1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To enhance the skills of graduates to design a variety of electronic or computer based devices and develop software for applications including biomedical instrumentation, medical imaging, physiological measurement and biomedical signal processing.

II. To enable the graduates to acquire technical knowledge and skills required for Biomedical Engineering that meets industrial and hospital requirements.

III. To enable graduates to effectively involve themselves in product development for solving Biomedical Engineering cutting-edge technology problems.

IV. To facilitate the graduates to exhibit leadership skills, make decisions with societal and ethical responsibilities, function and communicate effectively in multidisciplinary settings.

V. To enable the graduates to recognize the need for lifelong learning, enhance their technical competencies throughout their career and become successful Entrepreneurs.

2. PROGRAMME OUTCOME

1. Research aptitude: An ability to independently carry out research/investigation and development work to solve practical problems

2. Technical documentation: An ability to write and present a substantial technical report/document

3. Technical competence: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

4. Engineering Design: Apply knowledge of mathematics, science, and engineering to design, experiment, analyze and interpretation of health care devices

5. Environment and Society: Demonstrate leadership in their respective careers in biomedical engineering or interrelated areas of industry, government, academia, and clinical practice and understanding of professional and ethical responsibility

6. Life-long Learning: Continuously update knowledge to bridge the gap between healthcare / Medicine and Technology.
### SEMESTER I

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### PROFESSIONAL ELECTIVES

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### Employability Enhancement Courses (EEC)

<table>
<thead>
<tr>
<th>S. No</th>
<th>Course Code</th>
<th>Course Title</th>
<th>PERIODS PER WEEK</th>
<th>Credits</th>
<th>Semester</th>
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<tbody>
<tr>
<td>1.</td>
<td>BM4212</td>
<td>Term Paper Writing and Seminar</td>
<td>Lecture 0</td>
<td>0</td>
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<td>2.</td>
<td>BM4311</td>
<td>Hospital / Biomedical</td>
<td>Lecture 0</td>
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<td>3.</td>
<td>BM4312</td>
<td>Project Work I</td>
<td>Lecture 0</td>
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<td>4.</td>
<td>BM4411</td>
<td>Project Work II</td>
<td>Lecture 0</td>
<td>0</td>
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### Summary

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>NAME OF THE PROGRAMME: M.E. BIOMEDICAL ENGINEERING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SUBJECT AREA</td>
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<tr>
<td>1.</td>
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<td>OEC</td>
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<td>6.</td>
<td>EEC</td>
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<td>7.</td>
<td>Non Credit/Audit Course</td>
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<td></td>
<td>TOTAL CREDIT</td>
</tr>
</tbody>
</table>
COURSE OBJECTIVES:

- To encourage students to develop a working knowledge of the central ideas of Linear Algebra.
- To enable students to understand the concepts of Probability and Random Variables.
- To make students understand the notion of a Markov chain, and how simple ideas of conditional probability and matrices can be used to give a thorough and effective account of discrete-time Markov chains.
- To familiarize the students with the formulation and construction of a mathematical model for a linear programming problem in real life situation.
- To introduce the Fourier Transform as an extension of Fourier techniques on parodic functions and to solve partial differential equations.

UNIT – I  LINEAR ALGEBRA  12

UNIT – II  ONE DIMENSIONAL RANDOM VARIABLES  12

UNIT – III  RANDOM PROCESSES  12
Classification – Auto correlation – Cross correlation - Stationary random process – Markov process – Markov chain – Poisson process – Gaussian process.

UNIT – IV  LINEAR PROGRAMMING  12

UNIT – V  FOURIER TRANSFORM FOR PARTIAL DIFFERENTIAL EQUATIONS  12

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to

- apply the concepts of linear algebra to solve practical problems.
- use the ideas of probability and random variables in solving engineering problems.
- classify various random processes and solve problems involving stochastic processes.
- formulate and construct mathematical models for linear programming problems and solve the transportation and assignment problems.
- apply the Fourier transform methods of solving standard partial differential equations.
REFERENCES:

RM4151 RESEARCH METHODOLOGY AND IPR L T P C
2 0 0 2

UNIT I RESEARCH DESIGN
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.
Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING
Overview of Multivariate analysis, Hypotheses testing and Measures of Association.
Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS

UNIT V PATENTS

TOTAL: 30 PERIODS

REFERENCES:

BM4151 BIO SIGNAL PROCESSING

COURSE OBJECTIVES:
- To introduce the characteristics of different biosignals
- To discuss linear and non-linear filtering techniques to extract desired information
- To demonstrate the significance of wavelet detection applied in biosignal processing.
- To extract the features from the biosignal
- To introduce techniques for automated classification and decision making to aid diagnosis

UNIT I SIGNAL, SYSTEM AND SPECTRUM

UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION

UNIT III ADAPTIVE FILTERING AND WAVELET DETECTION
Filtering – LMS adaptive filter, adaptive noise cancelling in ECG, improved adaptive filtering in FECG, EEG and other applications in Bio signals, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV ANALYSIS OF BIOSIGNAL
Removal of artifact – ECG, Event detection –ECG, P Wave, QRS complex, T wave, Correlation analysis of ECG signals, Average of Signals-PCG, ECG and EMG.

UNIT V BIOSIGNAL CLASSIFICATION AND RECOGNITION
Statistical signal classification, linear discriminate function, direct feature selection and ordering, Back propagation neural network based classification.
Case study: 1. Various methods used to extract features from EEG signal
Case Study 2: Diagnosis and monitoring of sleep apnea

COURSE OUTCOMES:
Upon Completion of the course, the students will be able to:
CO1: Analyse the different types of signals & systems
CO2: Analyse signals in time series domain & estimate the spectrum
CO3: Understand the significance of wavelet detection applied in biosignal processing
CO4: Extract the features from biosignal
CO5: Describe the performance of the classification of biosignals

TOTAL:45 PERIODS
REFERENCES:
5. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006

<table>
<thead>
<tr>
<th>BM4152</th>
<th>HUMAN ANATOMY AND PHYSIOLOGY</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>C</th>
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<td>3</td>
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</tbody>
</table>

COURSE OBJECTIVES:
- To identify all the organelles of an animal cell and their function.
- To understand the structure and functions of the different types of systems of the human body.
- To understand about sensory organs and accessory organs of human beings.
- To demonstrate their knowledge of importance of anatomical features and physiology of human systems.
- Gain knowledge in regulatory mechanism of human body.

UNIT I ORGANIZATION OF THE HUMAN BODY

UNIT II INTEGUMENTARY, SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS

UNIT III CARDIOVASCULAR, LYMPHATIC AND ENDOCRINE SYSTEMS

UNIT IV NERVOUS, SENSE ORGANS AND REPRODUCTIVE SYSTEMS
UNIT V DIGESTIVE AND URINARY SYSTEMS


TOTAL:45 PERIODS

COURSE OUTCOMES:
Upon Completion of the course, the students will be able to:

CO1: Explain the general terminology, cell structure and function, histology, gross anatomy, and physiology related to the various human systems

CO2: Acquire knowledge various anatomical parts of the human systems

CO3: Understand about interconnectedness of anatomy and physiology of various systems

CO4: Acquire knowledge in human organ systems interrelation and apply a holistic approach to human health.

CO5: Apply concept and knowledge of human systems to novel technical and/or clinical scenarios

REFERENCES:


BM4101 MEDICAL IMAGING SYSTEMS

CURSE OBJECTIVES:
- To understand the production of x-rays and its application to different medical Imaging
- To explore the different types of Radio diagnostic techniques.
- To understand the special imaging techniques for visualizing the cross sections of the body.
- To understand the production of Magnetic resonance images for various pulse sequences.
- To realize the importance of image quality assessments for medical imaging systems.

UNIT I X – RAYS

UNIT II CT AND ULTRASOUND IMAGING
CT principle- Multi section Radiography, Computerised Axial Tomography, Type of Detection, image reconstruction, Spiral CT, Transverse Tomography,3D Imaging. Ultrasonic frequency for medical application, different modes of Display A, B and M, ultrasonic probes, Real time echo and 2D scanner.
UNIT III  COMPUTER AIDED TOMOGRAPHY  9
Need for sectional images, Principles of sectional scanning, Method of convolution and Back
Propagation, Methods of reconstruction, Multislice CT, artifacts.

UNIT IV  MAGNETIC RESONANCE IMAGING AND EMISSION COMPUTED
TOMOGRAPHY IMAGING  9
Principle of MRI, MRI instrumentation, Imaging Different Sections of the Body, Tissue
Characterization, MR Spectroscopy, Functional MRI. Alpha, Beta, Gamma Emission, different
types of Radiation Detectors, Functions of Gamma Camera, PET, SPECT, PET/CT, PET/MRI.

UNIT V  QUALITY METRICS FOR IMAGING SYSTEMS  9
Global parameter assessment, spatial – frequency assessment, Image – processing assessment,
Observer assessment, Image discrimination models, figure of merit, Comparing model to human
Performance.

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

CO1: Explain the functionalities and applications of X ray in medicine.
CO2: Demonstrate the images acquisition procedures using CT.
CO3: Explain the suitable projection methods for anatomy and biology specific.
CO4: Demonstrate the applications of magnetic field in the field of medicine.
CO5: Explain the assessment method to quantify the presence of noise in the image.

