# Vidyalankar Institute of Technology

***(Autonomous Institute Affiliated to the University of Mumbai)***

## Scheme and Detailed Syllabus

## of

## Final Year

## in

## Bachelor of Engineering

## in

## Biomedical Engineering

(Curriculum of REV- 2019 'C' Scheme of UoM)

With effect from Academic Year 2022-23

**Program Structure for Final Year Biomedical Engineering**

**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**

**Semester VII**

| Course Code | Course Name | Teaching Scheme(Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. Tut. | Theory | Pract. | Total |
| BMC701 | Biomedical Instrumentation – III | 3 | -- | 3 | -- | 3 |
| BMC702 | Machine Learning | 3 | -- | 3 | | 3 |
| BMDO701X | Department Optional Course – 3 | 3 | -- | 3 | -- | 3 |
| BMDO702X | Department Optional Course – 4 | 3 | -- | 3 | -- | 3 |
| BMIO701 | Institute Optional Course – 1 | 3 | -- | 3 | -- | 3 |
| BML701 | Biomedical Instrumentation – III Lab | -- | 2 | -- | 1 | 1 |
| BML702 | Machine Learning Lab | -- | 2 | -- | 1 | 1 |
| BMDL701X | Department Optional Course – 3 Lab | -- | 2 | -- | 1 | 1 |
| BMP701 | Major Project - I | -- | 6# | -- | 3 | 3 |
| **Total** | | **15** | **12** | **15** | **6** | **21** |

**Evaluation Scheme for Final Year Biomedical Engineering**

**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**

**Semester VII**

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMC701 | Biomedical Instrumentation – III | 20 | 30 | 50 | 100 |
| BMC702 | Machine Learning | 20 | 30 | 50 | 100 |
| BMDO701X | Department Optional Course – 3 | 20 | 30 | 50 | 100 |
| BMDO702X | Department Optional Course – 4 | 20 | 30 | 50 | 100 |
| BMIO701 | Institute Optional Course | 20 | 30 | 50 | 100 |

| | | | | | |
|---|---|---|---|---|---|
| | – 1 | | | | |
| BML701 | Biomedical Instrumentation – III Lab | 25 | | 25 | 50 |
| BML702 | Machine Learning Lab | 25 | | 25 | 50 |
| BMDL701X | Department Optional Course – 3 Lab | 25 | | 25 | 50 |
| BMP701 | Major Project - I | 25 | | 25 | 50 |
| **Total** | | **200** | **150** | **350** | **700** |

Total Contact Hours/weeek :27

Total Credit : 21

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination

# indicates work load of Learner (Not Faculty), for Major Project

**Sem. VII: Department Optional Course – 3**

BMDO7011: Biological Modeling and SimulationBMDO7012: Bioinformatics

BMDO7013: IoT based Systems

**Sem. VII: Department Optional Course – 4**BMDO7021: Rehabilitation Engineering BMDO7022: Lasers and Fibre Optics

BMDO7023: Networking and Information Systems in Medicine

**Sem. VII: Institute Level Optional Course –I**ILO1011: Product Lifecycle Management ILO1012: Reliability Engineering

ILO1013: Management Information SystemILO1014: Design of Experiments
ILO1015: Operation Research
ILO1016: Cyber Security and Laws
ILO1017: Disaster Management and Mitigation MeasuresILO1018: Energy Audit and Management
ILO1019: Development Engineering

**Program Structure for Final Year Biomedical Engineering**

**Vidyalankar Institute of Technology, Mumbai (w.e.f. 2022-2023)**

**Semester VIII**

| Course Code | Course Name | Teaching Scheme(Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. /Tut. | Theory | Pract. | Total |
| BMC801 | Hospital Management | 3 | -- | 3 | -- | 3 |
| BMDO801X | Department Optional Course – 5 | 3 | -- | 3 | -- | 3 |
| BMDO802X | Department Optional Course – 6 | 3 | -- | 3 | -- | 3 |
| BMIO801 | Institute Optional Course - 2 | 3 | -- | 3 | -- | 3 |
| BML801 | Hospital Management Lab | -- | 2 | -- | 1 | 1 |
| BMDL801X | Department Optional Course – 5 Lab | -- | 2 | -- | 1 | 1 |
| BMP801 | Major Project - II | -- | 12# | -- | 6 | 6 |
| **Total** | | **12** | **16** | **12** | **8** | **20** |

**Evaluation Scheme for Final Year Biomedical Engineering**

**Vidyalankar Institute of Technology (Autonomous status with effect from A.Y. 2022-23)**

**Semester VIII**

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMC801 | Hospital Management | 20 | 30 | 50 | 100 |
| BMDO801X | Department Optional Course – 5 | 20 | 30 | 50 | 100 |
| BMDO802X | Department Optional Course – 6 | 20 | 30 | 50 | 100 |
| BMIO801 | Institute Optional Course - 2 | 20 | 30 | 50 | 100 |
| BML801 | Hospital Management Lab | 25 | | 25 | 50 |
| BMDL801X | Department Optional Course – 5 Lab | 25 | | 25 | 50 |
| BMP801 | Major Project - II | 100 | | 50 | 150 |
| **Total** | | **230** | **120** | **300** | **650** |

Total Contact Hours/weeek : 28

Total Credit :20

ISA=In Semester Assessment, MSE=Mid Semester Examination, ESE= End Semester Examination

**Sem. VIII: Department Optional Course – 5** BMDO8011: Robotics in Medicine
BMDO8012: Healthcare Informatics
BMDO8013: Artificial Intelligence in Medicine

**Sem. VIII: Department Optional Course – 6**BMDO8021: Biomedical Microsystems
BMDO8022: Medical Device Regulations
BMDO8023: Ergonomics

**Sem. VIII: Institute level Optional Course - II**

ILO2021: Project Management ILO2022: Finance Management
ILO2023: Entrepreneurship Development and ManagementILO2024: Human Resource Management
ILO2025: Professional Ethics and Corporate Social Responsibility (CSR)
ILO2026: Research Methodology
ILO2027: IPR and Patenting
ILO2028: Digital Business ManagementILO2029: Environmental Management
Students group and load of faculty per week.

**Major Project 1 and 2 :**

Students can form groups with minimum 2 (Two) and not more than 4 (Four)Faculty Load : In Semester VII – ½ hour per week per project group In Semester VIII – 1 hour per week per project group

# Semester – VII

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. Tut. | Theory | Pract. | Total |
| BMC701 | Biomedical Instrumentation – III | 3 | -- | 3 | -- | 3 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMC701 | Biomedical Instrumentation – III | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BMC701** | **Biomedical Instrumentation- -III** | **03** |
| **Course Objectives** | • To understand the basic principles and working of life Saving Equipment.<br>• To develop skills enabling Biomedical Engineers to serve the health care industry<br>• To develop core competency and skill in the field of Biomedical Engineering, to design anddevelop new health care systems. | |
| **Course Outcomes** | **Learner will be able to...**<br>• Distinguish between the types of pacemakers on the basis of ICHD code and analyze thevarious circuits.<br>• Apply the knowledge of electronics to analyze defibrillator circuits.<br>• Explain the importance of use of Anesthesia machine and Capnograph during Surgery.<br>• Explain the basic principle, working and applications of surgical equipment with safety aspects.<br>• Explain the importance of measurement of oxygen saturation in human body and application ofheart lung machine during surgery. | |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Cardiac Pacemakers**<br>Need for a pacemaker, modes of operation, classification codes for pacemaker, external and implantable pacemaker, programmable pacemaker, Power sources for pacemakers, leads and electrodes, recent developments of Implantable Pacemakers. | 09 |
| 2 | **Cardiac Defibrillator**<br>Need for defibrillator, D C defibrillator, modes of operation and electrodes, performance aspects of dc-defibrillator, implantable defibrillator, cardioverter. | 08 |
| 3 | **Physiotherapy equipments**<br>Basic principle, working and technical specifications of<br>1.Shortwave Diathermy<br>2.Ultrasonic therapy unit<br>3. Nerve and Muscle Stimulator. | 06 |
| 4 | **Surgical equipment**<br>Operation theatre Lights and Table.<br>Surgical Diathermy machine, automated electrosurgical systems, electrodes used with surgical diathermy, safety aspects in electronic surgical units. | 08 |
| 5 | **Heart Lung machine**<br>Heart Lung Machine and types of oxygenators | 04 |
| 6 | **Oximeters**<br>Basics of oximeter, In-vitro and In-vivo oximetry, ear oximetry, pulse oximetry, skin reflectance oximeters, intravascular oximeters, | 04 |

**Books Recommended:**

*Text books:*


1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements: Leslie Cromwell, Fred J. Weibell, Enrich A.Pfeiffer. (PHI Pub)


*Reference books:*


1. Introduction to Biomedical Equipment Technology: Carr –Brown.
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV
3. Various Instrument Manuals.
4. Various internet websites.

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. Tut. | Theory | Pract. | Total |
| BMC702 | Machine Learning | 3 | -- | 3 | | 3 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMC702 | Machine Learning | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BMC702** | **Machine Learning** | **03** |
| **Course Objectives** | • To build a strong base in artificial intelligence through algorithm development.<br>• To develop competency in logical thinking, computer programming and knowledge application.<br>To train and motivate for higher education and research in order to make contribution to state of the art health care for all | |
| **Course Outcomes** | **Learner will be able to…**<br>• Understand the fundamental techniques and applications in neural networks, deep learning and machine learning<br>• Understand supervised and unsupervised learning, backpropogation and gradient descent algorithms<br>• Understand and implement efficient computational techniques using neural networks, deep learning and machine learning<br>Design and implementation of neural network models with deep learning and machine learning will be strong base for dsigning artificial intelligent systems | |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Learning methods:** Introduction , types of learning, supervised learning, unsupervised learning, statistical learning, reinforcement learning, elements of reinforcement learning, model-based learning, temporal difference learning, linear regression, least squares, linear regression for polynomial regression tasks, logistic regression, model selection and validation, | **06** |
| 2 | **Clustering:** Introduction, mixture densities, k-means clustering, expectation-maximization algorithm, supervised learning after clustering, spectral clustering, hierarchical clustering, choosing the number of clusters.<br>**Decision Trees:** Introduction, univariate trees, rule extraction from trees, learning rules from data, multivariate trees, clustering, overfitting and evaluation | **06** |
| 3 | **Design and analysis of machine learning experiments:** Introduction, factors, response, and strategy of experimentation, response surface design, randomization,replication, and blocking, guidelines for machine learning experiments, cross-validation and resampling methods, measuring classifier performance | **06** |
| 4 | **Introduction of artificial neural networks:** structure and function of a biological neurons, artificial neuron models, concepts of neural network, single layer and multilayer preceptor, structure of an ANN, feed-forward neural network, gradient descent, back propagation, architectures of neural networks, optimisation of neural network model | **07** |
| 5 | **Architecture and training the ANN:** Type of learning the neural network, training of a single-layer neural network, delta rule, designing ANN models, radial basis function, overview of learning rules and parameters, activation functions, multilayer feed forward network, backpropagation networks, architecture, radial basis function network | **07** |
| 6 | **Fundamentals of deep networks:** Deep Learning, architectural principles of deep networks, parameters, layers, loss function , optimization algorithms, hyper parameters, building blocks of deep networks, architectures of deep networks, convolutional neural networks, architecture of convolutional neural networks, inputlayers, convolutional layers, pooling layers, fully connected layers, recurrent neural networks, architecture of recurrent neural network | **07** |

## Books Recommended:

Text books


1. Introduction to Machine Learning, 3rd edition, Ethem Alpaydin, PHI Learning PrivateLimited, New Delhi, 2015
2. Deep Learning by Josh Patterson and Adam Gibson, O'Reilly Media, Inc., GravensteinHighway North, Sebastopol CA, 2017
3. Neural Networks and Learning Machines Third Edition, Simon Haykin, Pearson, PrenticeHall, 2009


Reference books


1. Machine learning in Action, Peter Harrington, dreamtech Press, New Delhi, 2012
2. Machine learning, Tom M, Mitchell, Mc Graw Hill Education(India) Private Limited NewDelhi, 2013


## Useful Links:

***1.*** *Course 1:* Introduction to Machine Learning
*https://nptel.ac.in/courses/1061061392*.

***2.*** *Course 2:* Introduction to Machine Learning
https://onlinecourses.nptel.ac.in/noc22_cs29/preview

| Course Code | Course Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut | Theory | Pract. | Tut | Total |
| **BMDO7011** | **Biological Modeling and Simulation (Abbreviated asBMS)** | 3 | -- | - | 3 | -- | - | 3 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO701X | Biological Modeling and Simulation | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BMDO7011** | **Biological Modeling and Simulation** | **03** |
| **Course Objectives** | • To understand basic concepts of modeling for designing biological model.<br>• To simulate physiological processes for better understanding.<br>• To develop competency in terms of logical thinking, programming andapplication skills<br>• To train and motivate students for pursuing higher education and research for developing cutting edge technologies. | |
| **Course Outcomes** | **A learner will be able to:**<br>• Categorise different types of biological models.<br>• Develop a model of a neuron using Hodgkin Huxley exp setup.<br>• Differentiate a spindle receptor and Golgi tendon bodies.<br>• Design a quantitative model for eye movement system.<br>• Understand a basic model of a thermoregulatory system.<br>• Understand the behaviour of immune system | |

| Module | Contents | Time |
|---|---|---|
| 1 | **Physiological modeling**: Steps in modeling, purpose of modeling, lumped parameter models, distributed parameter models, compartmental modeling, modeling of circulatory system. | 04 |
| 2 | **Model of neurons:** Biophysics tools, Nernst Equation, Donnan Equilibrium, active transport (Pump) GHK equation, action potential, voltage clamp, channel characteristics, Hodgkin- Huxley conductance equations, simulation of action potential, electrical equivalent model of a biological membrane, impulse propagation- core conductor model, cable equations. | 11 |
| 3 | **Neuromuscular system:** Modeling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex,reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome. | 06 |
| 4 | **Eye movement model:** Four eye movements, quantitative eye movement models, validity criteria. | 06 |
| 5 | **Thermo-regulatory systems:** Thermoregulatory mechanisms, electrical model of thermoregulatory system, controller model, validation and application. | 06 |
| 6 | **Modeling of other physiological systems.Modeling the immune response:** Behavior of the immune system, linearized model of the immune response. Modeling of insulin glucose feedback system and Pulsatile insulin secretion | 06 |

