, 2017. ISBN: 9780070226258.
2. Yoram Koren, Robotics for Engineers, McGraw-Hill Education, Reprint Edition, 2018.
3. P. A. Janakiraman, Robotics and Image Processing: An Introduction, Tata McGraw-Hill Education, Reprint Edition, 2011. ISBN: 9780070702561.
4. John J. Craig, Introduction to Robotics: Mechanics and Control, 4th Edition, Pearson Education, 2022. ISBN: 9780137848744.
5. Reza N. Jazar, Theory of Applied Robotics: Kinematics, Dynamics and Control, 3rd Edition, Springer, 2022. ISBN: 9783030933623.


**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | | | | | | | | 3 | 2 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | | | | | | | | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | | | | | | | | 3 | 3 | 2 |
| **CO4** | 3 | 2 | 2 | 2 | | | | | | | | 2 | 3 | 3 |
| **CO5** | 3 | 2 | 2 | 2 | | | | | | | | 3 | 3 | 2 |
| **Avg** | **3.00** | **2.00** | **2.00** | **2.00** | | | | | | | | **2.60** | **2.80** | **2.20** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE III**
**(Common to: B.E-BME, CSE & B.TECH-AI&DS, IT)**

| AD24903 | MULTIVARIATE DATA ANALYSIS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the basic concepts and types of multivariate data analysis techniques.
- Learning how to prepare data and test assumptions for multivariate analysis.
- Understanding the regression and factor analysis methods and their interpretation.
- Studying advanced techniques like SEM, CFA, mediation and moderation models.
- Learning advanced methods like classification, clustering and scaling techniques.

**UNIT I INTRODUCTION TO MULTIVARIATE DATA ANALYSIS 9**

Introduction – Basic concepts – Uni-variate, Bi-variate and Multivariate techniques – Classification of multivariate techniques – Guidelines for multivariate analysis and interpretation. Big data analytics concepts – Introduction to machine learning in multivariate analysis – Data visualization techniques – Real-time analytics applications

**UNIT II DATA PREPROCESSING 9**

Conceptualization of research problem – Measurement scales and data collection – Data preprocessing and transformation – Handling missing data – Testing assumptions of multivariate analysis. Outlier detection methods – Feature engineering techniques – Data reduction and dimensionality handling – Ethical considerations in data analytics.

**UNIT III MULTIPLE REGRESSION AND FACTOR ANALYSIS 9**

Introduction to Multiple Linear Regression – Regression model building – Model adequacy checking – Introduction to Factor Analysis – Principal Component Analysis – Exploratory Factor Analysis – Factor extraction methods. Applications in predictive analytics – Software implementation using SPSS and Python.

**UNIT IV LATENT VARIABLE TECHNIQUES 9**

Confirmatory Factor Analysis – Structural Equation Modelling (SEM) – Mediation and Moderation models – Bayesian inference methods – Model fit indices and interpretation. Partial Least Squares SEM (PLS-SEM) – SmartPLS software applications – Measurement and structural model assessment – Advanced predictive modelling techniques.

**UNIT V ADVANCED MULTIVARIATE TECHNIQUES 9**

Cluster Analysis – Discriminant Analysis – Logistic Regression – MANOVA – Canonical Correlation Analysis – Applications in data science and analytics – Case studies using statistical software tools. – Artificial Neural Networks (ANN) – Support Vector Machines (SVM) – Decision tree based multivariate models.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

On successful completion of this course, the student will be able to:

**CO1:** Understand different types of multivariate analysis techniques.
**CO2:** Apply data preparation methods and test assumptions for analysis.
**CO3:** Analyze data using regression and factor analysis techniques.
**CO4:** Apply latent variable models like SEM and CFA for data analysis.
**CO5:** Use advanced techniques like clustering, classification, and scaling methods.

**TEXT BOOKS:**


1. Joseph F. Hair Jr., William C. Black, Barry J. Babin and Rolph E. Anderson, "Multivariate Data Analysis", Cengage Learning, 8th Edition, 2022.
2. T.W. Anderson, "An Introduction to Multivariate Statistical Analysis", Wiley India, 3rd Edition, Reprint 2021.