REFERENCES:
1. Richard L. Van Metter, Jacob Beutel, Harold L. Kundel, Handbook of Medical Imaging,
2. Chesney D. N., Chesney M. O. Radio graphic imaging, CBS Publications, New Delhi, 1989
3. Donald W. McRobbice, Elizabeth A. Moore, Martin J. Grave and Martin R. Prince MRI
4. Frederick W Kremkau, Diagnostic Ultrasound Principles & Instruments, Saunders
5. Jerry L. Prince, Jnathan M. Links, Medical Imaging Signals and Systems- Pearson
6. Education Inc. 2014.
7. Peggy, W., Roger D. Ferimarch, MRI for Technologists, McGraw Hill, New York, second

TOTAL:45 PERIODS

BM4102  BIO MEDICAL SENSORS, INSTRUMENTATION AND
EQUIPMENT  L T P C  4 0 0 4

COURSE OBJECTIVES:
• To understand the purpose of measurement, the methods of measurements, errors
  associated with measurements.
• To obtain the knowledge of biosensors in medical field.
• To gain the domain knowledge in bio potential and its measurements
• To Study the design of bio amplifiers
• Get familiarized with important medical equipment used in critical care.
UNIT I INTRODUCTION TO MEASUREMENT
Measurement System – Instrumentation - Classification and Characteristics of Transducers – Static and Dynamic - Errors in Measurements and their statistical analysis – Calibration - Primary and secondary standards.

UNIT II BIO SENSORS
Chemical sensors, characteristics, classes of chemical sensors, electrochemical cell, biochemical sensors, multisensory arrays, RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Biomedical applications of temperature sensors. Active type: Thermocouple - characteristics.

UNIT III BIOPOTENTIAL AND ITS MEASUREMENTS

UNIT IV DESIGN OF BIOAMPLIFIERS

UNIT V MEDICAL EQUIPMENT

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of this course the student will be able to
CO1: Understand the science behind the measurement systems
CO2: Explain the different types of Bio sensors
CO3: Understand various bio signals and its measurements
CO4: Design a bio-amplifier
CO5: Describe various medical equipment used in critical care

REFERENCES:
5. Leslie Cromwell, Biomedical Instrumentation and measurement, Prentice Hall of India, New Delhi, 2nd edition, 2015
BM4111 CLINICAL INSTRUMENTATION AND DESIGN LABORATORY

COURSE OBJECTIVES:
- Familiarize the design of preamplifiers and its significance
- Design various bio signals acquisition amplifiers and Isolation Circuits
- To Study the various medical equipment used in medical field
- Study the critical care equipment in medical field
- Design 3D printing model for medical application

LIST OF EXPERIMENTS:
1. Design of pre amplifiers to acquire any Bio-signals
2. Design of ECG amplifier with suitable filter to remove movement artifacts and power line noise
3. Design of suitable circuit to calculate heart rate
4. Design of optical Isolation Amplifier
5. Measurement of Pulse Rate using suitable device
6. Measurement of Respiratory Rate using Suitable device
7. Study the working of Defibrillator and pacemakers
8. Study of ventilators
9. Study the use of any 2-D and 3-D Modelling Software
10. Develop prototyping using 3D printing

TOTAL: 45 PERIODS

COURSE OUTCOMES:
Upon completion of this course the student will be able to
CO1: Design a preamplifier on his own
CO2: Design amplifier and Isolation circuits for any bio signals
CO3: Obtain the domain knowledge in Basic medical equipment
CO4: Obtain the domain knowledge in critical care equipment
CO5: Get familiarized with important of 3D printing in medical field.

BM4161 BIO SIGNAL PROCESSING LABORATORY

COURSE OBJECTIVES:
- To understand the analysis of biosignals
- To know the various methods for denoising of biosignals.
- To understand the extraction of features in biosignals
- To gain knowledge about biosignal compression.
- To detect and classify the abnormalities in biosignals

LIST OF EXPERIMENTS: MATLAB / EQUIVALENT SOFTWARE PACKAGE
1. Removal of noise and artifact using filtering
2. Denoising of biosignals using wavelets
3. Noise cancellation using Adaptive filters
4. QRS detection using Pan-Tompkins algorithm
5. Heart rate variability analysis in ECG signals
6. Event detection in EEG signals
7. Cepstral analysis of speech signals
8. Multiresolution analysis of EEG signal using wavelet transform
9. Feature extraction in EMG signals
10. Adaptive segmentation of EEG signals
11. Feature reduction using PCA
12. Disease classification of biosignals
13. Autoregressive modelling of biosignals
14. Biosignal compression
15. Biosignal analysis in virtual instrumentation platform

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On completion of the laboratory course, the students will be able to:
CO1: Develop an algorithm for preprocessing of biosignals.
CO2: Perform denoising and analyze the spectral characteristics of biosignals.
CO3: Perform biosignal compression.
CO4: Analyze the biosignals in virtual instrumentation platform

BM4201 MEDICAL DEVICE DESIGN L T P C 3 0 0 3

COURSE OBJECTIVES:
- To understand about basic design processes of medical device
- To introduce with basics of design, construction and development devices
- To follow a deterministic engineering design process to create new products.
- To apply engineering theory to practice.
- To perform design transfer and countermeasure development.

UNIT I INTRODUCTION Needs finding, problem identification, prior art searches, strategy and concept generation, estimation, sketching, sketch modelling, machine elements, ergonomics and prototyping.

UNIT II DESIGN OF MEDICAL DEVICES & SYSTEM Medical device classification, bioethics, and privacy, biocompatibility and sterilization techniques, design of clinical, trials, design control and regulatory requirements, introduction to specific, medical technologies: biopotentials measurement (EMG, EOG, ECG, EEG), medical diagnostics (In-vitro diagnostics), medical diagnostics (Imaging), minimally invasive devices, surgical tools and implants.


UNIT IV HARDWARE AND SOFTWARE DESIGN Hardware design, Hardware risk analysis, Design and project merits, Design for six sigma, software
design, software coding, software risk analysis, software metrics, licensing and alternate pathways

UNIT V     DESIGN TRANSFER AND IPR  9

TOTAL: 45 PERIODS

REFERENCES

BM4202     BIOMATERIALS AND BIOMECHANICS     L T P C
                          3 0 0 3

COURSE OBJECTIVES:
- To introduce concepts of materials, surface and tissue placement in biomaterial functions
- To understand diverse elements controlling biological responses to materials
- To get the clear understanding of application of mechanics in medicine.
- To study the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments
- To gain necessary knowledge about accident and injuries.

UNIT I     INTRODUCTION TO BIOMATERIALS  9
Definition of biomaterials, Metals, Ceramics, Polymers and Biomimetic Materials, Composites. mechanical properties, surface chemistry of materials, surface modification, Tissue Reaction, Wound Kinetics, Bio Compatibility, Material preparation, Properties, uses in medicine and biosciences and failure mechanisms.

UNIT II     STERILIZATION AND TESTING OF BIOMATERIALS  8

UNIT III    TISSUE AND FLUID BIOMECHANICS  10
UNIT IV  MOVEMENT BIOMECHANICS AND IMPLANTS

Gait analysis, body & limbs: mass & motion characteristics actions, forces transmitted by joints. Joints forces results in the normal & disable human body, normal & fast gait on the level. Patterns: Push/Throw Continuum Biomechanics of push - like motions, Biomechanics of throw - like motions. General concepts of Implants, classification of implants, Soft tissue replacements and Hard tissue replacements, basic consideration and limitation of tissue replacement, Design of orthopedic implant, specifications for a prosthetic joint, fixation of implants.

UNIT V  CARDIAC & RESPIRATORY MECHANICS


SUGGESTED ACTIVITIES:
1: Stress-strain analysis of hip prosthesis
2: Estimation of haemocompatibility of biomaterials by hemolysis studies
3: Measurement of torque required to tap and screwing in jaw bone.
4: Determination of moment of inertia of human limb using dynamometer.

COURSE OUTCOMES:
CO1: Analyze different types of materials and apply in designing a device.
CO2: Select the materials for designing an implants in tissue replacement.
CO3: To get the clear understanding of application of mechanics in medicine.
CO4: To study the properties of blood, bone and soft tissues like articular cartilage tendons and ligaments
CO5: Acquired a conceptual and theoretical framework of the design, development, and implementation of orthopedic implants.

REFERENCES

TOTAL:45 PERIODS
COURSE OBJECTIVES:

- To understand the fundamentals of medical image processing techniques.
- To understand the basic concepts of image enhancement, image restoration, morphological image processing, image segmentation, feature recognition in medical images.
- To provide information about various medical imaging modalities.
- To provide information about classification and image visualization in medical image processing projects.
- To familiarize the student with the image processing facilities in Matlab, Python and openCV.

UNIT I  FUNDAMENTALS OF IMAGE PROCESSING

- Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms – 2D-DFT and other transforms. DFT, DCT, KLT, SVD.

UNIT II  MEDICAL IMAGE ENHANCEMENT AND RESTORATION


UNIT III  MEDICAL IMAGE REPRESENTATION

- Pixels and voxels – algebraic image operations - gray scale and color representation- depth-color and look up tables - image file formats- DICOM- other formats- Analyze 7.5, NifTI and Interfile, Image quality and the signal to noise ratio.