**Books Recommended:**

*Text books:*


1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey


*Reference Books:*


1. Biomedical Engineering Handbook by Bronzino (CRC Press)

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDO7012 | Department Optional Course – 3 Bioinformatics (Abbreviated as BI ) | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO7012 | Bioinformatics | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO7012 | Bioinformatics | 03 |
| Course Objectives | • The course introduces the students to the field of Bioinformatics.<br>• To make students aware about the methods to characterize and manage the different typesof biological data.<br>• To introduce students to the basics of sequence alignment and analysis. | |
| Course Outcomes | **Learner will be able to**<br>• Get introduced to the basic concepts of Bioinformatics and its significance in Biologicaldata analysis.<br>• Apply knowledge of basic principles of mathematics and statistics.<br>• Apply existing software effectively to extract information from large databases and to use this information in computer modelling<br>• Apply problem-solving skills to multivariate methods in bioinformatics<br>• Search and apply bioinformatics tools to analyse and interpret biological data | |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to bioinformatics and biological databases:**<br>Basic principles of genetics**, c**ells, DNA and chromosome, genes and the genome,DNA sequencing, proteomics, discovery of gene sequence.<br>Human genome project, biological databases and their classification, genome sequence databases, protein structure databases, composite databases. | **08** |
| 2 | **Statistical methods used in bioinformatics:**<br>Basic statistical modelling and Bayesian inference, gene expression and microarray analysis, sequence alignment, sequence pattern discovery, combining sequence andexpression information. | **10** |
| 3 | **Algorithms in bioinformatics:**<br>Introduction, dynamic programming and sequence alignment, Needleman–Wunsch algorithm, Greedy algorithms for Genome rearrangement, string algorithm, breakpoint graph, approximation algorithm, FASTA and BLAST algorithms.. | **08** |
| 4 | **Multivariate Methods in Bioinformatics:**<br>Multivariate normal distribution, multivariate hypothesis tests, principle component analysis, orthogonal factor model, linear discriminant analysis, classification methods, Naïve Bayes classification. | **06** |
| 5 | **Applications and tools of bioinformatics:**<br>Sequence alignment and dotplot, DNA sequence analysis, protein sequence analysis, database similarity search, phylogenic analysis and tree construction, gene, protein and tissue microarray. | **07** |

**Recommended Online Courses ( optional):**

1. "Bioinformatics and Computational Biology" offered by IIT Kanpur **https://piazza.com/iitk.ac.in/secondsemester2018/bse322a/**

2. "Network Analysis in Systems Biology" offered by Icahn School of Medicine at Mount Sinai,in New York City **https://www.coursera.org/learn/network-biology**
3. "Bioinformatics: Introduction and Methods"from Peking University. **https://www.coursera.org/learn/bioinformatics-pku**

4. "Biology Meets Programming : Bioinformatics for Beginners", offered by UC San Diego **https://www.coursera.org/learn/bioinformatics**

**Books Recommended:**

*Text books:*

1. Basics of Bioinformatics, Rui Jiang, Xuegong Zhang, Michael Q. Zhang, Springer, E-book.
2. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 2002, First Edition.

*Reference Books:*

1. Essential Bioinformatics, Jin Xiong, Cambridge University Press, 2006, First Edition.

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDO7013 | IoT Based Systems (Abbreviated as IoT) | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO7013 | IoT Based Systems | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO7013 | IOT Based Systems | 03 |
| Course Objectives | • Learn the concepts of IOT<br>• Identify different technologies and schemes<br>• Learn different applications in IOT<br>• Learn different protocols used in IOT<br>• Learn how to analyze the data in IOT | |
| Course Outcomes | **Learner will be able to**<br>• Apply the concepts of IOT<br>• Identify and select different technologies and scheme for IOT applications<br>• Apply IOT to different applications<br>• Analyze and evaluate protocols used in IOT systems<br>• Analyze dataflow in IOT systems | |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction:**<br>History of IoT, Objects in IoT, Identifier in the IoT, Technologies in IoT. What are wireless sensors, Sensor family, Architecture of single node sensor. | 04 |
| 2 | **IoT schemes and models:**<br>Block diagram of an IoT device (node), characteristics of IoT, functional blocks of IoT, communication models. IoT levels and deployment templates. IoT enabling technologies. | 08 |
| 3 | **IoT stack:**<br>M2M stack and examples, IoT stack and examples, IoT stack variants, difference between IoT and M2M.<br>IoT Access Technologies: Physical and MAC layers, IEEE 802.15.4, 802.15.4g,802.15.4e, 1901.2a, 802.11 and LoRaWAN. | 08 |
| 4 | **Network and Communication Aspects:**<br>Network Layer Protocols: IPv4 and IPv6, Constrained nodes and Constrained networks Optimizing IP for IoT: From 6LoWPAN to 6Lo, routing over low power and lossy networks.<br>Application Layer Protocols: CoAP and MQTT. | 05 |
| 5 | **Components of IoT:**<br>IoT platform design methodology.<br>IoT end device computing –boards based on microcontroller and SoC. Sensor technologies, sensor data communication protocols: UART, SPI, I2C. | 06 |
| 6 | **IoT Case Studies:**<br>Home automation, smart cities, environment monitoring and control, agriculture, retailsector, healthcare and lifestyle, logistics and supply chain, access control and tracking. | 08 |

**Recommended Online Courses ( optional):**

1) Introduction To Internet Of Things
By Prof. Sudip Misra | IIT Kharagpur
https://onlinecourses.nptel.ac.in/noc22_cs52/preview

2) Introduction To Industry 4.0 And Industrial Internet Of ThingsBy Prof. Sudip Misra | IIT Kharagpur
https://onlinecourses.nptel.ac.in/noc22_cs52/preview

**Books Recommended:**

*Text books:*

1) Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, universitiespress.
2) IOT fundamentals, David, Gonzalo, Patrick, Cisco press.
3) Data and Computer communications, william stallings, Pearson Education.
4) Data communication and networking, Behrouz A. Forouzan, McGraw Hill Education
Communication Networks, Alberto Leon Garcia, McGraw Hill Education.

*Reference Books:*

1) Computer Networks, S. Tanenbaum, Pearson Education.
2) Computer Networking: A Top-Down Approach, J. F. Kurose and K. W. Ross, AddisonWesley.

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDO7021 | Department Level Optional Course –4<br>Rehabilitation Engineering (Abbreviated as RE) | 03 | | | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO7021 | Rehabilitation Engineering | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO7021 | Rehabilitation Engineering | 03 |
| Course Objectives | • To Introduce the socio-legal aspects of Rehabilitation Engineering<br>• To understand the importance of Orthotics, and Prosthesis<br>• To introduce learners to basics of Kinetics and Kinematics.<br>• To understand the flow properties of blood.<br>• To understand various upper and lower limb deformities.<br>• To understand the rehabilitation management of various deformities | |
| Course Outcomes | **A learner will be able to**<br>• Understand the basic difference between Impairment, Disability and Handicap<br>• Understand the reasons for Amputation, need of Orthosis, Prosthesis.<br>• Understand the human joint's stability.<br>• Understand the flow pattern of blood in normal and abnormal conditions.<br>• Understand management of simple to complex deformities<br>• Understand the rehabilitation management during paralytic conditions of the limb | |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction and socio-legal aspects of rehabilitation engineering:** Medical rehabilitation, epidemiology of rehabilitation, preventive rehabilitation,impairment disability and handicap. | 03 |
| 2 | **Orthotics, amputation, and prosthetics, activities of daily living (ADL):** Orthotics: General principles of orthotics, biomechanics of orthotics, classification: upper & lower extremity orthotics, spinal orthotics<br>Amputation & prosthetics: Causes of amputation, types of amputation, and levels of amputation for upper and lower extremity, preoperative and post-operative period. pre-prosthetic stage, endo & exo-skeletal prosthetics, classification of upper & lower limb prosthetics<br>Activities of daily living: ADL grouping, Barthel's index of ADL, functionalindependence, measures, environmental control system, communication, ADL training. | 10 |
| 3 | **Mechanical principles of Kinematics and Kinetics:**<br>Planar classification of position and motion, rotary and translatory motion, degree of freedom, kinematic chain theories of motion, levers, torque, parallel force, resolutionof force, calculation of muscle and joint forces<br>Clinical application on weight and center of gravity ,applied weights and resistance,muscle force and leverage, joint forces, clinical application on stretching versus jointmobilization. | 06 |
| 4 | **Flow properties of blood:** An outline of blood rheology, constitutive equation of blood based viscometric data and Casson's equation, laminar flow of blood in a tube, fluid mechanical interaction of RBCs with a solid wall, thrombus formation and dissolution, medical application of blood rheology. | 06 |
| 5 | **Common deformities and role of surgery in rehabilitation engineering.** Types of deformities, management of 1st and 2nd degree deformities, common deformities oflower limb, treatment for partial foot deformities, deformities of the foot, arm Deformities, torticollis | 06 |
| 6 | **An overview of rehabilitation of muscular dystrophy, paraplegia, and quadriplegia:** Muscular dystrophy, Duchenne muscular dystrophy, rehabilitation, facioscapulohumeral muscular dystrophy<br>Paraplegia: Etiology, mechanism of injury, identification of level of lesion, management of active spinal cord injury, rehabilitation, gait training<br>Quadriplegia: Mobility, training, level of injury & outcome, management. | 08 |

**Books Recommended:**

*Text books:*

1. BRUNNSTROM'S CLINICAL KINESIOLOG, By Laura K Smith, ElizabethLaurance Weiss; Jaypee brothers Publication
2. Mechanical properties of living tissues by Y. C. Fung

*Reference Books:*

1. Textbook of Rehabilitation by S. Sundar,3rd edition Jaypee publication

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| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDO7022 | Lasers & Fiber Optics | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO7022 | Lasers & Fibre Optics | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO7022 | Lasers & Fibre Optics | 03 |
| Course Objectives | • To help the students to build up a detailed knowledge of the methods, fabrication, and applications of lasers & fiber optics in medical engineering.<br>• To create a platform for students to have deeper understanding on the fundamental principles of lasers and Optical fibers in bio-photonic systems. | |
| Course Outcomes | Learner will be able to:<br>• Understand types of optical source and its emission properties.<br>• Analyze the various types of lasers and their medical applications<br>• Familiarize the fundamentals of optical fibers.<br>• Understand the interaction of laser with tissue along with its applications<br>• Understand and implement the use of lasers and optical fibers for surgery and sensing. | |

| Module | Contents | Hours |
|---|---|---|
| 1. | **Introduction to optical radiation, emission & resonator:** Spontaneous and stimulated emission, Einstein's coefficients, gain coefficient, laser oscillation conditions, population inversion, three and four level systems, rate equations, optical resonators and types, modes and mode stability criteria, losses in optical resonators-quality factor. | 06 |
| 2. | **Types of Lasers:** Working principle of Ruby laser, dye laser, argon ion laser, solid state lasers-fundamental and higher harmonic generation. Detailed study of semiconductor lasers, Nd: YAG laser- flash lamp pumped and diode pumped lasers, He-Ne laser, CO2 laser, excimer laser, nitrogen laser, free electron laser, Ti: Saphire laser, rare earth doped and photonic crystal fiber basedlasers, soliton lasers. Chemical lasers, metal vapors lasers, medical applications of Lasers. | **07** |
| 3. | **Fundamentals of fiber optics:** Classification of fibers- step index, graded index fiber, numerical aperture, modes in optical fiber, single mode and multimode fiber, V- parameter, evanescent modes, losses in fiber, dispersion in fiber, special fiber-polarization maintaining fiber, non-linear effects in optical fiber, fiber fabrication techniques, splicing. | 07 |
| 4. | **Photobiology & bioimaging:** Interaction of light with cells and tissues, photo-processes in biopolymers, humaneye and vision, optical fiber delivery system, Optical coherence tomography, Applications of bio-imaging: bio-imaging probes and fluorophores, Endoscopy. | **06** |
| 5. | **Optical sensors:** MM and SM fibers for sensing, Lasers & LEDs suitable for sensing, PIN & APDsfor fiber optic sensing. Principles of electro optic modulators bulk & integrated optic modulators, opticalsensor types, advantages and disadvantages of fiber optic sensors, intensity modulated sensors, interferometric sensors, rotation sensors, bio sensors. | **07** |
| 6. | **Laser and fiber activated therapy:** Photodynamic therapy, photo-sensitizers for photodynamic therapy, tissue engineering using light, Laser system in cardiovascular disease, gastroenterology, gynecology, neurosurgery, oncology, ophthalmology, orthopedics, otolaryngology (ENT), urology, lasers and fibers in skin treatment. | **06** |

**Books Recommended:**

Textbooks:


