**ANNA UNIVERSITY, CHENNAI**
**NON- AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY**
**M.E. BIOMEDICAL ENGINEERING**
**REGULATIONS – 2021**
**CHOICE BASED CREDIT SYSTEM**

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. **PROGRAM SPECIFIC OUTCOMES (PSOs):**

   1. To acquire and understand the basic skill sets required for Biomedical Engineering.

   2. To implement the techniques and tools of Biomedical Engineering to address the needs of technology in healthcare domain.

   3. To address the technology associated with the interaction between living and non-living materials and systems

   4. To bridge the gap between healthcare / Medicine and technology doctors and Engineers

# ANNA UNIVERSITY, CHENNAI
## NON - AUTONOMOUS COLLEGES AFFILIATED ANNA UNIVERSITY
## M.E. BIOMEDICAL ENGINEERING
## REGULATIONS – 2021
## CHOICE BASED CREDIT SYSTEM
## I TO IV SEMESTERS CURRICULA AND 1st SEMESTER SYLLABI
## SEMESTER I

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA4152 | Advanced Applied Mathematics | FC | 3 | 1 | 0 | 4 | 4 |
| 2. | RM4151 | Research Methodology and IPR | RMC | 2 | 0 | 0 | 2 | 2 |
| 3. | BM4151 | Bio Signal Processing | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | BM4152 | Human Anatomy and Physiology | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | BM4101 | Medical Imaging Systems | PCC | 3 | 0 | 0 | 3 | 3 |
| 6. | BM4102 | Bio Medical Sensors, Instrumentation and   Equipment | PCC | 4 | 0 | 0 | 4 | 4 |
| 7. | | Audit Course – I* | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICALS** | | | | | | | | |
| 8. | BM4111 | Clinical Instrumentation and Design Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| 9. | BM4161 | Bio Signal Processing Laboratory | PCC | 0 | 0 | 3 | 3 | 1.5 |
| | | | **TOTAL** | **20** | **1** | **6** | **27** | **22** |

*Audit course is optional

## SEMESTER II

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | BM4201 | Medical Device Design | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | BM4202 | Bio Materials and Biomechanics | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | BM4203 | Applied Medical Image Processing | PCC | 3 | 0 | 2 | 5 | 4 |
| 4. | BM4251 | AI and Machine Learning | PCC | 3 | 0 | 2 | 5 | 4 |
| 5. | | Professional Elective I | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Professional Elective II | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Audit Course – II* | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICALS** | | | | | | | | |
| 8. | BM4211 | Medical Device Design Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | BM4212 | Term Paper and Seminar | EEC | 0 | 0 | 2 | 2 | 1 |
| | | | **TOTAL** | **20** | **0** | **10** | **30** | **23** |

*Audit course is optional

## SEMESTER III

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | | Professional Elective III | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | | Professional Elective VI | PEC | 3 | 0 | 2 | 5 | 4 |
| 3. | | Open Elective | OEC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 4. | BM4311 | Hospital / Biomedical Industry Training | EEC | 0 | 0 | 4 | 4 | 2 |
| 5. | BM4312 | Project Work I | EEC | 0 | 0 | 12 | 12 | 6 |
| | | | **TOTAL** | **9** | **0** | **18** | **27** | **18** |

## SEMESTER IV

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICALS** | | | | | | | | |
| 1. | BM4411 | Project Work II | EEC | 0 | 0 | 24 | 24 | 12 |
| | | | **TOTAL** | **0** | **0** | **24** | **24** | **12** |

**TOTAL NO. OF CREDITS: 75**

## PROFESSIONAL ELECTIVES
### SEMESTER II, PROFESSIONAL ELECTIVES - I

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | BM4001 | Diagnostic and Therapeutic Equipments | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | BM4073 | Rehabilitation Engineering | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | MX4072 | Medical Optics | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | MX4071 | Human Assist Devices | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | BM4002 | Micro and Nano Fluids | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | BM4072 | Medical Device Standards and Regulation | PEC | 3 | 0 | 0 | 3 | 3 |

## SEMESTER II, PROFESSIONAL ELECTIVES – II

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | BM4074 | Tele Health Technology | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | MX4073 | Medical Robotics | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | BM4075 | Wearable Technologies | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | BM4003 | Medical Ethics and Standards | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | BM4076 | Brain Computer Interface | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | DS4072 | Wavelet Transforms and Its Applications | PEC | 3 | 0 | 0 | 3 | 3 |