UNIT IV  MEDICAL IMAGE ANALYSIS AND CLASSIFICATION

- Image segmentation- pixel based, edge based, region based segmentation. Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and image classification – Statistical, Rule based, Neural Network approaches.

UNIT V  IMAGE REGISTRATIONS AND VISUALIZATION

- Image Registration: Rigid body transformation – Affine transformation, Principal axes registration, Iterative principal axes registration, Feature based registration, Elastic deformation based registration, Registration of Images from Different modalities, Evaluation of Registration Methods. Image visualization: 2-D display methods, 3-D display methods, surface and volume based 3-D display methods – Surface Visualization and Volume visualization, 3-D Echocardiography, 3D+time Echocardiography, virtual reality based interactive visualization.

PRACTICAL EXERCISES:
The following experiments should be performed in OpenCV / Python / Scilab / Matlab Octave / other Open source software.
LIST OF EXPERIMENTS
1. Preprocessing of medical images
2. Filtering of medical images.
3. Edge detection using Python
4. Segmentation of ROI in medical images.
5. Feature extraction in medical images
6. Steganography using OpenCV.
7. Medical image fusion.
8. Statistical analysis of features

COURSE OUTCOMES:
Upon Completion of the course, the students should be able to:
CO1: Apply basic medical image processing algorithms
CO2: Image pre-processing applications that incorporates different concepts of filters for medical Image Processing and reconstruction of an image
CO3: Describe the image representation model
CO4: Analysis of image segmentation, feature extraction and image classification
CO5: Explore the knowledge in image registration and visualization and possibility of applying Image processing concepts in modern hospitals

TOTAL:75 PERIODS

REFERENCES

BM4251 AI AND MACHINE LEARNING

COURSE OBJECTIVES:
- To introduce the concept of machine learning
- To learn and apply neural networks for pattern classification and regression problems
- To introduce the ideas of fuzzy sets, fuzzy logic
To familiarize with genetic algorithms for seeking global optimum in self-learning situations
To introduce the Deep learning concept for medical image analysis

UNIT I  INTRODUCTION TO MACHINE LEARNING  

UNIT II  NEURAL NETWORKS  

UNIT III  FUZZY LOGIC SYSTEMS  
Fuzzy Logic System: Basic of fuzzy logic theory, crisp and fuzzy sets, Basic set operation like union, interaction, complement, T-norm, T-conorm, fuzzy relations, fuzzy if-then rules, fuzzy reasoning, Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference System (ANFIS), ANFIS architecture, Hybrid Learning Algorithm

UNIT IV  EVOLUTIONARY COMPUTATION & GENETIC ALGORITHMS  

UNIT V  ADVANCES AND APPLICATIONS  
Support Vector Machines, RBF Network. Introduction to Deep Learning – Convolutional Neural Network. Case Study – Neural Network based Classification of Biosignal and Medical Images.

PRACTICAL EXERCISES:
1. Implement Simple Programs like vector addition in TensorFlow.
2. Implement a simple problem like regression model in Keras.
4. Implement a Feed-Forward Network in TensorFlow/Keras.
5. Implement an Image Classifier using CNN in TensorFlow/Keras.
6. Develop an abnormal detection system for bio signal data using fuzzy logic.
7. Develop a system to implement Neural Networks techniques to define predictive models for Abnormal detection.
8. Develop a system that can optimize the solution of the abnormal detection system developed by fuzzy logic
9. Implement a biosignal/medical image Classifier using CNN.

COURSE OUTCOMES:
On completion of this course the student will be able to:
CO1: Identify and describe machine learning techniques and their roles in building intelligent system
CO2: Design neural networks for pattern classification and regression problems
CO3: Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
CO4: Apply genetic algorithms to optimization problems.
CO5: Apply Deep learning concept for biomedical signal analysis and Medical image analysis

TOTAL: 75 PERIODS

REFERENCES
In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (at least 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.

Activities to be carried out

<table>
<thead>
<tr>
<th>Activity</th>
<th>Instructions</th>
<th>Submission week</th>
<th>Evaluation</th>
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<tbody>
<tr>
<td>Selection of area of interest and Topic</td>
<td>You are requested to select an area of interest, topic and state an objective</td>
<td>2nd week</td>
<td>3% Based on clarity of thought, current relevance and clarity in writing</td>
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<tr>
<td>Stating an Objective</td>
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</table>
| Collecting Information about your area & topic | 1. List 1 Special Interest Groups or professional society  
2. List 2 journals  
3. List 2 conferences, symposia or workshops  
4. List 1 thesis title  
5. List 3 web presences (mailing lists, forums, news sites)  
6. List 3 authors who publish regularly in your area  
7. Attach a call for papers (CFP) from your area. | 3rd week        | 3% (the selected information must be area specific and of international and national standard) |
| **Collection of Journal papers in the topic in the context of the objective – collect 20 & then filter** | **You have to provide a complete list of references you will be using- Based on your objective -**Search various digital libraries and Google Scholar
- When picking papers to read - try to:
  - Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them,
  - Favour papers from well-known journals and conferences,
  - Favour “first” or “foundational” papers in the field (as indicated in other people’s survey paper),
  - Favour more recent papers,
  - Pick a recent survey of the field so you can quickly gain an overview,
  - Find relationships with respect to each other and to your topic area (classification scheme/categorization)
- Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered | **4th week** | **6%** (the list of standard papers and reason for selection)

| **Reading and notes for first 5 papers** | **Reading Paper Process**
- For each paper form a Table answering the following questions:
  - What is the main topic of the article?
  - What was/were the main issue(s) the author said they want to discuss?
  - Why did the author claim it was important?
  - How does the work build on other’s work, in the author’s opinion?
  - What simplifying assumptions does the author claim to be making?
  - What did the author do?
  - How did the author claim they were going to evaluate their work and compare it to others?
  - What did the author say were the limitations of their research?
  - What did the author say were the important directions for future research?
Conclude with limitations/issues not addressed by the paper (from the perspective of your survey) | **5th week** | **8%** (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)
<table>
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<tr>
<th>Task</th>
<th>Description</th>
<th>Week</th>
<th>Evaluation Notes</th>
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</thead>
<tbody>
<tr>
<td>Reading and notes for next 5 papers</td>
<td>Repeat Reading Paper Process</td>
<td>6th</td>
<td>8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</td>
</tr>
<tr>
<td>Reading and notes for final 5 papers</td>
<td>Repeat Reading Paper Process</td>
<td>7th</td>
<td>8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</td>
</tr>
<tr>
<td>Draft outline 1 and Linking papers</td>
<td>Prepare a draft Outline, your survey goals, along with a classification / categorization diagram</td>
<td>8th</td>
<td>8% (this component will be evaluated based on the linking and classification among the papers)</td>
</tr>
<tr>
<td>Abstract</td>
<td>Prepare a draft abstract and give a presentation</td>
<td>9th</td>
<td>6% (Clarity, purpose and conclusion)</td>
</tr>
<tr>
<td>Introduction Background</td>
<td>Write an introduction and background sections</td>
<td>10th</td>
<td>5% (clarity)</td>
</tr>
<tr>
<td>Sections of the paper</td>
<td>Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey</td>
<td>11th</td>
<td>10% (this component will be evaluated based on the linking and classification among the papers)</td>
</tr>
<tr>
<td>Your conclusions</td>
<td>Write your conclusions and future work</td>
<td>12th</td>
<td>5% (conclusions – clarity and your ideas)</td>
</tr>
<tr>
<td>Final Draft</td>
<td>Complete the final draft of your paper</td>
<td>13th</td>
<td>10% (formatting, English, Clarity and linking)</td>
</tr>
<tr>
<td>Seminar</td>
<td>A brief 15 slides on your paper</td>
<td>14th &amp; 15th</td>
<td>10% (based on presentation and Viva-voce)</td>
</tr>
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TOTAL: 30 PERIODS
COURSE OBJECTIVES:
- To study the measurement of various biopotential and non-electrical parameters.
- To explore the various functional blocks present in cardiac care units and various assist devices.
- To develop an understanding of the physiotherapy and diathermy equipment.
- To study the electrical safety in the hospital environment.

UNIT I BIO POTENTIAL RECORDING

UNIT II MEASUREMENT OF NON ELECTRICAL PARAMETER

UNIT III CARDIAC CARE UNITS
Pace makers - different types, batteries for pace makers, Design Concept. DC defibrillators, asynchronous and synchronous types, patient monitoring system, principles of bio telemetry.

UNIT IV ASSIST DEVICES

UNIT V DIATHERMY, STIMULATOR AND PATIENT SAFETY
Diathermy-Physiological effects of HF radiation, Depth of Penetration, short wave, Ultrasonic and microwave diathermy, Surgical diathermy, Hazards and safety procedures. Medical Stimulators – Intensity Duration Curve, Current waveforms - Galvanic, Faradic, surged faradic, exponential, biphasic, TENS, Interferential therapy. Electrical Safety-Leakage current, Micro and macro electric shock, GFI units, Earthing Scheme, Electrical safety Analyser.

COURSE OUTCOMES:
Upon completion of this course the student will be able to
CO1: Design and analyze the bioamplifiers.
CO2: Measure vital and non-electrical parameters
CO3: Design and demonstrate the pacemaker and defibrillator.
CO4: Demonstrate the function of assist devices.
CO5: Design stimulators and test the electrical safety of medical equipment in the hospital environment.