- Tu Vo Dinh, Biomedical Photonics: A Handbook- CRC Press, Boca Raton, FL 2003
- V N Prasad, Introduction to Biophotonics, Wiley-Interscience, 2003
- Orazio Svelto, Principles of Lasers, 4thEdn, Plenum Press, 1998
- Dakin J and Culshow B., (Ed), Optical fiber sensors, Vol I,II, III, Artech House, 1998
- Francis T.S Yu, Shizhuo Yin (Eds), Fiber Optic Sensors, Marcel Dekker Inc., New York, 2002
- Silfvast. W T., Laser Fundamentals, Cambridge University Press, New Delhi, 1998


Reference Books:


- Lihong V and Hsin-IWU, Biomedical Optics-Principles, and Imaging - Wiley Interscience 1st ed. 2007
- Mark E.Brezinski, Optical Coherence Tomography-Principles and Applications-(AcademisPress 1st ed. 2006)
- Rodney Cotterill, Biophysics –An Introduction (John Wiley Student edition)

- Valery .V.Tuchin, A Handbook of Optical Biomedical diagnostics, SPIE press monograph volpm 107
- Bahaa E. A Saleh & Malvin Carl Teich, Fundamentals of Photonics, John Wiley & Sons, 1991
- Jeff Hecht, The Laser Guide Book, McGraw Hill, 1986
- Koechner (W alter), Solid State Laser Engineering, Springer, 1992
- Marvin J. Weber, Handbook of Lasers, CRC Press, 2001
- Yariv A, Optical Electronics, 4thEdn, Holt, Rinehart and Winston, 1991

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract | Tut | Total |
| BMDO7023 | Department Optional Course – 4 Networking and Information Systems in Medicine (Abbreviated asNISM) | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO7023 | Networking and Information Systems in Medicine | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO7023 | Networking and Information Systems in Medicine | 03 |
| Course Objectives | • To understand the fundamental component of computer Networking.<br>• To understand the functioning and configuration of various networking devices andcomponents.<br>• To understand a concept about network security.<br>• Understand various Information system used in Healthcare System<br>• To understand the healthcare IT infrastructure Understand various IHE domains | |
| Course Outcomes | **Learners will be able to:**<br>• Understand the fundamental components of computer networks and networkingprotocols.<br>• Understand IP addressing, functioning and configuration of various networkingdevices and components<br>• Understand concepts about network security<br>• Understand the PACS components, architecture and PACS tele radiology<br>• Understand HIS, RIS, integration of HIS/RIS/PACS, PACS archive storage<br>• Understand IHE and IHE domains | |

| Module | Contents | Hours |
|---|---|---|
| **1.** | PACS Components; PACS generic workflow; PACS architectures: stand-alone, client-server, and web-based; PACS and teleradiology | **06** |
| **2.** | Introduction to RIS and HIS, HIS/RIS/PACS integration; PACS archive storage: RAID; HIPPA | **06** |
| **3.** | Integrating Healthcare Enterprise: IHE workflow model, IHE domains, IHE patient information reconciliation profile, IHE radiology information integration profile | **06** |
| **4.** | Performance of network/device parameters: bandwidth, throughput, jitter, latency network technology; types of cables and connectors, crossover and straight throughcables, colour coding of cables; OSI Model; TCP/IP, Addressing types (IP, MAC, Port& Specific) | **08** |
| **5.** | IP V4 addressing, subnetting, supernetting; IP V6 addressing; Detailed working of networking equipment: Hub, bridge , switch, router, modem | **07** |
| **6.** | Basic Security Concepts:<br>Security Mechanism and security services, authentication, authorization, confidentiality, integrity, non-repudiation; Symmetric and asymmetric key cryptography, RSA algorithm | **06** |

**Books Recommended:**

*Textbooks:*

1. PACS and Imaging Informatics by H.K. Huang, Second Edition, Wiley and Blackwell.
2. PACS: A Guide to the Digital Revolution by Keith J. Dreyer, Springer.
3. Data Communication and Networking by Behrouz A. Forouzan, McGraw Hill.
4. Computer Networks by A.S. Tanenbaum, Pearson Education.

*Reference Books:*

1. Governance of Picture Archiving and Communications Systems by Carrison K.S. Tong, Eric T.T.Wong (Medical Information Science Reference).
2. Practical Imaging Informatics, By Barton F. Branstetter, Springer.
3. PACS Fundamentals by Herman Oosterwijk.
4. Cryptography and Network Security By William Stalling, Pearsons.

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **BMIO701** | **Product Life Cycle Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| BMIO701 | Product Life Cycle Management | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To familiarize the students with the need, benefits and components of PLM<br>• To acquaint students with Product Data Management & PLM strategies<br>• To give insights into new product development program and guidelines for designing and developing a product<br>• To familiarize the students with Virtual Product Development |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.<br>• Illustrate various approaches and techniques for designing and developing products.<br>• Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.<br>• Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | **Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm,Importance & Benefits of PLM, Widespread Impact of PLM, Focus andApplication, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM | 10 |

| | | |
|---|---|---|
| 2 | **Product Design:**<br>Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of<br>Design for X Tools and Their Use in the Design Process | 09 |
| 3 | **Product Data Management (PDM):**<br>Product and Product Data, PDM systems and importance, Components of PDM,Reason for implementing a PDM system, financial justification of PDM, barriers<br>to PDM implementation | 05 |
| 4 | **Virtual Product Development Tools:**<br>For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies | 05 |
| 5 | **Integration of Environmental Aspects in Product Design:**<br>Sustainable Development, Design for Environment, Need for Life CycleEnvironmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design | 05 |
| 6 | **Life Cycle Assessment and Life Cycle Cost Analysis:**<br>Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolutionof Models for Product Life Cycle Cost Analysis | 05 |

**REFERENCES:**


1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century ProductRealisation", Springererlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, Antonino Risitano, "Product Design for the environment-Alife cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer,Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of leanthinking", Tata McGraw Hill, 2006, ISBN: 0070636265

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **BMIO7012** | **Reliability Engineering** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| BMIO7012 | Reliability Engineering | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To familiarize the students with various aspects of probability theory<br>• To acquaint the students with reliability and its concepts<br>• To introduce the students to methods of estimating the system reliability of simple and complex systems<br>• To understand the various aspects of Maintainability, Availability and FMEA procedure |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Understand and apply the concept of Probability to engineering problems<br>• Apply various reliability concepts to calculate different reliability parameters<br>• Estimate the system reliability of simple and complex systems<br>• Carry out a Failure Mode Effect and Criticality Analysis |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| **1** | **Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.<br>**Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.<br>**Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis. | **08** |
| **2** | **Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.<br>**Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time ToFailure (MTTF), MTBF, Reliability Functions.<br>**Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis. | **08** |
| **3** | **System Reliability:**<br>System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems. | **05** |

| | | |
|---|---|---|
| **4** | **Reliability Improvement:**<br>Redundancy Techniques: Element redundancy, Unit redundancy, Standbyredundancies. Markov analysis.<br>System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method. | **08** |
| **5** | **Maintainability and Availability:**<br>System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects. | **05** |
| 6 | **Failure Mode, Effects and Criticality Analysis:**<br>Failure mode effects analysis, severity/criticality analysis, FMECA examples.Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis | 05 |

**REFERENCES:**


1. L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980.
4. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata McGraw-Hill Publishing Co. Ltd

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **BMIO7013** | **Management Information System** | Theory | Pract./Tut. | Theory | Pract./Tut. | Tota l |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| BMIO7013 | **ManagementInformation System** | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • The course is blend of Management and Technical field.<br>• Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built<br>• Define and analyze typical functional information systems and identify how they meetthe needs of the firm to deliver efficiency and competitive advantage<br>• Identify the basic steps in systems development |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Explain how information systems Transform Business<br>• Identify the impact information systems have on an organization<br>• Describe IT infrastructure and its components and its current trends<br>• Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making<br>• Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | **Introduction To Information Systems (IS):** Computer Based Information Systems, Impact of IT on organizations, Importanceof IS to Society. Organizational Strategy, Competitive Advantages and IS | **04** |
| 2 | **Data and Knowledge Management:** Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management **Business intelligence (BI):** Managers and Decision Making, BI for Data analysis and Presenting Results | **07** |
| 3 | **Ethical issues and Privacy:** Information Security. Threat to IS, and Security Controls | **07** |

| | | |
|---|---|---|
| 4 | **Social Computing (SC):**<br>Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce. | **07** |
| 5 | **Computer Networks** Wired and Wireless technology, Pervasive computing, Cloud computing model. | **06** |
| 6 | **Information System within Organization:**<br>Transaction Processing Systems, Functional Area Information System, ERP andERP support of Business Process.<br>Acquiring Information Systems and Applications: Various System development life cycle models. | **08** |

**REFERENCES:**


1 Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2 K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the DigitalFirm, 10th Ed., Prentice Hall, 2007.
3 D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization,Prentice Hall, 2008

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **BMIO7014** | **Design of Experiments** | Theory | Pract./Tut. | Theory | Pract./Tut. | Tota l |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| BMIO7014 | **Design of Experiments** | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand the issues and principles of Design of Experiments (DOE)<br>• To list the guidelines for designing experiments<br>• To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Plan data collection, to turn data into information and to make decisions that leadto appropriate action<br>• Apply the methods taught to real life situations<br>• Plan, analyse, and interpret the results of experiments |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | **Introduction**<br>1.1 Strategy of Experimentation<br>1.2 Typical Applications of Experimental Design<br>1.3 Guidelines for Designing Experiments<br>1.4 Response Surface Methodology | 06 |
| 2 | **Fitting Regression Models**<br>2.1 Linear Regression Models<br>2.2 Estimation of the Parameters in Linear Regression Models<br>2.3 Hypothesis Testing in Multiple Regression<br>2.4 Confidence Intervals in Multiple Regression<br>2.5 Prediction of new response observation<br>2.6 Regression model diagnostics<br>2.7 Testing for lack of fit | 08 |

| | | |
|---|---|---|
| 3 | **Two-Level Factorial Designs**<br>3.1 The $2^2$ Design<br>3.2 The $2^3$ Design<br>3.3 The General$2^k$ Design<br>3.4 A Single Replicate of the $2^k$ Design<br>3.5 The Addition of Center Points to the $2^k$ Design,<br>3.6 Blocking in the $2^k$ Factorial Design<br>3.7 Split-Plot Designs | 07 |
| 4 | Two-Level Fractional Factorial Designs<br>4.1 The One-Half Fraction of the 2k Design<br>4.2 The One-Quarter Fraction of the 2k Design<br>4.3 The General 2k-p Fractional Factorial Design<br>4.4 Resolution III Designs<br>4.5 Resolution IV and V Designs<br>4.6 Fractional Factorial Split-Plot Designs | 07 |
| 5 | Response Surface Methods and Designs<br>5.1 Introduction to Response Surface Methodology<br>5.2 The Method of Steepest Ascent<br>5.3 Analysis of a Second-Order Response Surface<br>5.4 Experimental Designs for Fitting Response Surfaces | 07 |
| 6 | Taguchi Approach<br>6.1 Crossed Array Designs and Signal-to-Noise Ratios<br>6.2 Analysis Methods<br>**6.3** Robust design examples | 04 |

**REFERENCES:**


1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design,Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Practical Experiment Designs for Engineers and Scientists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T. Voss

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **BMIO7015** | **Operations Research** | Theory | Pract./Tut. | Theory | Pract./Tut. | Tota l |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| BMIO7015 | **Operations Research** | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • Formulate a real-world problem as a mathematical programming model.<br>• Understand the mathematical tools that are needed to solve optimization problems.<br>• Use mathematical software to solve the proposed models. |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.<br>• Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.<br>• Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.<br>• Understand the applications of integer programming and a queuing model and compute important performance measures |

| Module | Detailed Contents | Hours |
|---|---|---|
| 1 | **Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research<br>**Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**,<br>Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis<br>**Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m<br>Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, Travelling Salesman Problem<br>**Integer Programming Problem**: Introduction, Types of Integer Programming Problems,<br>Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms. | 14 |
| 2 | **Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population | 05 |
| 3 | **Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation<br>Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo<br>Simulation, Applications of Simulation, Advantages of Simulation, Limitationsof Simulation | 05 |
| 4 | **Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems. | 05 |
| 5 | **Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point<br>– mixed strategy for 2 X 2 games. | 05 |
| 6 | **Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model, | 05 |

**REFERENCES:**


1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles andPractice", John Willey and Sons, 2nd Edition, 2009
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGrawHill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **BMIO7016** | **Cyber Security and Laws** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| BMIO7016 | **Cyber Securityand Laws** | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand and identify different types cybercrime and cyber law<br>• To recognized Indian IT Act 2008 and its latest amendments<br>• To learn various types of security standards compliances |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Understand the concept of cybercrime and its effect on outside world<br>• Interpret and apply IT law in various legal issues<br>• Distinguish different aspects of cyber law<br>• Apply Information Security Standards compliance during software design and development |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | **Introduction to Cybercrime:**<br>Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes. | 4 |
| 2 | **Cyber offenses & Cybercrime:**<br>How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations,<br>Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops | 9 |
| 3 | **Tools and Methods Used in Cyberline:**<br>Phishing, Password Cracking, Key loggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft) | 6 |

| | | |
|---|---|---|
| 4 | **The Concept of Cyberspace** :<br>E-Commerce, The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law | 8 |
| 5 | **Indian IT Act:**<br>Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under theIT Act, 2000, IT Act. 2008 and its Amendments | 6 |
| 6 | **Information Security Standard compliances**<br>SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI. | 6 |