## SEMESTER III, PROFESSIONAL ELECTIVES – III

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | BM4004 | Hospital Planning, Organization and Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | BM4005 | Human Resource Management in Hospitals | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | BM4006 | Health Policy and Equipment Management | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | BM4007 | Hospital Waste management | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | BM4008 | Quality Assurance and Patient Safety standards in Hospitals | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | BM4071 | Genetic Algorithms and Fuzzy Logics | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | BM4009 | Tissue Engineering | PEC | 3 | 0 | 0 | 3 | 3 |

## SEMESTER III , PROFESSIONAL ELECTIVES – IV

| S. NO. | COURSE CODE | COURSE TITLE | CATE-GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | BM4010 | Embedded System and Internet of Things for Biomedical Applications | PEC | 3 | 0 | 2 | 5 | 4 |
| 2. | BM4011 | Medical Informatics | PEC | 3 | 0 | 2 | 5 | 4 |
| 3. | MX4074 | Pattern Recognition Techniques and Applications | PEC | 3 | 0 | 2 | 5 | 4 |
| 4. | BM4012 | Data Analytics for Health Care Technologies | PEC | 3 | 0 | 2 | 5 | 4 |
| 5. | MU4253 | Mixed Reality | PEC | 3 | 0 | 2 | 5 | 4 |

# AUDIT COURSES (AC)

## Registration for any of these courses is optional to students

| SL. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1. | AX4091 | English for Research Paper  Writing | 2 | 0 | 0 | 0 |
| 2. | AX4092 | Disaster Management | 2 | 0 | 0 | 0 |
| 3. | AX4093 | Constitution of India | 2 | 0 | 0 | 0 |
| 4. | AX4094 | நற்றமிழ் இலக்கியம் | 2 | 0 | 0 | 0 |

**MA4152**     **ADVANCED APPLIED MATHEMATICS**     **L T P C**
                                                     **3 1 0 4**

**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**
Vector spaces – Norms – Inner products – Eigenvalues using QR transformations – QR factorization – Generalized eigenvectors – Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations – Toeplitz matrices and some applications.

**UNIT – II     ONE DIMENSIONAL RANDOM VARIABLES                           12**
Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

**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**
Formulation – Graphical solution – Simplex method – Two phase method – Transportation and Assignment models.

**UNIT – V     FOURIER TRANSFORM FOR PARTIAL DIFFERENTIAL**
               **EQUATIONS                                                 12**
Fourier transforms:  Definitions, properties – Transform of elementary functions, Dirac Delta functions – Convolution theorem, Parseval's identity – Solutions to partial differential equation: Heat equations, Wave equations, Laplace and Poisson's equations.

                                                          **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:**

1. Andrews, L. C. and Philips. R.L., "Mathematical Techniques for engineering and scientists", Prentice Hall of India, New Delhi,2006.
2. Bronson, R.," Matrix Operation", Schaum's outline series, Tata McGrawHill, New York,2011.
3. O'Neil P.V.,, "Advanced Engineering Mathematics", Cengage Learning", 8th Edition, India, 2017.
4. Oliver C. Ibe, "Fundamentals of Applied Probability and Random Processes", Academic Press, Boston, 2014.
5. Sankara Rao,K., " Introduction to partial differential equations" Prentice Hall of India Pvt. Ltd., 3rd Edition, New Delhi,2010.
6. Taha H.A., "Operations Research: An Introduction", Ninth Edition, Pearson Education, Asia, 10th Edition, New Delhi, 2017.

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

## UNIT I RESEARCH DESIGN 6
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 6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods.
Data - Preparing, Exploring, examining and displaying.

## UNIT III DATA ANALYSIS AND REPORTING 6
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 6
Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

## UNIT V PATENTS 6
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

**TOTAL: 30 PERIODS**

**REFERENCES:**

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).

2.  Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3.  David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4.  The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

| BM4151 | BIO SIGNAL PROCESSING | L T P C |
|---|---|---|
| | | 3 0 0 3 |

## 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                    9**

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

**UNIT II          TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION        9**

Time series analysis – linear prediction models, process order estimation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG and HRV signals, model based ECG simulator. Spectral estimation – Blackman Tukey method, periodogram and model based estimation. Application in Heart rate variability, PCG signals.