**REFERENCES:**


1. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, 6th Edition, 2019.
2. K.V.S. Sharma, "Statistics Made Simple: *Do It Yourself on PC*", Pearson Education, 3rd Edition, 2015.
3. James P. Stevens, "Applied Multivariate Statistics for the Social Sciences", Routledge, 6th Edition, 2022.
4. Bryan F.J. Manly and Jorge A. Navarro Alberto, "Multivariate Statistical Methods*: A Primer*", Chapman & Hall/CRC, 4th Edition, 2016.
5. Alvin C. Rencher and William F. Christensen, "Methods of Multivariate Analysis", Wiley Series, 3rd Edition, 2012.


## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | 2 | | | | | 1 | | 2 | 1 | |
| **CO2** | 3 | 3 | 2 | 2 | 3 | | | | | 1 | | 3 | 2 | 1 |
| **CO3** | 3 | 3 | 3 | 2 | 3 | | | | | 1 | | 3 | 3 | 2 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | | | | | 1 | | 3 | 3 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 3 | | | | | 2 | | 3 | 3 | 3 |
| **Avg** | **3.00** | **2.80** | **2.20** | **2.50** | **2.80** | | | | | **1.20** | | **2.80** | **2.40** | **2.00** |

**1 - Low, 2 - Medium, 3 - High**

**OPEN ELECTIVE III**
**(Common to: B.E – BME, ECE & B. Tech – AI&DS)**

| AI24904 | AGRICULTURE ENTREPRENEURSHIP DEVELOPMENT | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Introducing the concept of entrepreneurship.
- Understanding the insights into agripreneurship and international trade
- Analyzing the entrepreneurship management.
- Exploring the Entrepreneurial opportunities.
- Familiarizing with entrepreneurial promotion measures.

**UNIT I ENTREPRENEURIAL ENVIRONMENT IN INDIAN CONTEXT 9**

Entrepreneur Development (ED): Concept of entrepreneur and entrepreneurship assessing overall business environment in Indian economy, Entrepreneurial and managerial characteristics, Entrepreneurship development programmers (EDP), Generation incubation and commercialization of ideas and innovations, Motivation and entrepreneurship development, Globalization and the emerging business entrepreneurial environment.

**UNIT II AGRIPRNEURSHIP IN GLOBAL ARENA: LEGAL PERSPECTIVE 9**

Importance of agribusiness in Indian economy, international trade, WTO agreements- Provisions related to agreements in agricultural and food commodities, Agreements on Agriculture (AOA), Domestic supply, market access, export subsidies agreements on sanitary and Phyto-sanitary (SPS) measures, Trade related intellectual property rights (TRIPS).

**UNIT III ENTREPRENEURSHIP MANAGEMENT: FINANCIAL PERSPECTIVE 9**

Entrepreneurship, Essence of managerial Knowledge, Management functions, communication and control, Understanding Financial Aspects of Business, Importance of financial statements, liquidity ratios leverage ratios, coverage ratios-turnover ratios, Profitability ratios.

**UNIT IV ENTREPRENEURIAL OPPORTUNITIES 9**

Managing an enterprise: Importance of planning, budgeting, monitoring evaluation and follow-up managing competition. Role of ED in economic development of a country, Economic system and its implication for decision making by individual entrepreneurs

**UNIT V ENTREPRENEURIAL PROMOTION MEASURES 9**

Social responsibility of business, Morals and ethics in enterprise management, SWOT analysis, Government schemes and incentives for promotions of entrepreneurship, overview of agricultural engineering industry, characteristics of Indian farm machinery industry.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to:

**CO1:** Judge about agricultural finance, banking and cooperation.
**CO2:** Evaluate basic concepts, principles and functions of financial management.
**CO3:** Improve the skills on basic banking and insurance schemes available to customers.
**CO4:** Analyze various financial data for efficient farm management.
**CO5:** Identify the financial institutions.

**TEXT BOOKS:**


1. Joseph L. Massie, 1995, "Essentials of Management", prentice Hall of India Pvt limited, New Delhi.
2. Mohanty S K, 2007, Fundamentals of Entrepreneurship, Prentice Hall India, New Delhi.