**REFERENCES:**


1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information Technology Act, 2000; Bare Act- Professional Book Publishers, NewDelhi.
4. Cyber Law & Cyber Crimes by Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security,* Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information SciencePublishing.
7. William Stallings*, Cryptography and Network Security,* Pearson Publication
8. Websites for more information is available on: The Information Technology ACT, 2008-TIFR: https://www.tifrh.res.in
9. Website for more information: A Compliance Primer for IT professional: https://www.sans.org/reading-room/whitepapers/compliance/compliance-primerprofessionals-33538

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **BMIO7017** | **Disaster Management and Mitigation Measures** | Theory | Pract./Tut. | Theory | Pract./Tut. | Tota l |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| BMIO7017 | **Disaster Management and Mitigation Measures** | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand physics and various types of disaster occurring around the world<br>• To identify extent and damaging capacity of a disaster<br>• To study and understand the means of losses and methods to overcome /minimizeit.<br>• To understand role of individual and various organization during and after disaster<br>• To understand application of GIS in the field of disaster management<br>• To understand the emergency government response structures before, during and after disaster |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Get to know natural as well as manmade disaster and their extent and possible effects on the economy.<br>• Plan of national importance structures based upon the previous history.<br>• Get acquainted with government policies, acts and various organizational structure associated with an emergency.<br>• Get to know the simple do's and don'ts in such extreme events and act accordingly. |

| Module | Detailed Contents | Hours |
|---|---|---|
| 1 | **Introduction**<br>*1.1* Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change. | 03 |
| 2 | **Natural Disaster and Manmade disasters:**<br>2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion<br>2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters. | 09 |
| 3 | **Disaster Management, Policy and Administration**<br>3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.<br>3.2 Policy and administration:<br>Importance and principles of disaster management policies, command and coordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process. | 06 |
| 4 | **Institutional Framework for Disaster Management in India:**<br>4.1 Importance of public awareness, Preparation and execution of emergency management program. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations.<br>4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard. | 06 |
| 5 | **Financing Relief Measures:**<br>5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams.<br>5.2 International relief aid agencies and their role in extreme events. | 09 |
| 6 | **Preventive and Mitigation Measures:**<br>6.1 Pre-disaster, during disaster and post-disaster measures in some events in general<br>6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication<br>6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. | 06 |
| | 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids. | |

**REFERENCES:**


1. 'Disaster Management' by Harsh K. Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S. Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elsevier Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications. (Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **BMIO7018** | **Energy Audit and Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Tota l |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| BMIO7018 | Energy Auditand Management | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand the importance energy security for sustainable development and the fundamentals of energy conservation.<br>• To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management<br>• To relate the data collected during performance evaluation of systems for identification of energy saving opportunities. |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• To identify and describe present state of energy security and its importance.<br>• To identify and describe the basic principles and methodologies adopted in energy auditof a utility.<br>• To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.<br>• To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities<br>• To analyze the data collected during performance evaluation and recommend energy saving measures |

| Module | Detailed Contents | Hours |
|---|---|---|
| 1 | **Energy Scenario:**<br>Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance | 04 |
| 2 | **Energy Audit Principles:**<br>Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment(ROI), Internal rate of return (IRR) | 08 |
| 3 | **Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control;Power factor improvement, Energy efficient equipments and appliances, starratings.<br>**Energy efficiency measures in lighting system, lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers.<br>Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives. | 10 |
| 4 | **Energy Management and Energy Conservation in Thermal Systems:**<br>Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.<br>General fuel economy measures in Boilers and furnaces, Waste heat recovery, useof insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities. | 10 |
| 5 | **Energy Performance Assessment:**<br>On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis. | 04 |
| 6 | **Energy conservation in Buildings:**<br>Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources | 03 |

**REFERENCES:**


1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata EnergyResearch Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **BMIO7019** | **Development Engineering** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| BMIO7019 | Development Engineering | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development<br>• To study Implications of 73rd CAA on Planning, Development and Governance ofRural Areas<br>• An exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals<br>• To understand the Nature and Type of Human Values relevant to Planning Institutions |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Apply knowledge for Rural Development.<br>• Apply knowledge for Management Issues.<br>• Apply knowledge for Initiatives and Strategies<br>• Develop acumen for higher education and research.<br>• Master the art of working in group of different nature.<br>• Develop confidence to take up rural project activities independently |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Introduction to Rural Development:**<br>Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services. | 08 |
| 2 | **Post-Independence Rural Development:**<br>Balwant Rai Mehta Committee - three tier system of rural local Government; Needand scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development. | 04 |
| 3 | **Rural Development Initiatives in Five Year Plans:**<br>Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development. | 06 |
| 4 | **Post 73rd Amendment Scenario:** 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments. | 04 |
| 5 | Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education.<br>Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values;Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom. | 10 |
| 6 | **Ethics:** Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility;Work ethics; Professional ethics; Ethics in planning profession, research and education | 04 |

**References:**


1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning CommissionNew Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V., Conflicting Rationalities: -Implications for Planning Theory and Ethics,Planning Theory and Practice, Vol. 4, No.4, pp.395 – 407

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. Tut. | Theory | Pract. | Total |
| BML701 | Biomedical Instrumentation – III Lab | -- | 2 | -- | 1 | 1 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BML701 | Biomedical Instrumentation – III Lab | 25 | | 25 | 50 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BML701** | **Biomedical Instrumentation- -III** | **01** |
| **Course Objectives** | • To understand the basic principles and working of life Saving Equipment.<br>• To develop skills enabling Biomedical Engineers to serve the health care industry<br>• To develop core competency and skill in the field of Biomedical Engineering, to design and develop new health care systems. | |
| **Course Outcomes** | **Learner will be able to...**<br>• Design and implement basic Pacemaker circuits.<br>• Design and implement basic oscillator circuits for Surgical Diathermy.<br>• Demonstrate the knowledge of application techniques of physiotherapy machines.<br>• Demonstrate the knowledge of application technique of oximeter | |

**Syllabus: Same as that of (Course Code) Biomedical Instrumentation- -III (BMI-III)**

**List of Experiments: (Any Seven)**

1. Implementation and testing of basic circuit of pacemaker.
2. Implementation of NAND Gate Oscillator in Surgical Diathermy.
3. Implementation of RLC Over damped system.
4. Implementation of OT lights.
5. Demonstration of Defibrillator.
6. Demonstration of Pacemaker.
7. Demonstration of Surgical Diathermy
8. Demonstration of Ultrasonic Diathermy
9. Demonstration of Nerve and Muscle Stimulator
10. Demonstration of Oximeter.
11. Industry / Hospital visits may be conducted.

Any other experiment based on syllabus which will help learner to understand topic/concept. Group

Presentation on the latest technology in hospitals based on the topics covered in the syllabus.

**In Semester Assessment (ISA):**

ISA shall consist of minimum 7 experiments.
The final certification and acceptance of ISA ensures the satisfactory performance of laboratorywork and minimum passing in the ISA.

**Books Recommended:**

*Text books:*

1. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
2. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
3. Biomedical Instrumentation and measurements: Leslie Cromwell, Fred J. Weibell, Enrich A.Pfeiffer. (PHI Pub)

*Reference books:*

1. Introduction to Biomedical Equipment Technology: Carr –Brown. (PH Pub)
2. Encyclopedia of Medical Devices and Instrumentation: J G. Webster. Vol I- IV (PH Pub)
3. Various Instruments Manuals.
4. Various internet websites.

**Oral examination will be based on entire syllabus.**

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. Tut. | Theory | Pract. | Total |
| BML702 | Machine Learning Lab | -- | 2 | -- | 1 | 1 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BML702 | Machine Learning Lab | 25 | | 25 | 50 |

| BMC702 | Machine Learning | 03 |
|---|---|---|
| **Course Objectives** | • To build a strong base in artificial intelligence through algorithm development.<br>• To develop competency in logical thinking, computer programming and knowledgeapplication.<br>• To train and motivate for higher education and research in order to make contributionto state of the art health care for all | |
| **Course Outcomes** | **Learner will be able to…**<br>• Understand the fundamental techniques and applications in neural networks, deeplearning and machine learning<br>• Understand supervised and unsupervised learning, back propagation and gradientdescent algorithms<br>• Understand and implement efficient computational techniques using neural networks,deep learning and machine learning<br>• Design and implementation of neural network models with deep learning and machine learning will be strong base for designing artificial intelligent systems | |

**Syllabus:** Same as that of (BMC702) Machine Learning (ML)

**List of Experiments:** (Any Seven)

1. Implement the activation functions used in the neural network
2. Implement ANDNOT and XOR function using McCulloch-Pitts neural net
3. Implementation of learning rules for neural network
4. Implementation of backpropagation with gradient descent algorithm neural network
5. Design and implement the neural network model for estimation problem.
6. Design and implement the neural network model for classification problem
7. Optimize the neural network model for estimation problem.
8. Optimize the neural network model for classification problem.
9. Design and implement the neural network model for estimation problem with deep learning
10. Design and implement the neural network model for estimation problem with deep learningAny

other experiment based on syllabus which will help learner to understand topic/concept.

**In Semester Assessment(ISA):**

ISA shall consist of minimum 7 experiments.
The final certification and acceptance of ISA ensures the satisfactory performance oflaboratory work and minimum passing in the ISA.

**Text books**


1. Introduction to Machine Learning, 3rd edition, Ethem Alpaydin, PHI Learning Private Limited, NewDelhi, 2015
2. Deep Learning by Josh Patterson and Adam Gibson, O'Reilly Media, Inc., Gravenstein HighwayNorth, Sebastopol CA, 2017
3. Neural Networks and Learning Machines Third Edition, Simon Haykin, Pearson, Prentice Hall, 2009


**Reference books**


1. Machine learning in Action, Peter Harrington, dreamtech Press, New Delhi, 2012
2. Machine learning, Tom M, Mitchell, Mc Graw Hill Education(India) Private Limited New Delhi, 2013


**Practical examination will be based on experiments and related topics in the laboratory sessions.**

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDL7011 | Biological Modelling and Simulation Lab (Abbreviated as BMS Lab) | -- | 02 | -- | -- | 01 | -- | 01 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDL7011 | Biological Modelling and Simulation Lab | 25 | | 25 | 50 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDL7011 | Biological Modelling and Simulation Lab | 01 |
| Course Objective | • To understand basic approach of modeling for designing biological model.<br>• To simulate physiological processes for better understanding.<br>• To develop competency in terms of logical thinking, programming and application skills<br>• To train and motivate students for pursuing higher education and research fordeveloping cutting edge technologies. | |
| Course Outcome | Learner will be able to:<br>• Apply concept of physiological modelling to model thermometer system.<br>• Virtually understand biophysical laws for calculation of membrane potential under different equilibrium conditions and develop simulation programs for understanding neuronal functions.<br>• Simulate mathematical model for the eye movement<br>• Electrically simulate model of thermoregulatory system<br>• Understand the usage of, and the assumptions behind biological models | |

**List of Laboratory Experiments (Any Seven)**

1. Simulations thermometer system using MATLAB
2. Simulation of Nernst/Goldman Equation using MATLAB(**(Two practicals)**)
3. Simulation of eye movement using MATLAB
4. Simulation using HHSim **(Two practicals)**
5. Simulation using Neurons in Action **(Two practicals)**
6. Developing a model of a neuron using NEURON
7. Electrical simulation of thermoregulatory model

Any other experiment / assignment / presentation based on syllabus which will help students to understand topic/concept.

**In Semester Assessment(ISA):**

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactoryperformance of laboratory work and minimum passing in the ISA.

**Books Recommended:**

*Text Books:*

1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

*Reference Books:*

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

**Oral examination will be based on entire syllabus.**

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDL7012 | Bioinformatics Lab (Abbreviated as BI Lab) | -- | 02 | -- | -- | 01 | -- | 01 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDL7012 | **Bioinformatics Lab** | 25 | | 25 | 50 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BML7012** | **Bioinformatics Lab** | **01** |
| **Course Objectives** | • The course introduces the students to the field of Bioinformatics.<br>• To make students aware about the methods to characterise and manage the different typesof biological data.<br>• To introduce students to the basics of sequence alignment and analysis. | |
| **Course Outcomes** | **Learner will be able to**<br>• Get introduced to the basic concepts of Bioinformatics and its significance in Biologicaldata analysis.<br>• Apply knowledge of basic principles of mathematics and statistics.<br>• Apply existing software effectively to extract information from large databases and to usethis information in computer modelling<br>• Apply problem-solving skills to multivariate methods in bioinformatics<br>Search and apply bioinformatics tools to analyse and interpret biological data | |

**Syllabus: Same as that of BMDO7012 Bioinformatics**

**List of Tutorials: (any seven Tutorials based on following topics)**

1. Steps in DNA sequencing
2. Different methods of DNA sequencing
3. Discovery of Gene Sequence.
4. Types of Proteomics
5. Mendel's postulates and laws of inheritance
6. Steps of dynamic programming
7. Classification of biological databases
8. Steps in Hypothesis Testing
9. Types of statistical models
10. Important Algorithms in Bioinformatics

Any other tutorial based on syllabus may be included, which would help the learner to understandtopic/concept. A power point presentation on any of the topics in syllabus should be carried out.

**In Semester Assessment(ISA):**

ISA shall consist of minimum 7 tutorials.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratorywork and minimum passing in the ISA.

**Books Recommended:**

*Text books:*

1. Basics of Bioinformatics, Rui Jiang, Xuegong Zhang, Michael Q. Zhang, Springer, E-book.
2. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, 2002, First Edition.