**UNIT III          ADAPTIVE FILTERING AND WAVELET DETECTION         9**

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                         9**

Removal of artifact – ECG, Even detection –ECG, P Wave, QRS complex, T wave, Correction analysis of ECG signals, Average of Signals-PCG, ECG and EMG,

**UNIT V          BIOSIGNAL CLASSIFICATION AND RECOGNITION        9**

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:**
1. P.Ramesh Babu, —Digital Signal Processing, Sixth Edition, Scitech publications, Chennai, 2014.
2. Raghuveer M. Rao and AjithS.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000
3. Rangaraj M. Rangayyan, 2$^{nd}$ edition "Biomedical Signal Analysis-A case study approach", Wiley- Interscience /IEEE Press, 2015
4. Emmanuel C. Ifeachor, Barrie W.Jervis, second edition, "Digital Signal processing- A Practical Approach" Pearson education Ltd., 2002
5. Willis J.Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2006

| **BM4152** | **HUMAN ANATOMY AND PHYSIOLOGY** | **L** | **T** | **P** | **C** |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**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 being
- 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                                    8**

Organization of the human body: from atoms to the entire organism. Anatomical directions and planes. Cell structures and functions – Plasma membrane and sub-organelles. Cell membrane transport. Cell to cell signaling, Cell cycle and regulations. Action potential, Homeostasis, Types of specialized tissues

**UNIT II          INTEGUMENTARY, SKELETAL,  MUSCULAR AND                        9**
**                      RESPIRATORY SYSTEMS**

Skin: Structure of skin and their parts, Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton – Types of joints and function – Types of cartilage and function. Muscular: Parts of Muscle – Movements. Respiratory: Parts of Respiratory Systems – Types of respiration - Mechanisms of Breathing – Regulation of Respiration

**UNIT III          CARDIOVASCULAR, LYMPHATIC AND ENDOCRINE                    10**
**                        SYSTEMS**

Cardiovascular: Structure of Heart, Conducting System of Heart – Properties of Cardiac Muscle - Cardiac Cycle – Heart Beat – Types of Blood vessel – Regulation of Heart rate and Blood pressure. Blood: Components of Blood and functions.- Blood Groups and importance Lymphatic:

Types of Lymphatic organs and vessels – Functions. Endocrine: Pituitary and Thyroid glands

| UNIT IV | NERVOUS, SENSE ORGANS AND REPRODUCTIVE SYSTEMS | 10 |

Nervous: Structure, types and properties of Neuron, Mechanism of Nerve impulse. Brain: Structure and parts of brain – central and peripheral nervous system – Reflex mechanism. Sense: Structure and functions of eye and ear. Reproductive: Anatomy of testis and ovary

| UNIT V | DIGESTIVE AND URINARY SYSTEMS | 8 |

**Digestive:** Organs of Digestive system – Digestion and Absorption. **Urinary:** Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulation of Blood pressure by Urinary System – Urinary reflex

**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:**

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. 11<sup>th</sup> Edition, Pearson Publishers, 2014 -
2. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Fifth Edition , Oxford University Press, USA, 2017.
3. William F.Ganong, "Review of Medical Physiology", 22<sup>nd</sup> Edition, Mc Graw Hill, New Delhi, 2010.
4. Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", - 4<sup>th</sup> Edition , W.B. Saunders Company, 2015.
5. Guyton & Hall, "Medical Physiology", 13<sup>th</sup> Edition - Elsevier Saunders, 2015.
6. Elaine.N.Marieb, "Essential of Human Anatomy and Physiology", Eleventh Edition, Pearson Education, New Delhi, 2015.

| BM4101 | MEDICAL IMAGING SYSTEMS | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**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                                          9**

Principle and production of soft X – Rays, X- ray machine and digital radiography, principles of Angiography and Fluoroscopic Techniques, digital subtraction angiography, mammography.

**UNIT II          CT AND ULTRASOUND IMAGING                      9**

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          9**
                    **COMPUTED TOMOGRAPHY IMAGING**

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.

                                                          **TOTAL:45 PERIODS**

**REFERENCES:**
1. Richard L. Van Metter, Jacob Beutel, Harold L. Kundel, Handbook of Medical Imaging,
2. Volume 1. Physics and Psychophysics, SPIE, 2000
3. Chesney D. N., Chesney M. O. Radio graphic imaging, CBS Publications, New Delhi, 1989
4. Donald W. McRobbice, Elizabeth A. Moore, Martin J. Grave and Martin R. Prince MRI
5. from Picture to proton, Cambridge University press, second edition, New York 2007.