**REFERENCES:**


1. Harih S B, Conner U J and Schwab G D, 1981, Management of the Farm Business, Prentice Hall Inc, New Jersey.
2. Omri Ralins, N.1980, Introduction to Agricultural: Prentice Hall Inc, New Jersey.
3. Gittenger Price, 1989, Economic Analysis of Agricultural project, John Hopkins University, Press, London.
4. Thomas W Zimmer and Norman M Scarborough, 1996, Entrepreneurship, Prentice Hall, New Jersey.
5. Mar J Dollinger, 1999, Entrepreneurship strategies and resources, Prentice –Hall, Upper Saddal Rover, New Jersey.
6. Khanka S, 1999, Entrepreneurial Development, S, Chand and Co, New Delhi.


## CO-PO & PSO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 |
| **CO2** | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 2 | 1 |
| **CO3** | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 2 | 2 |
| **CO4** | 3 | 3 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 2 | 1 |
| **CO5** | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 |
| **Avg** | **2.4** | **1.8** | **1.6** | **1.8** | **1.2** | **1.4** | **1.2** | **1.8** | **1.2** | **1.2** | **1.8** | **1.8** | **1.8** | **1.2** |

**1 - Low, 2 - Medium, 3 –High**

**OPEN ELECTIVE III**
**(Common To B.E - BME, CSE & B. Tech – IT, AI&DS)**

| RA24904 | DRONE TECHNOLOGIES | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

The main learning objective of this course is to prepare the students for:

- Understanding the fundamentals of drone systems and UAV architecture .
- Studying aerodynamic principles and flight mechanics of drones .
- Analyzing components such as sensors, controllers, and communication systems .
- Learning navigation, control, and autonomous flight techniques.
- Exploring applications of drones in various engineering and societal domains.

**UNIT I INTRODUCTION TO DRONE SYSTEMS 9**

Overview of UAVs and drones, classification of drones, applications of drones, basic flight principles, drone anatomy and system components, regulatory framework and safety guidelines.

**UNIT II AERODYNAMICS AND FLIGHT MECHANICS 9**

Basics of aerodynamics, lift, thrust, drag, and weight, multirotor dynamics, stability and control, propulsion systems, battery and power systems.

**UNIT III DRONE HARDWARE AND SENSORS 9**

Flight controller architecture, IMU, GPS, magnetometer, barometer, ultrasonic and vision sensors, motor and ESC systems, communication modules.

**UNIT IV NAVIGATION AND CONTROL SYSTEMS 9**

Drone navigation systems, PID control, trajectory planning, autonomous flight control, obstacle detection and avoidance, path planning algorithms.

**UNIT V DRONE APPLICATIONS AND EMERGING TRENDS 9**

Applications in agriculture, surveillance, disaster management, delivery systems, mapping and surveying, AI-based drones, swarm robotics, future trends in UAV technology.

**TOTAL PERIODS: 45**

**COURSE OUTCOMES:**

Upon successful completion of the course, students should be able to

**CO1:** Explain drone architecture and UAV systems.
**CO2:** Apply aerodynamics and flight principles in drones.
**CO3:** Analyze sensors and control systems used in UAVs.
**CO4:** Analyze navigation and autonomous flight techniques.
**CO5:** Identify real-world applications and emerging drone technologies.

**TEXT BOOKS:**

1. Reg Austin, Unmanned Aircraft Systems: UAV Design, Development and Deployment, Wiley, 2023 Edition.
2. Kimon P. Valavanis, Advances in Unmanned Aerial Vehicles, Springer, 2022 Updated Edition.

**REFERENCES:**

1. Rafael Yanushevsky, Guidance of Unmanned Aerial Vehicles, CRC Press, 2023 Edition.
2. Abdul Basit et al., Drone Technology in Engineering Applications, Elsevier, 2024 Edition.
3. S. N. Omkar, Unmanned Aerial Vehicles: A Primer on Drone Technology, CRC Press, 2024 Edition.

**CO-PO MAPPING**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | 2 | 2 | 2 | 2 |
| **CO2** | 3 | 3 | | 2 | | 2 | | | | | 2 | 2 | 2 | 2 |
| **CO3** | 3 | 2 | | 2 | | 2 | | | | | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 3 | | 2 | | 2 | | | | | 2 | 3 | 3 | 3 |
| **CO5** | 3 | 3 | | 2 | | | | | | | 2 | 3 | 3 | 2 |
| **Avg** | **3.00** | **2.60** | | **2.00** | | **2.00** | | | | | **2.00** | **2.40** | **2.40** | **2.20** |

**1 - Low, 2 - Medium, 3 - High**