*Reference Books:*

1. Essential Bioinformatics, Jin Xiong, Cambridge University Press, 2006, First Edition.

**Oral examination will be based on entire syllabus.**

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDL7013 | IOT Based Systems Lab | -- | 02 | -- | -- | 01 | -- | 01 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDL7013 | **IOT Based Systems Lab** | 25 | | 25 | 50 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BMDL7013** | **IOT Based Systems Lab** | **01** |
| **Course Objectives** | • Learn the concepts of IOT<br>• Identify different technologies and schemes<br>• Learn different applications in IOT<br>• Learn different protocols used in IOT<br>• Learn how to analyze the data in IOT | |
| • **Course Outcomes** | **Learner will be able to**<br>• Apply the concepts of IOT<br>• Identify and select different technologies and scheme for IOT applications<br>• Apply IOT to different applications<br>• Analyze and evaluate protocols used in IOT systems<br>• Analyze dataflow in IOT systems | |

**Syllabus: Same as that of (Course Code) Bioinformatics**

**List of Experiments: (any seven Experiments based on following list)**

1) To demonstrate I/O operations, interrupts, ADC and other onboard features using any onehardware platform (Arduino/Raspberry Pi/BeagleBone/ESP32).
2) To demonstrate interfacing various sensors and storing data on-board [ and on-board processing ofdata] using any one hardware platform (Arduino/Raspberry Pi/BeagleBone/ESP32).

3) To demonstrate interfacing various sensors and communicating data using Internet using any onehardware platform (Arduino/Raspberry Pi/BeagleBone/ESP32).

4) To demonstrate CoAP protocol (client – server model) with SOC platform as server.
5) To demonstrate CoAP protocol (client – server model) with SOC platform as client.
6) To demonstrate MQTT broker (publish - subscribe model) with SOC platform as broker.
7) To demonstrate MQTT broker (publish - subscribe model) with SOC platform as publisher.
8) To demonstrate the use of cloud storage.
9) To demonstrate the use/role of cloud computing.

Any other Experiment based on syllabus may be included, which would help the learner to understandtopic/concept.

**In Semester Assessment(ISA):**

ISA shall consist of minimum 7 tutorials.

The final certification and acceptance of ISA ensures the satisfactory performance of laboratorywork and minimum passing in the ISA.

**Books Recommended:**

**Books Recommended:**

*Text books:*

1. Internet of Things: A Hands-On Approach, Arshdeep Bahga, Vijay Madisetti, universities press.
2. IOT fundamentals, David, Gonzalo, Patrick, Cisco press.
3. Data and Computer communications, william stallings, Pearson Education.
4. Data communication and networking, Behrouz A. Forouzan, McGraw Hill EducationCommunication Networks, Alberto Leon Garcia, McGraw Hill Education.

*Reference Books:*

1. Computer Networks, S. Tanenbaum, Pearson Education.
2. Computer Networking: A Top-Down Approach, J. F. Kurose and K. W. Ross, Addison Wesley.

**Oral examination will be based on entire syllabus.**

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. Tut. | Theory | Pract. | Total |
| BMP701 | Major Project - I | -- | 6# | -- | 3 | 3 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMP701 | Major Project - I | 25 | | 25 | 50 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BMP701** | **Major Project-I** | **03** |
| **Course objective** | • To apply the knowledge gained during Curriculum to develop anddesign problem statement.<br>• Conduct literature survey.<br>• Design Circuit/ Flow chart of the statement.<br>• Documentation and project report writing. | |
| **Course Outcome** | **Learner will be able to**<br>• Review literature to define problem statement<br>• Apply knowledge of the engineering fundamentals acquired during the curriculum and beyond<br>• Develop and create design using appropriate design methodologies considering the various health, society and environmental needs.<br>• Write problem statement, Design concept in prescribed format.<br>• Learn the behavioral science by working in a group. | |

**Project Guidelines:**

1. Learner is allotted 6 hrs per week for the project work
2. Learners should carry out literature survey /visit industry / analyze current trends and identify theproblem for Project and finalize in consultation with Guide/Supervisor.
3. Group of maximum four students will be completing a comprehensive project work.
4. Learners should use multiple literatures and understand the problem.
5. Learners should attempt solution to the problem by experimental/simulation methods.
6. The solution to be validated with proper justification and compile the report in standard format
7. Learner may use this opportunity to learn different computational techniques as well as some modeldevelopment.

### Faculty Load:

1. In semester VII – 1/2 (half) period of 1/2 hour per week per project group
2. Each faculty is permitted to take (guide) maximum 4 (Four) project groups

### In Semester Assessment(ISA):

ISA should be examined by approved internal faculty appointed by the head of the institute basedon the following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Report in prescribed University format.

### Guidelines for Assessment of Project Stage- I

1. Project I should be assessed through a presentation jointly by Internal and External Examiners approved by the University of Mumbai
2. Project stage I should be assessed based on following points
   - Quality of problem selected
   - Literature Survey
   - Clarity of Problem definition and Feasibility of problem solution
   - Relevance to the specialization / Industrial trends
   - Clarity of objective and scope
   - Quality of Project Design
   - Compilation of Project Report
   - Quality of Written and Oral Presentation

## Semester – VIII

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. /Tut. | Theory | Pract. | Total |
| BMC801 | Hospital Management | 3 | -- | 3 | -- | 3 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMC801 | Hospital Management | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BMC801** | **Hospital Management** | **03** |
| **Course Objectives** | • To understand the basic principles used for designing of various departments in thehospital.<br>• To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve hospitals.<br>• To understand the overall functioning of various departments in the hospital. | |
| **Course Outcomes** | **Learner will be able to…**<br>• Apply the management concepts used specifically in hospital.<br>• Explain the management structure and its functions in hospital.<br>• Demonstrate the knowledge about the principles of designing and commissioning ofclinical services in the hospital.<br>• Demonstrate the knowledge about the roles and responsibilities of Biomedical Engineer in hospital.<br>• Demonstrate the knowledge about the functions of other Engineering and auxiliaryservices in the hospital.<br>• Apply environment and waste management concepts in healthcare industry. | |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Process of management:**<br>Principles of management, leadership, motivation, time management, H.R. management (recruitment, performance appraisal, training and development,), effective communication, accounting - types of Budget. | 07 |
| 2 | **Organization of the hospital and hospital planning:**<br>Management structure, types of hospitals, governing body, hospital committee and hospital functionaries, duties and responsibilities of various positions.<br>Guiding principles in planning hospital facilities and services and planning the hospital building | 04 |
| 3 | **Clinical services: (Location, layout, equipment, personnel, and functions):**<br>OUT patient, IN patient (wards), intensive care, pathology laboratory & blood bank, radiology, physiotherapy, surgical operation theatre, emergency (casualty). | 10 |
| 4 | **Biomedical engineering department: (Location, layout, equipment, personnel, and its main functions)**<br>Roles and responsibilities of a biomedical engineer in hospitals,<br>Equipment management: maintenance types: routine(preventive) and breakdown, maintenance contracts (CMC and AMC)<br>Purchase management: Purchase system (centralized, decentralized, local purchase), types of purchase, purchase procedures: selection of suppliers, tendering procedures, analyzing bids, price negotiations<br>Material's (store) management: Functions of store manager, materials handling, flow of goods/FIFO, inventory control**:** lead-time, buffer stock, reorder level, two bin system, EOQ | 09 |
| 5 | **Other engineering services:**<br>Engineering services (electrical, mechanical and civil): responsibilities and functions.<br>Hospital ventilation and air conditioning, medical gas system, hospital information system. | 05 |
| 6 | **Environment and waste management:**<br>Hospital infection control, central sterile service department (CSSD), biomedical waste management, disaster management. | 04 |

**Books Recommended:**

*Text Books:*

1. Hospital Management by Dr. Pradyna Pai
2. Hospital Planning, Designing and Management: Kunders G D, Gopinath, A katakam (Private PubBangalore)

*Reference Books:*

1. Computers in Medicine: R. D. Lele (TMH Pub)
2. Hospital Care and Hospital Management AICTE Journal Vol. 1,2,3 by Dr. Kalanidhi. (AICTE PubBangalore
3. Careers in Biomedical: Shantanu Thatte.

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDO8011 | Department Optional Course –5 Robotics In Medicine (Abbreviated as RIM) | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO8011 | Department Optional Course –5 Robotics In Medicine (Abbreviated as RIM) | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO8011 | Robotics In Medicine | 03 |
| Course Objectives | • To make the learner aware of fundamental concepts of Robotics<br>• To make learner study direct and Inverse Kinematics of Robots<br>• To make learner know the Trajectory and Motion planning.<br>• To make the learner know the Biomedical applications of robotics | |
| Course Outcomes | **Learner will be able to...**<br>• To describe direct and inverse kinematics of robots.<br>• To describe workspace envelop and trajectory planning for robots<br>• To apply various image processing tools for robotic manipulation<br>• To implement motion planning solutions using various algorithms<br>• To illustrate medical applications of robots | |

| Module No. | Contents | Hours |
|---|---|---|
| 1 | **Introduction:**<br>Automation and robots, classification, application, specification and notations. | 04 |
| 2 | **Direct Kinematics:**<br>Dot and cross products, co-ordinate frames, rotations, homogeneous coordinates, link co-ordinates, arm equation and arm matrix derivation (two axis, three axis and | 10 |

| | | |
|---|---|---|
| | four axis SCARA), configuration of five axis and six axis robots (arm matrix derivation and equation not expected) | |
| **3** | **Inverse kinematics:**<br>General properties of solutions of inverse kinematics, methods for finding solution,tool configuration vector and inverse kinematics solution for two axis, three axis and four axis robots.<br>Workspace analysis, work envelope and examples, workspace fixtures, trajectory planning, pick and place operations, continuous path motion, interpolated motion, straight-line motion. | **08** |
| **4** | **Robot vision:**<br>Image representation, template matching, polyhedral objects, shane analysis, segmentation (thresholding, region labelling, shrink operators, swell operators, Euler numbers, perspective transformation, structured illumination, cameracalibration). | **06** |
| **5** | **Task planning:**<br>Task level programming, uncertainty, configuration, space, gross motion, planning, Grasp planning, fine-motion planning, simulation of planar motion, source and goal scenes, task planner simulation. | **06** |
| **6** | **Applications in biomedical engineering:**<br>Application in rehabilitation: clinical and surgery | **05** |

**Books Recommended:**

*Text Books:*


1. Fundamentals of Robotics-Analysis and control, Robert Shilling, Prentice Hall of India
2. Introduction to Robotics, Saeed B Niku, Pearson Education
3. Robotics, Fu, Gonzales and Lee, McGraw Hill, SecondEdition,2011
4. "Introduction to Robotics–Mechanics &Control" John J. Craig, PearsonEducation, India, Third Edition, 2009


*Reference Books:*


1. Robotics and AI, Staughard, , Prentice Hall Of India.
2. Industrial Robotics Grover, Wiess, Nagel, Oderey, McGraw Hill.
3. Robotics and Mechatronics, Walfram Stdder, Mc Graw Hill, NewYork, 2008
4. Robot Engineering, Klafter, Chmielewski, Negin. Prentice Hall Of India.
5. Robotics and Control. Mittal, Nagrath, Tata McGraw Hill publications

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract | Tut | Total |
| BMDO8012 | Department Optional Course –5 Healthcare Informatics (Abbreviated as HCI) | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO8012 | Department Optional Course –5 Healthcare Informatics (Abbreviated as HCI) | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO8012 | Healthcare Informatics | 03 |
| Course Objectives | • To understand the healthcare interoperability semantic and syntactic.<br>• To understand the standards of healthcare interoperability standards for Medical Imagesand Medical Messages. | |
| Course Outcomes | **Learners will be able to:**<br>• Understand Healthcare interoperability standards<br>• Fabricate HL7 Messages<br>• Understand and Design UML Diagrams<br>• Understand semantic interoperability through DICOM<br>• Edit and Compare DICOM file | |

| Module | Contents | Hours |
|---|---|---|
| 1. | **Healthcare interoperability:** Standards in healthcare system, categorizing standards, standard development, various healthcare informatics standards, need for a Lingua Franca, electronic health records, interoperability modelling basics. | **05** |
| 2. | **HL7 Version 2 (Part-I)** Message syntax, delimiters, segment definition, message header MSH, patient identification details (PID), patient visit (PV1), request and specimen details (OBR),result details (OBX). | **04** |
| 3. | **HL7 Version 2 (Part-II)** Z-Segments, data, simple data types, complex data types, codes and identifiers, names and addresses, other complex data types. | **04** |
| 4. | **DICOM standard:** Introduction, DICOM Grammar: VRs, DICOM data dictionary, DICOM objects, DICOM information hierarchy, modules, IODs and IEs. | **07** |
| 5. | **DICOM Communications:** DICOM SOPs, unit identification on n/w, services and data, DIMSE Example: C- Echo, storage, query: find, C-Find IOD, C-Find DIMSE, C-Cancel, modality Worklist, Basic DICOM retrieval: C-Get, advanced DICOM retrieval: C-Move, DICOM: ping, push and pull. | **09** |
| 6. | **DICOM Associations** Association establishment, transfer syntax, application context, **DICOM Media: Files, Folders, and DICOMDIRs** DICOM File format, DICOM file services, storing DICOM data in PACS. | **10** |

**Books Recommended:**

*Textbooks:*

1. Principles of Health Interoperability HL7 and SNOMED (Health Information TechnologyStandards) by Tim Benson, Springer Publication.
2. Digital Imaging and Communication in Medicine (DICOM) by Oleg S. Pianykh, SpringerPublication.
3. The CDATM Book, By Keith Boone, Springer Publication.