Anna University, Polytechnic & Schools

6. Frederick W Kremkau, Diagnostic Ultrasound Principles & Instruments, Saunders Elsevier,2005.
7. Jerry L. Prince, Jnathan M. Links, Medical Imaging Signals and Systems- Pearson
8. Education Inc. 2014.
9. Peggy, W., Roger D. Ferimarch, MRI for Technologists, McGraw Hill, New York, second edition, 2000.

| BM4102 | BIO MEDICAL SENSORS, INSTRUMENTATION AND EQUIPMENT | L T P C<br>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                        11**
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                        11**
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                        14**
Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Biosignals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode.

**UNIT IV          DESIGN OF BIOAMPLIFIERS                        12**
Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance
matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering.

**UNIT V          MEDICAL EQUIPMENT                        12**
Basics of Critical Care Equipment – Bedside monitors, ICU / CCU equipment – Defibrillator and its types, Pacemaker and its types. Ventilator and its types, Dialysers, Endoscopy, laparoscopy, Oxygenators.

**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:**

1. Geddes LA and Baker L.E Principals of Applied Biomedical Instrumentation, 3<sup>rd</sup> Edition, John Wiley and sons, New york 1989

2. Joseph J Carr and John Brown – Introduction to Biomedical equipment Technology- Pearson Education 4<sup>th</sup> edition New Delhi 2001

3. Khandpur R.S Hand Book of Biomedical Instrumentation – Tata Mc Graw Hill publication , New Delhi 3<sup>rd</sup> edition 2014

4. Webster J.G Medical Instrumentation application and design – John Wiley and sons New York 4<sup>th</sup> edition 2009

5. Leslie Cromwell, Biomedical Instrumentation and measurement, Prentice Hall of India, New Delhi, 2<sup>nd</sup> edition, 2015

6. Richard Aston, Principles of Biomedical Instrumentation and Measurement, Merril Publishing Company, 2002

| BM4111 | CLINICAL INSTRUMENTATION AND DESIGN LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 3 | 1.5 |

**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

**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.

**TOTAL:45 PERIODS**

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**BM4161**       **BIO SIGNAL PROCESSING LABORATORY**      **L T P C**
                                                                                     **0 0 3 1.5**

**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

**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

**TOTAL:45 PERIODS**

**AX4091**    **ENGLISH FOR RESEARCH PAPER WRITING**  **L  T  P C**
                               **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**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

**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

                     **TOTAL: 30 PERIODS**

**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:**
1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's
   book 1998.

**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**
Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

**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 Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
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 Revolutionin1917and 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**

District's Administration head: Role and Importance, ☐Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

**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.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

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|---|---|---|
| **AX4094** | **நற்றமிழ் இலக்கியம்** | **L T P C**<br>**2 0 0 0** |

**UNIT I      சங்க இலக்கியம்**                                          **6**

1.தமிழின் துவக்க நூல் தொல்காப்பியம்

 – எழுத்து, சொல், பொருள்

2.அகநானூறு (82)

 - இயற்கை இன்னிசை அரங்கம்

3.குறிஞ்சிப் பாட்டின் மலர்க்காட்சி

4.புறநானூறு (95,195)

 - போரை நிறுத்திய ஒளவையார்

**UNIT II      அறநெறித் தமிழ்**                                          **6**

1.      அறநெறி வகுத்த திருவள்ளுவர்

- அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்

2. பிற அறநூல்கள் - இலக்கிய மருந்து

– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல் )

**UNIT III      இரட்டைக் காப்பியங்கள்**                                          **6**

1. கண்ணகியின் புரட்சி

 - சிலப்பதிகார வழக்குரை காதை

2. சமூகசேவை இலக்கியம் மணிமேகலை

 - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

**UNIT IV      அருள்நெறித் தமிழ்**                                          **6**

1. சிறுபாணாற்றுப்படை

 - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப்

போர்வை கொடுத்தது, அதியமான் ஒளவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்

2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு

3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்

4. தர்மச்சாலையை நிறுவிய வள்ளலார்

5. புறநானூறு
   - சிறுவனே வள்ளலானான்

6. அகநானூறு (4)      - வண்டு
   நற்றிணை (11)       - நண்டு
   கலித்தொகை (11)    - யானை, புறா
   ஐந்திணை 50 (27)   - மான்
   ஆகியவை பற்றிய செய்திகள்

**UNIT V      நவீன தமிழ் இலக்கியம்                                    6**

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

                                                        **TOTAL : 30 PERIODS**

**தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்**

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)
   - www.tamilvu.org

2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)
   - https://ta.wikipedia.org

3. தர்மபுர ஆதின வெளியீடு

4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)

6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்