TOTAL: 45 PERIODS
REFERENCES

BM4072 REHABILITATION ENGINEERING L T P C 3 0 0 3

COURSE OBJECTIVES:
- To learn the basics of rehabilitation engineering
- To study about principle of rehabilitation engineering
- To understand different types of Therapeutic Exercise Technique.
- To understand the tests to assess the hearing loss and development techniques of electronic devices for visually and auditory impaired
- To study about various orthopaedic devices and prosthetic devices

UNIT I INTRODUCTION TO REHABILITATION
Rehabilitation: Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team Classification of members, The Role of Psychiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer

UNIT II PRINCIPLE OF REHABILITATION

UNIT III THERAPEUTIC EXERCISE TECHNIQUE

UNIT IV MANAGEMENT OF COMMUNICATION & VIRTUAL REALITY
Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids. Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.
UNIT V ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES


COURSE OUTCOMES:
CO1: Explain the fundamentals of rehabilitation and rehabilitation team members.
CO2: Describe the key engineering principles of rehabilitation and assistive technology.
CO3: Apply the types of therapeutic exercises to benefit the society
CO4: Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society.
CO5: Explain engineering concepts in Virtual reality based rehabilitation devices
CO6: Identify prosthetic and orthotic devices for restoration of limb function

TOTAL :45 PERIODS

REFERENCES

MX4072 MEDICAL OPTICS

COURSE OBJECTIVES:
- To understand various optical properties of tissue
- To gain the knowledge of photonics instruments
- To know the engineering and practical applications of optics related to diagnostics applications
- To acquire knowledge about therapeutic and surgical applications of lasers in medical fields
- To gain the knowledge of fiber optic sensors used in medical application

UNIT I OPTICAL PROPERTIES OF THE TISSUES

Optical properties of tissue- melanin, bilirubin, tissue and their spectrum, optical characteristics of constituents of blood – RBC, hemoglobin properties, plasma, oxygenated and deoxygenated hemoglobin, Laser tissue interaction-Chemical, Thermal, Electromechanical. Photo ablative processes. Laser safety procedures
UNIT II INSTRUMENTATION IN PHOTONICS

Review of basic properties of light – Reflection, Refraction, Scattering, fluorescence and phosphorescence. Instrumentation for absorption, scattering and emission measurements. Optical sources – high pressure arc lamps, LEDs, Medical Lasers. Optical filters. Optical detectors - Time resolved and phase resolved detectors, optical tweezers

UNIT III DIAGNOSTIC APPLICATIONS

Wood’s lamp, Imaging techniques - Optical coherence tomography, Elastography, Fluorescence Imaging, Raman Imaging, FLIM, FRAP, NIRS-Application, X-Ray Diagnostic Techniques, Speckle Correlometry, Near-Field Imaging in Biological and Biomedical Applications

UNIT IV THERAPEUTIC AND SURGICAL APPLICATIONS OF LIGHT

Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and non-oncological applications of PDT - Biostimulation effect – applications. Laser in tissue welding, lasers in dermatology, lasers in ophthalmology, otolaryngology, urology, neurology, orthopedics, gastroenterology.

UNIT V FIBER OPTIC SENSORS AND APPLICATIONS

Light transport in the optical fiber - Total internal reflection, Numerical aperture, Angle of acceptance. losses in fiber, Optical sensors based on polarization, magnetic sensors, Medical applications of fiber optic sensors in measuring temperature, pressure, flow and chemical activities

COURSE OUTCOMES:
On completion of this course the student will be able to:
CO1: Understand various optical properties of tissue
CO2: Describe the photonics instruments
CO3: Know the diagnostic applications of lasers in medical fields
CO4: Explain the therapeutic and surgical applications of lasers in medical fields
CO5: Describe the types of fiber optic sensors used in medical application

TOTAL: 45 PERIODS

REFERENCES

MX4071 HUMAN ASSIST DEVICES L T P C
3 0 0 3

COURSE OBJECTIVES:
- To know the principle and design of Heart lung machine and artificial heart
- To acquire knowledge of various cardiac assist devices,
- To study implantation of artificial kidney
To understand the principle of prosthetic and orthotic devices for the disability
To Gain knowledge in respiratory devices and hearing aids

UNIT I  HEART LUNG MACHINE AND ARTIFICIAL HEART  9
Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Mock test setup for assessing its Functions

UNIT II  CARDIAC ASSIST DEVICES  9
Synchronous Counter pulsation, Assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and closed Chest type, Intra Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardiac Valves, Principle and problem, Biomaterials for implantable purposes, its characteristics and testing.

UNIT III  ARTIFICIAL KIDNEY  9
Indication and Principle of Haemodialysis, Membrane, Dialysate, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type

UNIT IV  PROSTHETIC AND ORTHOTIC DEVICES  9

UNIT V  RESPIRATORY AND HEARING AIDS  9
Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, Construction and Functional Characteristics

TOTAL : 45 PERIODS

COURSE OUTCOMES:
CO1: Knowledge about the importance of Heart lung machine and artificial Heart
CO2: Knowledge about the importance of different types of assist devices and related issues
CO3: Understand about the implantation of artificial kidney
CO4: Explore the different types of models for Prosthetic and orthotic purpose
CO5: Perceive the knowledge in different types of respiratory and hearing aids

REFERENCES
COURSE OBJECTIVES:
- To develop a broad and deep understanding of transport phenomena at the micro/nanoscale
- To understand major applications of micro/nanofluidics
- To understand major methods to fabricate micro/nanofluidic devices
- To be able to design and test new micro/nanofluidic devices for certain applications
- To understand the process of nano fluid preparation

UNIT I INTRODUCTION
Microfluidics: Introduction, Benefits of size reduction, Benefits of automation and integration, Application areas; PDMS microfluidics:PDMS microvalve architectures, elastomeric microfluidic valve, Multilayer device fabrication. Nano fluids: Properties of nanofluids; thermophysical characteristics of nanofluids; Experimental methods of preparation of nano fluids; Theoretical models for thermal conductivity of nanofluids..

UNIT II BASIC PRINCIPLES OF MICROFLUIDICS
Laminar flow, Peclet number, Pressure driven flow, Electroosmotic flow, Micropumps: Peristaltic pump, Centrifugal pump, Electrokinetic pump, Magneto-hydro dynamic pump; Micromixers: Active micromixers, Passive micromixers; Soft lithography. Detection methods;

UNIT III MICROFLUIDICS IN BIOMEDICAL RESEARCH
Impact of microfluidics on biomedical research; microfluidics concepts: Laminar versus turbulent flow, Surface and interfacial tension, Capillary forces; Chemotaxis: Introduction, Agar-plate techniques, Two-chamber techniques, Boyden chamber, Capillary techniques; Microfluidic device fabrication; Diagnostics for low-resource settings; Organ-on-a-chip; Biomimetic blood vessel and capillary networks..

UNIT VI MICRO AND NANO EMULSIONS

UNIT V NANOFUID PREPARATION

COURSE OUTCOMES:
CO1: Understand the basic principles of micro and nano fluids
CO2: Understand the synthesis advantages and importance of micro and Nano fluids
CO3: Ability to analyze fluid flow in micro and nano-size devices.
CO4: Understand the concepts and Applications of micro- and nanofabrication
CO5: Understand commercialization Issues of Micro-Nano Technology
REFERENCES

BM4092  MEDICAL DEVICE STANDARDS AND REGULATION  L T P C
3 0 0 3

COURSE OBJECTIVES:
- Understand standards and safety aspects of medical devices.
- Understand the hospital safety standards and maintenance.
- Describe the medical equipment safety standards.
- Describe medical device regulations
- Describe medical device risk assessment and regulatory requirements.

UNIT I  STANDARDS AND SAFETY  9
Quality management system for medical devices (ISO 9001 and ISO13485), safety and standardization for risk management (ISO 14971), European standard conformity (CE marking), FDA guidelines for medical devices approval and classification based on risk assessment

UNIT II  HOSPITAL SAFETY STANDARDS  9

UNIT III  MEDICAL EQUIPMENT ESSENTIAL REQUIREMENTS  9
General requirements for basic safety & essential performance of medical equipment, IEC 60601 standards- Base Standard-general requirement of electrical medical devices, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device.

UNIT IV  MEDICAL DEVICE REGULATION  9

UNIT V  MEDICAL DEVICE RISK ASSESSMENT  9
COURSE OUTCOMES:
On completion of this course the student will be able to:
CO1: Describe the key point in standard and safety of medical devices
CO2: Introduce the students with the knowledge of hospital safety and standards.
CO3: Introduce the students with the knowledge of essential requirements in medical equipments
CO4: Introduce device regulation and its types.
CO5: Acquire knowledge medical device risk assessment.