*Reference Books:*

1. Informatics in Medical Imaging, George C. Kagadis, Steve G. Langer, CRC Press.

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDO8013 | Department Optional Course –5 Artificial Intelligence in Medicine (Abbreviated as AIM) | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO8013 | Department Optional Course –5 Artificial Intelligence in Medicine (Abbreviated as AIM) | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO8013 | Artificial Intelligence in Medicine | 03 |
| Course Objectives | • To understand basics of Artificial Intelligence, Intelligent Agents.<br>• To conceptualize search techniques.<br>• To understand exert system in Artificial Intelligence | |
| Course Outcomes | **Learner will be able to…**<br>• Develop a basic understanding of intelligent agents in artificial intelligence<br>• Choose an appropriate problem-solving method and knowledge representation technique<br>• Comprehend the concept of propositional logic<br>• Understand Reasoning and Knowledge Representation<br>• Develop basic understanding of expert system and it's applications<br>• Learn AI applications in health care | |

| Module | Contents | Hours |
|---|---|---|
| 1 | **Basics of Artificial Intelligent:**<br>Definition and concept of Artificial Intelligence, stages of AI, intelligent agents in artificial intelligence, foundations of AI and applications, current trends in AI | 04 |
| 2 | **Problem Spaces, and Search:**<br>Breadth first search, depth first search techniques, iterative deepening, bidirectional search, best first search, Heuristic search, Hill Climbing, A* Search,<br>**Problem reduction and game playing:** Introduction, problem reduction, game playing, alphabeta pruning, two-player perfect information games | 10 |
| 3 | **Logic concepts:**<br>Introduction, propositional calculus, propositional logic, natural deduction system, axiomatic system, semantic tableau system in proportional logic, resolution refutation in proportional logic, predicate logic | 07 |
| 4 | **Knowledge Representation:**<br>Problems in representing knowledge, knowledge representation using propositional and predicate logic, logical consequences, syntax and semantics of an expression, semantic Tableau.<br>Forward and backward reasoning. Proof methods, substitution and unification, conversion to clausal form, normal forms, resolution, refutation, deduction, theorem proving, inferencing, monotonic and non-monotonic reasoning. | 08 |
| 5 | **Expert system and applications:**<br>Introduction phases in building expert systems, expert system versus traditional systems, rule-based expert systems blackboard systems truth maintenance systems,application of expert systems | 06 |
| 6 | **AI in Healthcare:**<br>Benefits of AI in medicine, AI and Medical visualization, Medical Expert system, Applying AI to EHR Data, Artificial Intelligence in Medical Imaging | 04 |

**Books Recommended:**

*Text Books:*


1 Stuart J. Russell and Peter Norvig, "***Artificial Intelligence: A Modern Approach***", Fourth Edition" Pearson Education, 2020.
2 Saroj Kaushik, "***Artificial Intelligence***", Cengage Learning, First edition, 2011
3 Itisha Gupta and Garima Nagpal, "***Artificial Intelligence and Expert System***", Laxmi Publications, 1st Edition 2018


*Reference Books:*


1 Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.

2 Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication

3 Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.

4 Elaine Rich and Kevin Knight, "***Artificial Intelligence***", Third Edition, McGraw Hill Education,2017.


**Useful Links:**

1 https://nptel.ac.in/courses/106/105/106105078/

2 https://archive.nptel.ac.in/courses/106/105/106105077/#

3 https://nptel.ac.in/courses/106/105/106105079/

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDO8021 | Department Optional Course –6 Biomedical Microsystems (Abbreviated as BM) | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO8021 | Department Optional Course –6 Biomedical Microsystems (Abbreviated as BM) | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO8021 | Biomedical Microsystems | 03 |
| Course Objectives | • To understand various fabrication techniques for MEMS devices.<br>• To apply the knowledge of MEMS in Biomedical field.<br>• To understand recent advancements in Biomedical Engineering for a successful careerin the area of nanotechnology. | |
| Course Outcomes | **Learner will be able to...**<br>• Understand basic property and select appropriate material for MEMS application<br>• Develop or modify the MEMS processes for a simple MEMS device in order to reducethe fabrication time.<br>• Understand different microfabrication techniques and choose appropriate technique<br>• Analyse Micro total analysis system with designing of its components<br>• Demonstrate working principles of Bio Nano-sensors and drug delivery devices with types and fabrication<br>• Understand packaging techniques used in MEMS | |

| Module | Contents | Hours |
|---|---|---|
| 1. | **Introduction to miniaturization:**<br>• Difference between Microelectronics and MEMs, Block diagram of MEMS and BIOMEMS, examples. Introduction to generalised processes used.<br>• Clean room: definition, classification, air flow system<br>• Safety in handling hazardous materials in clean room<br>• Scaling Laws in Miniaturization<br>• Substrates and Wafers: CZ process and float zone process, Wafer types<br>• Materials: Properties and applications of single crystal silicon, $SiO_2$, $Si_3N_4$, SiC, Polysilicon, Glass<br>• Wafer cleaning processes: RCA, Piranha<br>• Positive and negative photoresist, mask, material properties of PMMA, SU8<br>• Different projection systems,<br>• Surface characterization techniques: AFM, SEM, TEM, Ellipsometer,Profilometer | 06 |
| 2. | **MEMS Fabrication Processes**<br>• Photolithography: Definition, steps, light sources (UV, DUV, EUV)<br>• PVD: definition, types: Evaporation (Thermal and E-beam) and Sputtering (DC and RF), advantages, disadvantages, Material properties of Al<br>• CVD: definition, reaction steps, types: APCVD, LPCVD, PECVD, and HWCVD, advantages, disadvantages<br>• Oxidation: Thermal<br>• Polymers coating techniques: spinning, spraying and electrodeposition<br>• Doping: definition, types: Ion implantation and Diffusion, advantages,disadvantages<br>• Etching: types: Dry etching (RIE, DRIE) and wet etching (isotropic and anisotropic), advantages, disadvantages, specific etchants | 07 |
| 3. | **Microfabrication Techniques**<br>• Bulk micromachining: definition, advantages and disadvantages**,** Examples: pressure sensor, dissolved wafer process<br>• Surface micromachining: definition, advantages and disadvantages Examples: pressure sensor, cantilever<br>• Non polysilicon surface micromachining: SOI fabrication<br>• LIGA: definition, process steps, examples, advantages and disadvantages<br>• X-ray lithography: Synchrotron radiation, X-ray mask<br>• Molding techniques: Injection, compression, hot embossing<br>• Soft lithography: Definition, SAMs, Types: Micro Contact Printing, Material properties of PDMS, Gold, Conducting polymers<br>• Micro molding techniques: Replica molding, Microtransfer molding,Micromolding in capillaries and Solvent-assisted micromolding | 07 |

| | | |
|---|---|---|
| **4.** | **MICRO TOTAL ANALYSIS SYSTEMS (µTAS)**<br>• Flow techniques in µ-fluidics: pressure driven force, electro-osmosis,electrophoresis<br>• Micropump, microvalves: types and fabrication<br>• Microchannels: Types and fabrication (SU8, glass, silicon) | **07** |
| | • Separation techniques: capillary electropherosis, electrochromatography, isoelectric focusing<br>• Detection techniques: fluorescence, chemiluminiscence | |
| **5.** | MICRO/ NANO BIOSENSORS AND DRUG DELIVERY DEVICES<br>• Biosensor: definition, block diagram<br>• Classification based on the basis of detection techniques: electric, magnetic, optical, thermal, mechanical, and chemical<br>• Basic steps involved in the development of biosensors: surface modification, immobilization, integration with transducer<br>• Design, fabrication of cantilever for antibody detection<br>• Hypodermic needles, transdermal patches: disadvantages<br>• Micro needles: solid, hollow, polymer, silicon (fabrication)<br>• Nano particles for drug delivery | **06** |
| **6** | MICROSYSTEM PACKAGING<br>• Packaging materials<br>• Levels of packaging<br>• Comparison between IC and MEMS packaging<br>• Packaging technologies: Die preparation, surface bonding, wire bonding, sealing<br>• Pressure sensor packaging | **06** |

**Text Books:**


1. MEMS & MICROSYSTEMS Design and Manufacture, Tai-Ran Hsu, TATA McGraw-Hill.
2. Fundamentals of Microfabrication, Marc Madou, CRC Press.


**Reference Books:**


1. Fundamentals of BioMEMS and Medical Microdevices, Steven S. Saliterman, (SPIE PressMonograph Vol. PM153 by Wiley Interscience
2. Microsystem Technology", W. Menz, J. Mohr, 0. Paul, WILEY-VCH, ISBN 3. 527-29634-4
3. Electro Mechanical System Design", James J. Allen, Taylor & Francis Group, LLC, ISBN-0-8247 -5824-2, 2005
4. MICROSYSTEM DESIGN, Stephen D. Senturia, KLUWER ACADEMIC PUBLISHERS, eBook ISBN: 0-306-47601-0

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDO8022 | Medical Devices Regulations (Abbreviated as MDR) | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO8022 | Medical Devices Regulations (Abbreviated as MDR) | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO8022 | Medical Devices Regulations | 03 |
| Course Objectives | • To familiarize the learners with the regulatory aspects of medical devices and instruments.<br>• To keep the learners abreast with the technological developments in the field of Medical devices regulatory affairs. | |
| Course Outcomes | Learner will be able to:<br>• Discuss credibility & authorities of approvals, medical devices life cycle, risk based classification and risk based approach for regulatory controls.<br>• Explain principles of safety and effectiveness, quality management system, Various standards (American, European, BIS), risk management, cyber security and clinical evaluation.<br>• Describe technical documentation required by regulators, essential requirements checklist, risk management summary report, manufacturing information, regulated product submissions and regulatory submission repository.<br>• Highlight premarket phase like design controls, information management during premarket phase, R&D planning stage, design & development process stage and product identification & traceability.<br>• Perform regulatory submissions, approvals and registration.<br>• Launch the product, do post market surveillance, look after product obsolescence, oversee quality management system and regulatory system & processes. | |

| Module | Contents | Hours |
|---|---|---|
| **1.** | **Overview of regulatory framework for medical devices:** Credibility and authority of approvals, medical devices life cycle, risk-based classification,risk-based approach for regulatory controls. Introduction to International Regulatory Requirements & Device Pathways. | **07** |
| **2.** | **Safety & Effectiveness:** Principles of safety and effectiveness, Quality management system, Standards, Risk management, Cybersecurity, Clinical evaluation. Classification of Biomedical Instruments, based on safety standards, Approach to Bioethics | **07** |
| **3.** | **Technical Documentation:** Technical documentation required by regulators, Essential requirements checklist, Risk management summary report, Manufacturing information, Regulated product submissions, Regulatory submission repository | **07** |
| **4.** | **Premarket phase:** Design controls, Information management during premarket phase, R&D planning stage, Design & development process stage,product identification & traceability, Case study | **06** |
| **5.** | **Regulatory submissions, approvals and registration**: Administrative provisions, regulatory submission and approval, International scenario | **06** |
| **6.** | **Post market phase:** Product launch, continued regulatory compliance, Post market surveillance, Product obsolescence, Quality management system, Regulatory system, and processes. Types of medical device audits. Medical device Compliance Audit | **06** |

## Books Recommended:

**Textbooks:**


1. Medical device regulatory practices, Val Theisz, PAN Satnford Publishing
2. Handbook of Medical Device regulatory affairs in Asia, edited by Jack Wong and Raymond KYTong
3. Medical Device Regulations: Global Overview and Guiding Principles, Michael Cheng, WorldHealth Organization.


## Reference Books:


1. Daniel A. Vallero - Biomedical Ethics for Engineers_ Ethics and Decision Making in Biomedicaland Biosystem Engineering (Biomedical Engineering Series)-Academic Press
2. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (MarcelDekkar Pub).
3. Ethics for Biomedical Engineers, Jong Yong Abdiel Foo, Stephen J. Wilson, Andrew P. Bradley,Winston Gwee, Dennis Kwok-Wing Tam (auth.) , Springer-Verlag New York

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDO8023 | Department Optional Course –6 Ergonomics (Abbreviated as ERG) | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDO8023 | Department Optional Course –6 Ergonomics (Abbreviated as ERG) | 20 | 30 | 50 | 100 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDO8023 | Ergonomics | 03 |
| Course Objectives | • To understand various fabrication techniques for MEMS devices.<br>• To apply the knowledge of MEMS in Biomedical field.<br>• To understand recent advancements in Biomedical Engineering for a successful careerin the area of nanotechnology. | |
| Course Outcomes | **Learner will be able to…**<br>• Understand basic property and select appropriate material for MEMS application<br>• Develop or modify the MEMS processes for a simple MEMS device in order to reducethe fabrication time.<br>• Understand different microfabrication techniques and choose appropriate technique<br>• Analyse Micro total analysis system with designing of its components<br>• Demonstrate working principles of Bio Nano-sensors and drug delivery devices with types and fabrication<br>• Understand packaging techniques used in MEMS | |

| Module | Contents | Hours |
|---|---|---|
| 1. | **Introduction to Ergonomics**<br>• Definition of Ergonomics and its application and overview.<br>• Ergonomics in systems design, and steps to performing a task analysis. In class practice performing a task analysis. | 08 |
| 2. | **Design Man Machine Environment System Design**<br>• Overview of Human body and its sub systems.<br>• Understanding musculoskeletal system and its function in terms of manualactivities<br>• Understanding nervous system, human sensory organs and their limitations.<br>• Basic Bio mechanics and its application in design | 09 |
| 3. | **Muscle Use and Anthropometry and Workspace**<br>• Anthropometry and its application<br>• Issues of cognition, perception and performance.<br>• Study of work posture and its impact on human performance.<br>• Physical environment and their impact on human performance<br>• Muscular work including dynamic and static work, nervous control of movement,skilled work and ways to improve work efficiency.<br>• Use of anthropometric data in ergonomics.<br>• Principles of workspace design, including seated work, standing work, work reaches and working heights, the office environment and visual work | 10 |
| 4. | **Occupational stress and Musculoskeletal disorders; Safety and health issues**<br>**Cognitive aspects of user-system interaction:**<br>• Perception, information processing, user behaviour, error and risk perception; | 04 |
| 5. | **Principles of human factors in visual communication**<br>• Visual display in different planes- static shape, size, font type and dynamic characters of display | 04 |
| 6 | **Environmental factors influencing human performance**<br>• Participatory ergonomics aspects | 04 |

**Books Recommended:**

**Text Books:**


1. Bridger, R., Introduction to Ergonomics, 3rd Ed., CRC Press, Taylor & Francis Group, 2009.
2. Sanders, M., McCormick, E., Human Factors in Engineering and Design, 7th Ed., McGraw-HillInternational Editions: Psychology Series, 2013
3. Wicknes, C., Gordon, S., Liu, Y., and Gordon-Becker, S., An Introduction to Human FactorsEngineering, Longman, New York, 2015
4. Chakrabarti, D., Indian Anthropometric Dimensions for ergonomic design practice, NationalInstitute of Design, Ahmedabad, 1997
5. Salvendy, G. (ed.), Handbook of Human Factors and ergonomics, 4th Ed., John Wiley & Sons, Inc.,2012

6. Dul, J., Weerdmeester, B., Ergonomics for beginners, a quick reference guide, 3rd Ed., CRC Press,Taylor & Francis Group, 2008.

**Reference Books:**

1. J. Dul, and B. Weerdmeester, Ergonomics for beginners, a quick reference guide, Taylor & Francis,1993.
2. E.Grandjean : Fitting the task to the man, Taylor & Francis Ltd.1980.
3. J. Ansel, Visual ergonomics in the workplace, Taylor & Francis, London, 1998
4. W. Karwowski and W. S. Marras, The Occupational Ergonomics handbook, CRC Press, New York,1999.
5. M. S. Sanders and E. J. McCormick, Human Factors in Engineering and Design, McGraw-Hill, Inc.,1993.
6. K. Kroemer, H. B. Kroemer and K. E. Kroemer, Ergonomics- How to Design for Easy andEfficiency, Prentice Hall Englewood Cliffs, NJ 07632, 1994.

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **ILO 8021** | **Project Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Tota l |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| ILO 8021 | Project Management | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.<br>• To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure. |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Apply selection criteria and select an appropriate project from different options.<br>• Write work break down structure for a project and develop a schedule based on it.<br>• Identify opportunities and threats to the project and decide an approach to deal with them strategically.<br>• Use Earned value technique and determine & predict status of the project.<br>• Capture lessons learned during project phases and document them for future reference |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | **Project Management Foundation:**<br>Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stagegate process. Role of project manager, Negotiations and resolving conflicts, Project management in various organization structures, PM knowledge areas as per Project Management Institute (PMI) | 05 |
| 2 | **Initiating Projects:**<br>How to get a project started, selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming &performing), team dynamics. | 06 |

| | | |
|---|---|---|
| 3 | **Project Planning and Scheduling:**<br>Work Breakdown structure (WBS) and linear responsibility chart, Interface; Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart, Introduction to Project Management Information System (PMIS). | 08 |
| 4 | Planning Projects:<br>Crashing project time, Resource loading and levelling, Goldratt's critical chain, Project Stakeholders and Communication plan<br>Risk Management in projects: Risk management planning, Risk identification and risk register, Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks | 06 |
| 5 | **5.1** Executing Projects:<br>Planning monitoring and controlling cycle, Information needs and reporting, engaging with all stakeholders of the projects, Team management, communication and project meetings<br>**5.2** Monitoring and Controlling Projects:<br>Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep, Project audit<br>**5.3** Project Contracting<br>Project procurement management, contracting and outsourcing, | 08 |
| 6 | 6.1 Project Leadership and Ethics:<br>Introduction to project leadership, ethics in projects, Multicultural and virtual projects<br>6.2 Closing the Project:<br>Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study. | 06 |

**REFERENCES:**


1. Project Management: A managerial approach, Jack Meredith & Samuel Mantel, 7th Edition,Wiley India
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, ProjectManagement Institute PA, USA
3. Project Management, Gido Clements, Cengage Learning
4. Project Management, Gopalan, Wiley India
5. Project Management, Dennis Lock, 9th Edition, Gower Publishing England

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **ILO 8022** | **Finance Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| ILO 8022 | Finance Management | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.<br>• To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure. |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Understand Indian finance system and corporate finance<br>• Take investment, finance as well as dividend decisions |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | **Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System.<br>**Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.<br>**Financial Markets:** Meaning, Characteristics and Classification of FinancialMarkets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges | 06 |
| 2 | **Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.<br>**Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting. | 06 |

| | | |
|---|---|---|
| 3 | **Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis. | 09 |
| 4 | **Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate ofReturn, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities. | 10 |
| 5 | **Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure | 05 |
| 06 | **Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affectingan Entity's Dividend Decision; Overview of Dividend Policy Theories andApproaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach | 03 |

**REFERENCES:**


1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham andJoel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers:McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw HillEducation, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) &Company Limited, New Delhi.

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **ILO8023** | **Entrepreneurship Development and Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| ILO8023 | Entrepreneurship Development and Management | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To acquaint with entrepreneurship and management of business<br>• Understand Indian environment for entrepreneurship<br>• Idea of EDP, MSME |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Understand the concept of business plan and ownerships<br>• Interpret key regulations and legal aspects of entrepreneurship in India<br>• Understand government policies for entrepreneurs |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | **Overview of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership<br>Role of Money and Capital Markets in Entrepreneurial Development:Contribution of<br>Government Agencies in Sourcing information for Entrepreneurship | 04 |
| 2 | **Business Plans and Importance of Capital to Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing aswell as<br>Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks,Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship and Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the<br>Entrepreneur Law and its Relevance to Business Operations | 09 |
| 3 | Women's Entrepreneurship Development, Social entrepreneurship-role and need,<br>EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises | 05 |

| | | |
|---|---|---|
| 4 | **Indian Environment for Entrepreneurship:** key regulations and legal aspects, MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc.,<br>Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc. | 08 |
| 5 | **Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing | 08 |
| 6 | **Achieving Success In The Small Business:** Stages of the small business life cycle,four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business | 05 |

**REFERENCES:**


1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise,Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latestedition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New centuryPublications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann PublicationLtd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **ILO8024** | **Human Resource Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| ILO8024 | Human Resource Management | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To introduce the students with basic concepts, techniques and practices of the human resource management<br>• To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations<br>• To familiarize the students about the latest developments, trends & different aspects of HRM<br>• To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Understand the concepts, aspects, techniques and practices of the human resource management.<br>• Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.<br>• Gain knowledge about the latest developments and trends in HRM.<br>• Apply the knowledge of behavioural skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers. |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | **Introduction to HR**<br>• Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions<br>• Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues | 05 |
| 2 | **Organizational Behaviour (OB)**<br>• Introduction to OB Origin, Nature and Scope of Organizational Behaviour,Relevance to Organizational Effectiveness and Contemporary issues | 07 |

| | | |
|---|---|---|
| | • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness<br>• Perception: Attitude and Value, Effect of perception on Individual Decision- making, Attitude and Behaviour<br>• Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor);<br>• Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development, Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team.<br>Case study | |
| 3 | **Organizational Structure &Design**<br>• Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.<br>• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.<br>• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. | 06 |
| 4 | **Human resource Planning**<br>• Recruitment and Selection process, Job-enrichment, Empowerment – Job Satisfaction, employee morale<br>• Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning<br>Training & Development: Identification of Training Needs, Training Methods | 05 |
| 5 | **Emerging Trends in HR**<br>• Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR. Organizational Change, Culture, Environment<br>• Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation | 06 |
| 6 | **HR & MIS:** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries<br>**Strategic HRM:** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals<br>**Labor Laws & Industrial Relations:** Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act | 10 |

**REFERENCES:**


1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015,Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial

relations, 5th Ed,2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, 2016, Pearson Publications

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **ILO8025** | **Professional Ethics and Corporate Social Responsibility (CSR)** | Theory | Pract./Tut. | Theory | Pract./Tut. | Tota l |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| ILO8025 | Professional Ethics and Corporate Social Responsibility (CSR) | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand professional ethics in business<br>• To recognized corporate social responsibility |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Understand rights and duties of business<br>• Distinguish different aspects of corporate social responsibility<br>• Demonstrate professional ethics<br>• Understand legal aspects of corporate social responsibility |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | **Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issuesin Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costsand Benefits; Rights and Duties of Business | 04 |
| 2 | **Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy<br>**Professional Ethics and the Environment:** Dimensions of Pollution and Resource<br>Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources | 08 |
| 3 | **Professional Ethics of Consumer Protection:** Markets and Consumer Protection;<br>Contract View of Business Firm's Duties to Consumers; Due Care Theory;Advertising Ethics; Consumer Privacy<br>**Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extentof Discrimination; Reservation of Jobs. | 06 |

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|---|---|---|
| 4 | **Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India | 05 |
| 5 | **Corporate Social Responsibility:** Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) inIndia, Corporate Social Responsibility and Public-Private Partnership (PPP) in India | 08 |
| 6 | **Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013. | 08 |

**REFERENCES:**


1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta;Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by AndrewCrane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Pearson,New Delhi.
4. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **ILO8026** | **Research Methodology** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| ILO8026 | Research Methodology | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand Research and Research Process<br>• To acquaint students with identifying problems for research and develop research strategies<br>• To familiarize students with the techniques of data collection, analysis of data and interpretation |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Prepare a preliminary research design for projects in their subject matter areas<br>• Accurately collect, analyze and report data<br>• Present complex data or situations clearly<br>• Review and analyze research findings |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 01 | **Introduction and Basic Research Concepts**<br>**1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology<br>**1.2** Need of Research in Business and Social Sciences<br>**1.3** Objectives of Research<br>**1.4 Issues** and Problems in Research<br>**1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical | 09 |
| 02 | **Types of Research**<br>**2.1.** Basic Research<br>**2.2.** Applied Research<br>**2.3.** Descriptive Research<br>**2.4.** Analytical Research<br>**2.5.** Empirical Research<br>**2.6** Qualitative and Quantitative Approaches | 07 |

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|---|---|---|
| 03 | **Research Design and Sample Design**<br>**3.1** Research Design – Meaning, Types and Significance<br>**3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in<br>Sample Design Sampling methods/techniques Sampling Errors | 07 |

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|---|---|---|
| 04 | **Research Methodology**<br>**4.1** Meaning of Research Methodology<br>**4.2**. Stages in Scientific Research<br>Process:<br>**a.** Identification and Selection of Research Problem<br>**b.** Formulation of Research Problem<br>**c.** Review of Literature<br>**d.** Formulation of Hypothesis<br>**e.** Formulation of research Design<br>**f.** Sample Design<br>**g.** Data Collection<br>**h.** Data Analysis<br>**i.** Hypothesis testing and Interpretation of Data<br>**j.** Preparation of Research Report | 08 |
| 05 | **Formulating Research Problem**<br>**5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysisof data, Generalization and Interpretation of analysis | 04 |
| 06 | **Outcome of Research**<br>**6.1** Preparation of the report on conclusion reached<br>**6.2** Validity Testing & Ethical Issues<br>**6.3** Suggestions and Recommendation | 04 |

**REFERENCES:**


1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS PublishersDistributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, WileyEastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded),Singapore, Pearson Education

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **ILO8027** | **IPR and Patenting** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| ILO8027 | IPR and Patenting | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To understand intellectual property rights protection system<br>• To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures<br>• To get acquaintance with Patent search and patent filing procedure and applications |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• understand Intellectual Property assets<br>• assist individuals and organizations in capacity building<br>• work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 01 | **Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs,Plant variety protection, Geographical indications, Transfer of technology etc.<br>**Importance of IPR in Modern Global Economic Environment:** Theories ofIPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development | 05 |
| 02 | **Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem,<br>Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR enforcement<br>**Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IPlaws in India, Indian IPR, Administrative Machinery, Major international treaties<br>signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc. | 07 |
| 03 | **Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc. | 05 |

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|---|---|---|
| 04 | **Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc.), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent | 07 |
| 05 | **Patent Rules:** Indian patent act, European scenario, US scenario, Australiascenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.) | 08 |
| 06 | **Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processingof patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement<br>**Patent databases:** Important websites, Searching international databases | 07 |

**REFERENCE BOOKS:**


1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights inIndia, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National WorkingGroup on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development:Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition,WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, ExcelBooks
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, SerialPublications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BSPublications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on IntellectualProperty Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers,World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting, Interpretation of PatentSpecifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEEPress

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **ILO 8028** | **Digital Business Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| ILO 8028 | Digital BusinessManagement | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • To familiarize with digital business concept<br>• To acquaint with E-commerce<br>• To give insights into E-business and its strategies |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Identify drivers of digital business<br>• Illustrate various approaches and techniques for E-business and management<br>• Prepare E-business plan |

| **Module** | **Detailed content** | **Hours** |
|---|---|---|
| 1 | **Introduction to Digital Business-**<br>Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts, Difference between physical economy and digital economy.<br>**Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services), Opportunities and Challenges in Digital Business | 09 |
| 2 | **Overview of E-Commerce**<br>**E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement<br>B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals<br>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing<br>EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and<br>Societal impacts of EC | 06 |

| | | |
|---|---|---|
| 3 | **Digital Business Support services**: ERP as e –business backbone, knowledgeTope Apps, Information and referral system<br>**Application Development:** Building Digital business Applications and infrastructure | 06 |
| 4 | **Managing E-Business**-Managing Knowledge, Management skills for e-business, managing Risks in e –business, Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications | 06 |
| 5 | **E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation) | 04 |
| 6 | **Materializing e-business: From Idea to Realization**-Business plan preparation<br>**Case Studies and presentations** | 08 |