REFERENCES
4. https://nptel.ac.in/courses/127106136
5. MDR17, Regulation of Medical Devices,

BM4073 TELE HEALTH TECHNOLOGY
L T P C 3 0 0 3

COURSE OBJECTIVES:
- To teach the key principles for telemedicine and health.
- To make student understand telemedical technology.
- To introduce the students with the knowledge of telemedical standards
- To design and develop m-Health platforms for telemedical applications. diagnosis
- To make student understand the applications of health care sectors

UNIT I TELEMEDICINE AND HEALTH
History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, Organs of telemedicine, Global and Indian scenario, International regulations in e-health and telemedicine, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II TELEMEDICAL TECHNOLOGY

UNIT III TELEMEDICAL STANDARDS SECURITY AND LEGAL ISSUES
UNIT IV m-HEALTH AND TELEMEDICINE
Mobile Devices: Smart phones, Tablet PCs, iPads, PDAs, Wearable computers – m-Health technology and communication infrastructure - Healthcare Apps – m-Health applications: Education and awareness, Remote data collection, Remote monitoring, Communication and training for healthcare workers, Disease and epidemic outbreak tracking, Diagnostic and treatment support – m-Health and the Transformation of Clinical Trials - Harnessing data, advanced analytics, and the Internet of Things to optimize digitized clinical trials

UNIT V TELEMEDICAL APPLICATIONS
Telemedicine access to health care services – health education and self-care. · Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services– health education and self-care, Business aspects - Project planning and costing, Usage of telemedicine. Telemedicine and in loco assistance of patients, Interactive videoconferencing consults, Store and forward consults, Remote monitoring and home care.

COURSE OUTCOMES:
On completion of this course the student will be able to:
CO1: Describe the key principles for telemedicine and health
CO2: Understand telemedical technology
CO3: Introduce the students with the knowledge of telemedical standards
CO4: Design and develop m-Health platforms for telemedical applications
CO5: Acquire knowledge of evaluating the force in implants.

TOTAL: 45 PERIODS

REFERENCES
COURSE OBJECTIVES:

- To explain the basic concepts of robots and types of robots
- To discuss the designing procedure of manipulators, actuators and grippers
- To impart knowledge on various types of sensors and power sources
- To explore various applications of Robots in Medicine
- To impart knowledge on wearable robots

UNIT I INTRODUCTION TO ROBOTICS
Introduction to Robotics, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Dynamic Stabilization

Sensors and Actuators
Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, PD and PID feedback actuator models

UNIT II MANIPULATORS & BASIC KINEMATICS
Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Navigation and Treatment Planning
Variable speed arrangements, Path determination – Machinery vision, Ranging – Laser – Acoustic, Magnetic, fiber optic and Tactile sensor

UNIT III SURGICAL ROBOTS
Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump, CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric and General Surgery, Gynecologic Surgery, General Surgery and Nanorobotics. Case Study

UNIT IV REHABILITATION AND ASSISTIVE ROBOTS
Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations, Hybrid assistive limb. Case Study

UNIT V WEARABLE ROBOTS
Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology, Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–robot physical interaction (pHRI), Wearable Robotic Communication - case study

COURSE OUTCOMES:

CO1: Describe the configuration, applications of robots and the concept of grippers and actuators
CO2: Explain the functions of manipulators and basic kinematics
CO3: Describe the application of robots in various surgeries
CO4: Design and analyze the robotic systems for rehabilitation
CO5: Design the wearable robots

REFERENCES

BM4074 WEARABLE TECHNOLOGIES

COURSE OBJECTIVES:
- Identify the motivation, guiding principles, and challenges of Wearable Computing.
- Develop skills pertaining to the design of a holistic interactive wearable system comprising of the physical, digital, and the human aspects.
- To provide the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life.
- To introduce the concept of the reactive sensors and self-generating sensors and its applications in real life
- To impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life

UNIT I INTRODUCTION
UNIT II WEARABLE SENSORS
Chemical and Biochemical sensors, System design, Challenges in chemical Bio-chemical sensing, Application areas - Inertia sensors, Parameters from inertia sensors - Applications for wearable motion sensors - Measurement of energy expenditure by body worn heat flow sensors.

UNIT III FLEXIBLE ELECTRONICS

UNIT IV ENERGY HARVESTING SYSTEMS

UNIT V MONITORING PHYSICAL AND PHYSIOLOGICAL PARAMETERS
Wearable sensors for physiological signal measurement - Physical measurement: Cardiovascular diseases, Neurological diseases, Gastrointestinal diseases - Wearable and non-invasive assistive technologies: Assistive devices for individuals with severe paralysis, Wearable tongue drive system, Sensor signal-processing algorithm, Dual-mode tongue drive system.

COURSE OUTCOMES:
CO1: Understand the fundamentals of wearables, wearable design issues and user interfaces
CO2: Identify the different types of sensors used in wearable devices
CO3 : Recognize the materials used in the field of flexible electronics technology and its power constraints
CO4: Summarize the techniques and issues associated with energy harvesting from human body
CO5: Elucidate the applications of wearable technology in health care

TOTAL: 45 PERIODS

REFERENCES
COURSE OBJECTIVES:
- Achieve familiarity with some basic ethical frameworks & understand how these ethical frameworks can help us to think through contemporary questions in medical ethics.
- Students will be able to know about the legal and ethical principles.
- To apply these principles in health care settings & gain knowledge about the medical standards that are to be followed in hospitals.

UNIT I  INTRODUCTION TO MEDICAL ETHICS  8
Definition of Medical ethics, Scope of ethics in medicine, American Medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor and Society.

UNIT II  ETHICAL THEORIES & MORAL PRINCIPLES  9

UNIT III  HOSPITAL ACCREDITATION STANDARDS  9

UNIT IV  HOSPITAL SAFETY STANDARDS  10

UNIT V  MEDICAL EQUIPMENT SAFETY STANDARDS  9

COURSE OUTCOMES:
On completion of this course the student will be able to:
CO1: Describe the Social responsibility in healthcare systems
CO2: Discuss the Bioethics and engineers role
CO3: Apply Legal and professional guidelines for the hospital accreditation
CO4: Understand hospital safety aspects
CO5: Comprehend the medical equipment safety standards and medical device maintenance.

REFERENCES
7. Nils Hoppe and Jose Miola - Medical law and Medical Ethics - Cambridge University Press-2014

BM4071 BRAIN COMPUTER INTERFACE

COURSE OBJECTIVES:
The objective of this course is to enable the student to

- Understand the basic concepts of brain computer interface.
- Explore the various signal acquisition methods.
- Understand the signal processing methods used in BCI.
- Understand the various machine learning methods of BCI.
- Learn the various applications of BCI.

UNIT I INTRODUCTION TO BCI
Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous - Invasive BCI, Partially Invasive BCI, Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, MEG, fMRI.

UNIT II BRAIN ACTIVATION

UNIT III FEATURE EXTRACTION METHODS
Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering - Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization.

UNIT IV MACHINE LEARNING METHODS FOR BCI
Classification techniques – Binary classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF’s, Support vector machine, Graph theoretical functional connectivity analysis.

UNIT V APPLICATIONS OF BCI
Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Ethics of Brain Computer Interfacing.

COURSE OUTCOMES
On successful completion of this course, the student will be able to
CO1: Evaluate concept of BCI.
CO2: Describe the different brain activation signals.
CO3: Select appropriate feature extraction methods.
CO4: Use machine learning algorithms for translation.
CO5: Develop high-fidelity BCI prototypes.

REFERENCE BOOKS:

DS4072 WAVELET TRANSFORMS AND APPLICATIONS L T P C 3 0 0 3

COURSE OBJECTIVES:
- To study the basics of signal representation and Fourier theory
- To understand Multi Resolution Analysis and Wavelet concepts
- To study the wavelet transform in both continuous and discrete domain
- To understand the design of wavelets using Lifting scheme
- To understand the applications of Wavelet transform

UNIT I FUNDAMENTALS

UNIT II MULTI RESOLUTION ANALYSIS
Definition of Multi Resolution Analysis (MRA) – Haar Basis – Construction of General Orthonormal MRA – Wavelet Basis for MRA – Continuous Time MRA Interpretation for the DTWT – Discrete Time MRA – Basis Functions for the DTWT – PRQMF Filter Banks.

UNIT III CONTINUOUS WAVELET TRANSFORMS
Wavelet Transform – Definition and Properties – Concept of Scale and its Relation with Frequency – Continuous Wavelet Transform (CWT) – Scaling Function and Wavelet Functions (Daubechies, Coiflet, Mexican Hat, Sinc, Gaussian, Bi Orthogonal) – Tiling of Time – Scale Plane for CWT
UNIT IV DISCRETE WAVELET TRANSFORM

UNIT V APPLICATIONS

COURSE OUTCOMES:
CO1: Use Fourier tools to analyse signals
CO2: Gain knowledge about MRA and representation using wavelet bases
CO3: Acquire knowledge about various wavelet transforms and design wavelet transform
CO4: Apply wavelet transform for various signal & communication applications
CO5: Apply wavelet transform for various image processing applications

TOTAL: 45 PERIODS

REFERENCES:

BM4004 HOSPITAL PLANNING, ORGANIZATION AND MANAGEMENT

COURSE OBJECTIVES:
• With an objective of imbibing a professional approach amongst students towards hospital management.
• The subject encompasses management principles, staffing and marketing processes, discussing their significance and role in the effective and efficient management of health care organizations.