**References:**


1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers &Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consultingjournal Vol.5
10. Measuring Digital Economy-A new perspective- DoI:10.1787/9789264221796-enOECDPublishing

| Course Code | Course Name | Teaching scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| **ILO8029** | **Environmental Management** | Theory | Pract./Tut. | Theory | Pract./Tut. | Total |
| | | **3** | **--** | **3** | **--** | **3** |

| **Course Code** | **Course Name** | **Examination Scheme** | | | |
|---|---|---|---|---|---|
| | | **ISA** | **MSE** | **ESE** | **Total** |
| ILO8029 | EnvironmentalManagement | 20 | 30 | 50 | 100 |

| | |
|---|---|
| **Course Objectives** | • Understand and identify environmental issues relevant to India and global concerns<br>• Learn concepts of ecology<br>• Familiarise environment related legislations |
| **Course Outcomes** | **Upon successful completion of this course, the learner will be able to:**<br>• Understand the concept of environmental management<br>• Understand ecosystem and interdependence, food chainetc.<br>• Understand and interpret environment related legislations |

| **Module** | **Detailed Contents** | **Hours** |
|---|---|---|
| 1 | Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities, Environmental issues relevant to India, Sustainable Development, the Energy scenario | 10 |
| 2 | Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity,<br>Industrial/Man-made disasters, Atomic/Biomedical hazards, etc. | 06 |
| 3 | Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc. | 05 |
| 4 | Scope of Environment Management, Role and functions of Government as a planning and regulating agency<br>Environment Quality Management and Corporate Environmental Responsibility | 10 |
| 5 | Total Quality Environmental Management, ISO-14000, EMS certification. | 05 |
| 6 | General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, FactoriesAct, etc. | 03 |

**REFERENCES:**


1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London,1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell,Edward Elgar Publishing
3. Environmental Management,**T V Ramachandra and Vijay Kulkarni, TERI Press**
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use,Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, MaclillanIndia, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC PressEnvironment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. /Tut. | Theory | Pract. | Total |
| BML801 | Hospital Management Lab | -- | 2 | -- | 1 | 1 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BML801 | Hospital Management Lab | 25 | | 25 | 50 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BML801** | **Hospital Management** | **01** |
| **Course Objectives** | • To understand the basic principles used for designing of various departments in the hospital.<br>• To understand the role of Biomedical Engineer in hospital and basic develop skills enabling to serve hospitals.<br>• To understand the overall functioning of various departments in the hospital. | |
| **Course Outcomes** | **Learner will be able to...**<br>• Apply the management concepts used specifically in hospital.<br>• Explain the management structure and its functions in hospital.<br>• Demonstrate the knowledge about the principles of designing and commissioning of clinical services in the hospital.<br>• Demonstrate the knowledge about the roles and responsibilities of Biomedical Engineer in hospital.<br>• Demonstrate the knowledge about the functions of other Engineering and auxiliary services in the hospital.<br>• Apply environment and waste management concepts in healthcare industry. | |

**Syllabus: Same as that of BMC801 Hospital Management (HM).**

## List of Experiments and Assignments: (Any Four Experiments and Any Four Assignments)

1. Design of Registration form of hospital.
2. Prepare an organization chart for multi-speciality hospital
3. Prepare budget using EXCEL sheet for purchase of hospital equipment.
4. Preparation of Comparative Statement in Excel for purchase of medical equipment. **(Any Two)**
5. Design the layout of Outpatient Department in hospital.
6. Design the layout of ICU in hospital.
7. Design the layout of Surgical Operation Theatre Complex in hospital.
8. Design the layout of Radiology Department in hospital.
9. Design the layout of Pathology Laboratory and Blood Bank Department in hospital.
10. Design the layout of Physiotherapy Department in hospital.
11. Design the layout of Central Sterile Supply Department in hospital.

Any other experiment based on syllabus which will help learner to understand topic/concept.Group

Presentation based on the assigned topic by visiting a hospital.

## Books Recommended:

*Text Books:*

1. Hospital Management by Dr. Pradyna Pai,
2. Hospital Planning, Designing and Management: Kunders G D, Gopinath, A Katakam (Private PubBangalore)

*Reference Books:*

1. Computers in Medicine: R. D. Lele (TMH Pub)
2. Hospital Care and Hospital Management AICTE Journal Vol. 1,2,3 by Dr. Kalanidhi. (AICTE PubBangalore
3. Careers in Biomedical: Shantanu Thatte.

## In Semester Assessment (ISA):

ISA shall consist of minimum 4 experiments, 4 assignments and presentation.The

The final certification and acceptance of ISA ensures the satisfactory performance oflaboratory work and minimum passing in the term work.

**Oral examination will be based on suggested practical list and entire syllabus.**

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDL8011 | Robotics In Medicine Laboratory (Abbreviated as RIM Lab) | -- | 02 | -- | -- | 01 | -- | 01 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDL8011 | Robotics In Medicine Laboratory (Abbreviated as RIM Lab) | 25 | | 25 | 50 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDL8011 | Robotics In Medicine Laboratory | 01 |
| Course Objectives | • To make the learner aware of fundamental concepts of Robotics<br>• To make learner study direct and Inverse Kinematics of Robots<br>• To make learner know the Trajectory and Motion planning.<br>• To make the learner know the Biomedical applications of robotics | |
| Course Outcomes | • To describe direct and inverse kinematics of robots.<br>• To describe workspace envelop and trajectory planning for robots<br>• To apply various image processing tools for robotic manipulation<br>• To implement motion planning solutions using various algorithms<br>• To illustrate medical applications of robots | |

**Syllabus: Same as that of BMDO8011 Hospital Management (HM).**

**List of Experiments: (Any Seven)**

**Students can perform any other experiment/Mini project/ Seminar/ Scholarly paper reviewbased on the theory syllabus. The coding can be done in MATLAB/SCILAB/Python/C**

1. Fundamental and Composite Rotations of Mobile frame with respect to fixed frame
2. Homogeneous Transformations and Screw Transformations
3. Kinematic configurations and Link Coordinate Transformations matrix(Arm Matrix)
4. Direct Kinematics of 2-3 axis Planar Robot and find the location of Tool tip.
5. Direct Kinematic Analysis of 4,5 Axis Robot
6. Inverse Kinematics of robots and prove that there are multiple ways to reach a particular point.
7. Develop Work Envelop for 2,3 axis Robot

8. To study segmentation using edge detection technique
9. Straight line trajectory planning-BDA Algorithm
10. Template Matching
11. Gross motion planning is a part of task planning of robot. Suggest any method of gross motion planning so that the task can be completed without hitting obstacles
12. Presentation/ Seminar/Case study on Biomedical Application of robotics

**In Semester Assessment(ISA):**

ISA shall consist of minimum 4 experiments, 4 assignments and presentation.The

The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

**Oral examination will be based on suggested practical list and entire syllabus.**

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDL8012 | Department Optional Course – 5 Lab Healthcare Informatics Laboratory (Abbreviated as HCI Lab) | -- | 02 | -- | -- | 01 | -- | 01 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDL8012 | Department Optional Course – 5 Lab Healthcare Informatics Laboratory (Abbreviated as HCI Lab) | 25 | | 25 | 50 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDL8012 | Healthcare Informatics Laboratory | 01 |
| Course Objectives | • To understand the healthcare interoperability semantic and syntactic.<br>• To understand the standards of healthcare interoperability standards for MedicalImages and Medical Messages. | |
| Course Outcomes | **Learners will be able to:**<br>• Fabricate HL7 Messages<br>• Edit and Compare DICOM file. | |

**Syllabus: Same as that of BMDO8012 Healthcare Informatics (HCI).**

**List of Experiments: (Any Seven)**

1. To find term/ Concept and ID or Vocabulary codes.
2. Identifying and Chapters of Health Level 7 for trigger Event and message types and message.
3. Structure should be sent to cover each requirement.
4. Reading and editing segment.
5. Create Health Level 7 Message.
6. Create Patient Information Database from Health Level 7 Messages.
7. To Study DICOM Validation Tool (DVTK).
8. Edit DICOM File using hex-Editor.
9. Creating Database of a patient.
10. Comparing DICOM file.

Any other experiment based on syllabus which will help learner to understand topic/concept.

**In Semester Assessment(ISA):**

ISA shall consist of minimum 7 experiments.
The final certification and acceptance of ISA ensures the satisfactory performance of laboratory work and minimum passing in the ISA.

**Books Recommended:**

*Textbooks:*

1. Principles of Health Interoperability HL7 and SNOMED (Health Information TechnologyStandards) by Tim Benson, Springer Publication.
2. Digital Imaging and Communication in Medicine (DICOM) by Oleg S. Pianykh, SpringerPublication.
3. The CDATM Book, By Keith Boone, Springer Publication.

*Reference Books:*

1. Informatics in Medical Imaging, George C. Kagadis, Steve G. Langer, CRC Press.

| Course Code | Course Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| BMDL8013 | Department Optional Course – 5 Lab Artificial Intelligence in Medicine (Abbreviated as AIM) | -- | 02 | -- | -- | 1 | -- | 1 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMDL8013 | Department Optional Course – 5 Lab Artificial Intelligence in Medicine (Abbreviated as AIM) | 25 | | 25 | 50 |

| Course Code | Course Name | Credits |
|---|---|---|
| BMDL8013 | Artificial Intelligence in Medicine | 01 |
| Course Objectives | • To understand the basic techniques to build intelligent systems<br>• To apply appropriate search techniques used in problem solving | |
| Course Outcomes | **Learner will be able to...**<br>• Identify languages and technologies for Artificial Intelligence<br>• Understand and implement searching techniques<br>• Create a knowledge base<br>• Design and implement expert systems | |

## Suggested List of Experiments

| Sr. No. | Title of Experiment |
|---|---|
| 1. | Introduce AI programming language |
| 2. | Knowledge representation and create knowledge base |
| 3. | One case study on AI applications published in IEEE/ACM/Springer or any prominent journal. |
| 4. | Assignments on State space formulation and PEAS representation for various AI applications |
| 5. | Uninformed search methods. |
| 6. | Informed search methods. |
| 7. | Game playing algorithms. |
| 8. | First order Logic |

Note: Any other practical/assignments covering the syllabus topics and subtopics can be conducted.

**In Semester Assessment(ISA):**

ISA shall consist of minimum 7 experiments.

The final certification and acceptance of ISA ensures the satisfactory performance oflaboratory work and minimum passing in the ISA.

## Books Recommended:

*Text Books:*


1. Stuart J. Russell and Peter Norvig, "***Artificial Intelligence: A Modern Approach***", Fourth Edition" Pearson Education, 2020.
2. Saroj Kaushik, "***Artificial Intelligence***", Cengage Learning, First edition, 2011
3. Itisha Gupta and Garima Nagpal, "***Artificial Intelligence and Expert System***", Laxmi Publications, 1st Edition 2018


*Reference Books:*


1. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
2. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
3. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
4. Elaine Rich and Kevin Knight, "***Artificial Intelligence***", Third Edition, McGraw Hill Education,2017.


**Oral examination will be based on suggested practical list and entire syllabus**

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | Credits Assigned | | |
|---|---|---|---|---|---|---|
| | | Theory | Pract. /Tut. | Theory | Pract. | Total |
| BMP801 | Major Project - II | -- | 12# | -- | 6 | 6 |

| Course Code | Course Name | Examination Scheme | | | |
|---|---|---|---|---|---|
| | | ISA | MSE | ESE | Total |
| BMP801 | Major Project - II | 100 | | 50 | 150 |

| Course Code | Course Name | Credits |
|---|---|---|
| **BMP801** | **Major Project-II** | **06** |
| **Course objective** | • Implement the concept of Project Stage-I<br>• Use advanced tools for Implementation<br>• Rectify/ Debug the design and Submit project report. | |
| **Course Outcome** | **Learner will be able to**<br>• Debug/ Rectify the design incurred during implementation<br>• Write Analysis, Results, Design in prescribed format<br>• Learn the behavioural science by working in a group | |

Pr**oject Guidelines:**

1. The students have already under gone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I and should attempt solution to the problem.
2. Learner is allotted 12 hrs per week for the project work
3. Report should be prepared as per the guidelines issued by the University of Mumbai
4. Learners should be motivated to publish a paper based on the work in Conferences/students competitions
5. Project Groups: Learners can form groups not more than 4 (Four)

**Faculty Load:**

1. In semester VIII - 1 (One) periods of 1 hour each per week per project group
2. Each faculty is permitted to take (guide) maximum 4 (Four) project groups.

### In Semester Assessment(ISA):

The ISA should be examined by approved internal faculty appointed by the head of the institutebased on following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Report in prescribed University format.

### Guidelines for Assessment of Project Stage- II

1. Project II should be assessed through a presentation jointly by Internal and External Examiners approved by the University of Mumbai
2. Project stage II should be assessed based on following points
    - Quality of problem selected
    - Clarity of Problem definition and Feasibility of problem solution
    - Relevance to the specialization / Industrial trends
    - Clarity of objective and scope
    - Quality of work attempted
    - Validation of results
    - Compilation of Project Report
    - Quality of Written and Oral Presentation