UNIT I FORMS OF ORGANISATION
Sole proprietorship, Partnership, Company-public and private sector enterprises, Principles of management, Evolution of management.
UNIT II PRINCIPLE OF HOSPITAL MANAGEMENT
Importance of management and Hospital, Management control systems. Forecasting techniques decision-making process

UNIT III STAFFING
Staffing pattern in hospitals, Selection, Recruiting process, Training of staff, Organizational structures, Career development

UNIT IV MARKETING AND MANAGEMENT
Basic concepts marketing, Principles of social marketing, Social marketing in the health sector, Consumer behavior and research health, Advertising in Health Sector, Relevance of e-marketing of Health care services

UNIT V COMPUTER IN HOSPITAL
System Development life cycle, Reasons to use computers in hospital, main categories of information systems in hospitals

COURSE OUTCOMES:
CO1: Understand the Roles and types of establishment
CO2: Discuss the functions of hospital management.
CO3: Understand the concepts of HR Management practices.
CO4: Discuss the methods and tools of marketing
CO5: Understand the impacts of Information technology in hospital management.

REFERENCES

BM4005 HUMAN RESOURCE MANAGEMENT IN HOSPITALS

COURSE OBJECTIVES:
- This subject acquaints the students with major functions of HRM aligned with the business strategy.
- The subject encompasses the concept of best fit employee, training & executive development, sustaining employee interest and performance appraisal

UNIT I PERSPECTIVES OF HUMAN RESOURCE MANAGEMENT
UNIT II  THE CONCEPT OF BEST FIT EMPLOYEE  9

UNIT III  TRAINING & EXECUTIVE DEVELOPMENT  9
Types of Training methods and their benefits - Executive development Programme - common practices - Benefits, self-development - knowledge Management.

UNIT IV  SUSTAINING EMPLOYEE INTEREST  9

UNIT V  PERFORMANCE APPRAISAL  9

COURSE OUTCOMES:
On completion of this course the student will be able to:

CO1: Discuss the scope and significance of HRM.
CO2: Understand the concepts of recruitment and selection process.
CO3: Understand the procedure of training and carrier development.
CO4: Understand the employee conflicts and administrative system
CO5: Discuss the methods and techniques of the appraisal system

TOTAL:45 PERIODS

REFERENCES

BM4006 HEALTH POLICY AND EQUIPMENT MANAGEMENT  L T P C
3 0 0 3

COURSE OBJECTIVES:
- To expose the students for planning and operation of hospitals in a detailed manner which will include all facts of hospital planning activities covering every department that is involved both in clinical care as well as supportive services.
- To introduce the equipment maintenance management skills and how to protect equipment from electromagnetic interferences.

UNIT I  HEALTH SYSTEM  9
Health organization of the country, the state and cities, health financial system, teaching cum research hospitals, General Hospital, PHC reference system, Ambulatory Care.
UNIT II  NATIONAL HEALTH POLICY  
Need for evaluating a health policy, need for providing primary health care, health education, health insurance, health legislation, inter-sectoral cooperation.

UNIT III  EQUIPMENT MAINTENANCE MANAGEMENT  
Organizing the maintenance operation, biomedical equipment procurement procedure, proper selection, compatibility, testing and installation, purchase and contract procedure, trained medical staff, on the proper use of the equipment and operating instructions. Maintenance job planning, preventive maintenance, maintenance budgeting, contract maintenance.

UNIT IV   LOGISTIC SUPPORT & RELIABILITY  
Maintenance equipment and Tools, failure analysis, spare parts, and maintenance materials. Reliability fundamentals.

UNIT V  EMI IN HOSPITAL EQUIPMENT  
Principles of EMI, computation of EMI, Method of suppressing and isolating the unit from interference.

COURSE OUTCOMES:  
On completion of this course the student will be able to:  
CO1: Discuss the basics of health organization  
CO2: Explain the various national health policies  
CO3: Perform equipment installation, service & calibration needs and planning activities at health care centres  
CO4: Repair methods for Material handling equipment  
CO5: Minimizing equipment failures and increasing patient safety  

TOTAL:45 PERIODS  

REFERENCES  

BM4007  HOSPITAL WASTE MANAGEMENT  

COURSE OBJECTIVES:  
- To understand the significance of infections, biomedical waste and its proper disposal.  
- To teach the students about the controls applied to waste management.

UNIT I  INTRODUCTION  
Medical waste stream, different types of medical waste, its source of origin. Waste management elements – categories of bio-medical waste, different colour codes and symbols – rules and regulation includes state and national level bodies.
UNIT II PRINCIPLES OF STERILIZATION
Disease and its mode of transmission - Disinfection methods - concept and mechanism – physical sterilization and chemical sterilization – Large scale autoclave - Microwave (Non-burn treatment technology).

UNIT III DISPOSAL OF WASTE

UNIT IV CONTROLS APPLIED TO WASTE MANAGEMENT
Air pollution and emission control, rules governing pollution, instrumentation and monitoring, emission filters and its types, crematories- gas emission control device. Case studies related to air pollution.

UNIT V ENVIRONMENTAL SAFETY, RISKS & PUBLIC ISSUES
Risk management in hospitals - Environment issues in hospitals - Risk analysis

COURSE OUTCOMES:
On completion of this course the student will be able to:
CO1: Get a clear understanding of regulations framed for waste management
CO2: Understand the significance of infections and the transmission of diseases
CO3: Acquire knowledge on proper disposal of waste
CO4: Acquire a conceptual idea about the controls applied to waste management.
CO5: Gain sufficient knowledge on Risk analysis and management of public issues

REFERENCES
1. C.R. BRUNNER, Medical Waste

BM4008 QUALITY ASSURANCE AND PATIENTS SAFETY STANDARDS IN HOSPITALS
COURSE OBJECTIVES:
- To provide basic knowledge on the concept of Healthcare Quality management towards continuous improvement of patient care.
- To make the students aware of the role of the biomedical engineer in hospitals, especially in the management of electrical supply, maintenance of electrical safety.

UNIT I STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS
Define Quality- Need for Standardization & Quality Management, TQM in Health care organization-Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipment

UNIT II REGULATORY REQUIREMENT FOR HEALTH CARE
FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes.
UNIT III  HOSPITAL SAFETY  
Security & Safety of Hospital - Property, Staff & Patients, Radiation safety, Safety precautions, hazardous effects of radiation, allowed levels of radiation, ICRP regulations for radiation safety, Disposal of Biological waste.

UNIT IV  ELECTRICAL & FIRE SAFETY  
Sources of shocks, macro & micro shocks - Hazards, monitoring and interrupting the Operation from leakage current- Elements of fire, causes of fire, Action to be taken in case of fire in a Hospital

UNIT V  ASSESSING QUALITY HEALTH CARE  
Patient Safety Organization- Governmental & Independent, Measuring Quality care – Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals Sop’s – Patient Orientation for Total Patient Satisfaction. 5S technique

COURSE OUTCOMES:
On completion of this course the student will be able to:

CO1: Understand the scope of Need and significance of quality practices in health care industry
CO2: Discuss the system of regulatory measures and accreditation
CO3: Differentiate the level of safety and security measures and significance
CO4: Understand the concepts of Electrical and Fire Safety Hazards Mitigations
CO5: Understand the assessing quality practices using tools

TOTAL:45 PERIODS

REFERENCES
1. B.M.Sakharkar, Principles of Hospital Administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd.
6. Sharon Myers “Patient Safety & Hospital Accreditation - A Model for Ensuring Success” Springer Publishers 2012

BM4091  GENETIC ALGORITHMS AND FUZZY LOGICS  
L T P C
3 0 0 3

COURSE OBJECTIVES:
- To provide basic knowledge about the fundamentals of genetic algorithm
- To familiarize with the ant colony and particle swarm optimization techniques
- To learn the basics of fuzzy logic
- To enrich the students knowledge with fuzzy systems and its applications
- To lean the neuro fuzzy system and fuzzy logic controller
UNIT I GENETIC ALGORITHMS
Introduction, Building block hypothesis, working principle, Basic operators and Terminologies like individual, gene, encoding, fitness function and reproduction, Genetic modeling; Significance of Genetic operators, Inheritance operator, cross over, inversion & deletion, mutation operator, Bitwise operator, GA optimization problems, Applications of GA.

UNIT II OTHER OPTIMIZATION TECHNIQUES

UNIT III FUZZY LOGIC

UNIT IV FUZZY RULE BASED SYSTEM

UNIT V ADVANCES AND APPLICATIONS
Case studies: Fuzzy logic control of Blood pressure during Anaesthesia, Fuzzy logic application to Biosignals and medical Image processing, Adaptive fuzzy system. Introduction to Neuro-fuzzy logic

COURSE OUTCOMES:
CO1: Apprehend the principles of genetic algorithms as well as techniques used in its implementation.
CO2: Apply the optimization algorithms for real time applications
CO3: Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
CO4: Design a fuzzy rule based system for biomedical application
CO5: Apply the fuzzy controller for resulting the blood pressure

REFERENCES
COURSE OBJECTIVES:
- To understand basics of tissue engineering
- To learn basics of cell mechanics in tissue engineering
- To know the importance of biomaterials in tissue engineering:
- To understand the importance of stem cell in tissue engineering
- To learn the tissue culture applications in human healthcare

UNIT I  INTRODUCTION TO TISSUE ENGINEERING  9
History and scope of tissue engineering – Scientific and Social Challenges - Structure and organization of Tissues – Development of Tissue – Cell and Extracellular matrix interaction – Morphogenesis and Tissue Engineering – Cell Determination and Differentiation

UNIT II  FUNDAMENTALS OF CELL MECHANISMS  9

UNIT III  BIOMATERIALS IN TISSUE ENGINEERING  9

UNIT IV  STEM CELLS IN TISSUE ENGINEERING  9
Introduction of Stem cells – Hemopoetic Stem cells - Embryonic Stem cells - Adult stem cells – Cancer Stem cells – Cord Blood cells – Induced Pluripotent Stem cells - Stem cell identification - Surface markers & FACS analysis – Differentiation, Dedifferentiation and Immortalization – Application of stem cells in tissue Engineering.

UNIT V  TISSUE ENGINEERING APPLICATIONS  9
Synthetic components – Artificial organs – Joints and dental prostheses - Connective Tissue Engineering – Cardiovascular Tissue Engineering – Neural Tissue Engineering - Cell and Drug Delivery systems

COURSE OUTCOMES:
CO1: Explain the mechanisms involved in interaction of different materials with cells and tissues
CO2: Explain different methods involved in characterization and preparation of biomaterials in tissue engineering
CO3: Apply the knowledge in creating new models in drug delivery systems using synthetic and natural scaffolds
CO4: Explain different types of stem cells and its application in tissue engineering
CO5: Develop new approaches to build new tissues using tissue engineering techniques
CO6: Define the applications of tissue engineering to healthcare

REFERENCES

BM4010 EMBEDDED SYSTEM AND INTERNET OF THINGS FOR BIOMEDICAL APPLICATIONS

COURSE OBJECTIVES:
- To understand hardware and software for ARM processor.
- To understand ARM processor and Building Blocks of Embedded Systems
- To provide information about sensor interfacing with Arduino
- To provide information about various protocols for IoT
- To familiarize the student with the various applications in healthcare using IOT

UNIT I ARM PROCESSOR HARDWARE AND SOFTWARE
Introduction to ARM Cortex-M Processors, Embedded Software Development, ARM architecture, ARM Instruction Set, Memory System, Exceptions and Interrupts.
The C language: The evolution of C, An overview of C programming, C operators, identifiers, keywords and constants; The C preprocessor: commands, definition and replacement, File inclusion, Conditional compilation; storage classes, variable types, expressions and precedence, statements, functions.

UNIT II EMBEDDED SYSTEM ARCHITECTURE - ARM CORE
ARM organization and implementation, The Thumb Instruction Set, Architectural Support for High-Level Languages. Introduction to Arduino Due; Arduino integrated development environment and programming.

UNIT III SENSOR INTERFACING WITH ARDUINO
Basics of hardware design and functions of basic passive components-sensors and actuators, Arduino code - library file for sensor interfacing-construction of basic applications

UNIT IV IOT: AN INTRODUCTION
Networked Embedded System types and overview, wireless communication standards-zigbee, Bluetooth & Wi-Fi. OSI & TCP/IP model in a nutshell. Introduction to the Internet and understand how internet works. Introduction to Smart Objects or Things. IOT- understand what IOT is and discuss its application in health-care systems- Patient Monitoring & diagnostics, Home healthcare & Personal care & Fitness.

UNIT V EMBEDDED WEB-SERVER & IOT CLOUD SERVICES APPLICATION DESIGN & CASE STUDY
Embedded web server: Basic introduction, its importance and role in IOT. Design of a simple embedded web server: understand the HTTP & HTML basics Overview of different IOT Cloud Services.
Case Study1: Wireless Patient Monitor system
Case Study2: Wearable Fitness & Activity Monitor
Application Design: Design of IOT based pulse oximeter, block diagram, concepts of analog front end, signal process and Wi-Fi integration.

PRACTICAL EXERCISES:

LIST OF EXPERIMENTS
1. Code for Sensor interface: Temperature sensor, pressure sensor, Light sensor, IR sensor.[1]
2. Temperature sensor Interfacing using ARM processor [2]
3. Flashing of LEDs using ARM processor [3]
4. ADC/DAC Interfacing using ARM processor
5. EPROM Interfacing using ARM processor.
6. Study of basic image processing algorithm using Single board computers such as Raspberry Pi, Beagle Bone block etc

COURSE OUTCOMES:
Upon Completion of the course, the students should be able to:

CO1: Develop hardware and software for ARM processor.
CO2: Understand ARM processor and Building Blocks of Embedded Systems
CO3: Acquire Knowledge on sensor interfacing with Arduino
CO4: Analyse various protocols for IoT,
CO5: Build various applications in healthcare using IOT based approach and substantiate the same with appropriate

TOTAL:75 PERIODS

REFERENCES
7. Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010 24 Course

BM4011 MEDICAL INFORMATICS L T P C
3 0 2 4

COURSE OBJECTIVES:
- To learn about operating systems and their uses
- To understand basics of medical informatics
- To study about databases and their types
- To learn about processing of data
- To study about recent trends in health informatics
UNIT I OPERATING SYSTEM, SEARCH ENGINE AND MEDICAL STANDARD

UNIT II INTRODUCTION TO MEDICAL INFORMATICS
Introduction – Medical Informatics – Health Informatics - Structure of Medical Informatics – Functional capabilities of Hospital Information System - On-line services and Off – line services - Dialogue with the computer

UNIT III DATABASE AND HEALTH INFORMATICS

UNIT IV MEDICAL DATA STORAGE AND AUTOMATION
Representation of Data, Data modeling Techniques, Relational Hierarchical and network Approach, Normalization techniques for Data handling - Plug-in Data Acquisition and Control Boards – Data Acquisition using Serial Interface – Medical Data formats – Signal, Image and Video Formats – Medical Databases - Automation in clinical laboratories - Intelligent Laboratory Information System – PACS

UNIT V RECENT TRENDS IN MEDICAL INFORMATICS
Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment – Surgical simulation - Telemedicine – virtual Hospitals - Smart Medical Homes – Personalized e-health services – Biometrics - GRID and Cloud Computing in Medicine – Artificial Intelligence in health informatics

PRACTICAL EXERCISES:
1. Computer and Internet basics
2. Operating systems – Linux and Windows Basics
3. PubMed search engine
4. Types of computer database
5. Types of graphs
6. Retrieval of data from biological and medical database
7. Data handling and analysis using Excel

COURSE OUTCOMES:
CO1: Explain the function of hospital information systems
CO2: Explain basic concepts of artificial intelligence
CO3: Explain the various concepts of hospital management and information system
CO4: Explain the importance of medical record storage for easy access
CO5: Compare different medical standards
CO6: Explain the concepts of expert system

TOTAL: 75 PERIODS

REFERENCES

MX4074 PATTERN RECOGNITION TECHNIQUES AND APPLICATIONS

COURSE OBJECTIVES:
- To understand the fundamentals of Pattern recognition
- To impart knowledge on various clustering techniques
- To study about feature extraction and selection
- To explore different classification models
- To understand Fuzzy Pattern Classifiers and applications

UNIT I PATTERN CLASSIFIER

UNIT II CLUSTERING
Clustering Concept – Hierarchical Clustering Procedures – Partitional Clustering, k- means algorithm – Clustering of Large Data Sets – EM Algorithm – Grid Based Clustering– Density Based Clustering.

UNIT III FEATURE EXTRACTION AND SELECTION
Entropy Minimization – KL Transforms – Regression-Linear, Non-linear and Logistic, Prediction, Feature Selection through Functions Approximation – Binary Feature Selection

UNIT IV HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE

UNIT V RECENT ADVANCES AND APPLICATIONS
Elementary Neural Network for Pattern Recognition, Fuzzy pattern classifier, Application of PR in image segmentation, CAD system in breast cancer detection, ECG signal classification, Fingerprint recognition, cell cytology classification

45 PERIODS

PRACTICAL EXERCISES:
1. Implementation of Image classification using Perceptron model in Matlab/python.

51
2. Implementation of Fuzzy pattern classifier in Matlab/OpenCV/python.
3. Implementation of Feature extraction using KL transform in Matlab/OpenCV/python.
5. Implementation of density based clustering in Matlab/OpenCV/python.
8. Implementation of Bayes classifier in Matlab/OpenCV/python.
9. Implementation of Classification using Neural Networks in Matlab/OpenCV/python.
10. Implementation of image segmentation in Matlab/OpenCV/python.

COURSE OUTCOMES:
On completion of this course the student will be able to:

CO1: Perform classification using Bayes approach
CO2: Implement clustering algorithms for classification
CO3: Perform Feature extraction, feature reduction
CO4: Apply HMM and SVM for real time applications
CO5: Apply pattern recognition techniques for biosignal and medical image applications

TOTAL: 75 PERIODS

REFERENCES

BM4012 DATA ANALYTICS FOR HEALTHCARE TECHNOLOGIES  L T P C  3 0 2 4

COURSE OBJECTIVES:
- To explore the various forms of electronic health care information.
- To learn the techniques adopted to analyse health care data.
- To understand the natural language based analytics
- To understand the predictive models for clinical data
- To gain knowledge health care analytics and its applications

UNIT I INTRODUCTION
UNIT II  DATA ANALYSIS  9
Biomedical Image Analysis- Mining of Sensor Data in Healthcare- Biomedical Signal Analysis- Genomic Data Analysis for Personalized Medicine

UNIT III  ANALYTICS  9
Natural Language Processing and Data Mining for Clinical Text- Mining the Biomedical -Social Media Analytics for Healthcare.

UNIT IV  ADVANCED ANALYTICS  9

UNIT V  APPLICATIONS  9

PRACTICAL EXERCISES:
1. Study of open source software
2. Data storage and retrieval on software
3. Creation of electronic patient record
4. Web page creation using HTML
5. Preprocessing the given dataset
6. User interface design
7. Univariate and Multivariate regression
8. Classification techniques

COURSE OUTCOMES:
CO1: Understand about health care analytics and benefits of Electronic health records.
CO2: Understand about Bio medical image analysis
CO3: Understand about Natural language processing and biomedical mining
CO4: Understand about information retrieval for health care.
CO5: Demonstrate about applications and practical systems for health care.

REFERENCES

TOTAL PERIODS: 45
30 PERIODS

TOTAL: 75 PERIODS
COURSE OBJECTIVES:
- To study about Fundamental Concept and Components of Virtual Reality
- To study about Interactive Techniques in Virtual Reality
- To study about Visual Computation in Virtual Reality
- To study about Augmented and Mixed Reality and Its Applications
- To know about I/O Interfaces and its functions.

UNIT I  INTRODUCTION TO VIRTUAL REALITY  9
Suggested Activities:
- Flipped classroom on uses of MR applications.
- Videos – Experience the virtual reality effect.
- Assignment on comparison of VR with traditional multimedia applications.
Suggested Evaluation Methods:
- Tutorial – Applications of MR.
- Quizzes on the displayed video and the special effects.

UNIT II  INTERACTIVE TECHNIQUES IN VIRTUAL REALITY  9
Suggested Activities:
- Flipped classroom on modeling three dimensional objects.
- External learning – Collision detection algorithms.
- Practical – Creating three dimensional models.
Suggested Evaluation Methods:
- Tutorial – Three dimensional modeling techniques.
- Brainstorming session on collision detection algorithms.
- Demonstration of three dimensional scene creation.

UNIT III  VISUAL COMPUTATION IN VIRTUAL REALITY  9
Suggested Activities:
- External learning – Different types of programming toolkits and Learn different types of available VR applications.
• Practical – Create VR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:
• Tutorial – VR tool comparison.
• Brainstorming session on tools and technologies used in VR.
• Demonstration of the created VR applications.

UNIT IV AUGMENTED AND MIXED REALITY

Taxonomy, technology and features of augmented reality, difference between AR and VR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications, mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems

Suggested Activities:
• External learning - AR Systems

Suggested Evaluation Methods:
• Brainstorming session different AR systems and environments.

UNIT V I/O INTERFACE IN VR & APPLICATION OF VR

Human factors: Introduction, the eye, the ear, the somatic senses. VR Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems. VR Software: Introduction, Modeling virtual world, Physical simulation, VR toolkits, Introduction to VRML, Input -- Tracker, Sensor, Digitalglobe, Movement Capture, Video-based Input, 3D Menus & 3DScanner etc. Output -- Visual /Auditory / Haptic Devices. VR Technology in Film & TV Production. VR Technology in Physical Exercises and Games. Demonstration of Digital Entertainment by VR.

Suggested Activities:
• External learning – Different types of sensing and tracking devices for creating mixed reality environments.
• Practical – Create MR scenes using any toolkit and develop applications.

Suggested Evaluation Methods:
• Tutorial – Mobile Interface Design.
• Brainstorming session on wearable computing devices and games design.
• Demonstration and evaluation of the developed MR application.

COURSE OUTCOMES:
CO1: Understand the Fundamental Concept and Components of Virtual Reality
CO2: Able to know the Interactive Techniques in Virtual Reality
CO3: Can know about Visual Computation in Virtual Reality
CO4: Able to know the concepts of Augmented and Mixed Reality and Its Applications
CO5: Know about I/O Interfaces and its functions.

TOTAL: 45 PERIODS
PRACTICALS: 30 PERIODS
1. Study of tools like Unity, Maya, 3DS MAX, AR toolkit, Vuforia and Blender.
2. Use the primitive objects and apply various projection methods by handling the camera.
3. Download objects from asset stores and apply various lighting and shading effects.
4. Model three dimensional objects using various modeling techniques and apply textures over them.
5. Create three dimensional realistic scenes and develop simple virtual reality enabled mobile applications which have limited interactivity.
6. Add audio and text special effects to the developed application.
7. Develop VR enabled applications using motion trackers and sensors incorporating full haptic interactivity.
8. Develop AR enabled applications with interactivity like E learning environment, Virtual walkthroughs and visualization of historic places.
10. Develop simple MR enabled gaming applications.

TOTAL: 75 PERIODS

REFERENCES

AUDIT COURSES
AX4091 ENGLISH FOR RESEARCH PAPER WRITING 2 0 0 0

COURSE OBJECTIVES:
- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check
UNIT IV  RESULT WRITING SKILLS  6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V  VERIFICATION SKILLS  6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

COURSE OUTCOMES:
CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES:

AX4092  DISASTER MANAGEMENT  L T P C  2 0 0 0

COURSE OBJECTIVES:
- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I  INTRODUCTION  6
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II  REPERCUSSIONS OF DISASTERS AND HAZARDS  6

UNIT III  DISASTER PRONE AREAS IN INDIA  6
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics
UNIT IV    DISASTER PREPAREDNESS AND MANAGEMENT    6
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk:
Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports:
Governmental and Community Preparedness.

UNIT V    RISK ASSESSMENT    6
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk
Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning,
People’s Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

COURSE OUTCOMES:
CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and
humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from
multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical
relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:
1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep
2. NishithaRai, Singh AK, “Disaster Management in India: Perspectives, issues and strategies
3. Sahni, PardeepEt.Al. ,” Disaster Mitigation Experiences And Reflections”, Prentice Hall OfIndia,
New Delhi,2001.

AX4093
CONSTITUTION OF INDIA

L T P C
2 0 0 0

COURSE OBJECTIVES:
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights
  perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional
  role and entitlement to civil and economic rights as well as the emergence nation
  hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik
  Revolutionin1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I    HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II    PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III    CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to
Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive
Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

UNIT VI ELECTION COMMISSION
Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING
1. The Constitution of India, 1950(Bare Act), Government Publication.
UNIT II

அறநநறியுடன் 6
1. அறநநறியுடன் சிறிய நடர்ந்தவர்
   - அறநநறியுடன் முன்னமை, அறநநறியுடன் முன்னமை, கொடு, புறம்
2. பின் அறநநறியுடன் - தூரக்குப்பாடற்கு
   - ராகா, சிறுப்பர்கலம், நீரக்கு, அளர்ச்சிக்கு (அம்பா அறநநறியுடன் போன)

UNIT III

இரட்டடக் காப்பியங்கள் 6
1. கணாணகியின் புரட்சி
   - சிறுப்பர்கலம் அறநநறியுடன் நடர்ந்த
2. மூக்கிய இலக்கியம்
   - சிற்பார்க்கு கொகாண்ட

UNIT IV

அறநநறியுடன் 6
1. சிறுப்பர்கலம்
   - பார்க்கு பார்க்கு பார்க்கு பார்க்கு, சிறுப்பர்கலம் பார்க்கு
2. பார்க்கு
   - சிறுப்பர்கலம் பார்க்கு
3. பார்க்கு (617, 618)
   - பார்க்கு பார்க்கு
4. காப்பியங்கள்
5. பார்க்கு
   - சிறுப்பர்கலம் காப்பியங்கள்
6. பார்க்கு (4)
   - பார்க்கு
   - பார்க்கு (11)
   - பார்க்கு
   - பார்க்கு (11)
   - பார்க்கு, பார்க்கு
   - பார்க்கு 50 (27)
   - பார்க்கு
   - சிறுப்பர்கலம் பார்க்கு பார்க்கு

UNIT V

நவீன தமிழிலக்கியம் 6
1. உகரநடத் தமிழ்
   - தமிழின் முதல் புதிய
   - தமிழின் முதல் சிறுககத
   - கட்டுகர இலக்கியம்
   - பயண இலக்கியம்
   - நொடகம்
   - நொட்டு விடுத்தகல
2. நொட்டு விடுத்தகலம்
3. முதொய விடுத்தகலயும்
4. தபண விடுத்தகலயும்
5. விளிம்பு நிகலயினரின் பமம்பொட்டில் தமிழ்
தமிழில் இலக்கியமும்  
5. அறிவியல் தமிழ்  
6. இகணயப் படமும் தமிழ் இலக்கியம்  
7.சுற்றுசூழல் பொட்டியில் தமிழ் இலக்கியம்  

TOTAL : 30 PERIODS

தமிழ் இலக்கிய வருவாய்ப் பல்கலைக்கழகங்கள்/பல்கலைக்கழகங்கள்

1. தமிழ் வில்லூ கல்வி கல்லூரிகள் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியொ (Tamil Wikipedia) - https://ta.wikipedia.org
3. டார்மபுர அகாதமி விளையாட்டு
4. பாரசநில் கல்லூரிகள்
   - தமிழ் பாரசநில் கல்லூரிகள்
5. கருங்கல்லு கல்லூரிகள்
   - தமிழ் மாநில கல்லூரிகள் (thamilvalarchithurai.com)
6. ஆர்யன்வாரியா கல்லூரிகள்
   - தமிழ் பாரசநில் கல்லூரிகள்