B. Tech. - Biomedical Engineering

SYLLABUS

SHOBHIT INSTITUTE OF ENGINEERINGAND TECHNOLOGY, MEERUT
(Deemed to-be-University)

Approved and adopted in year 2018 (Board of Studies, August 3, 2018)
by 23rd Academic council (Agenda no-03)

B. Tech. Biomedical Engineering

Overview: Biomedical engineering is identified as one of the niche engineering branches in the country which deals with the study of engineering principles. These principles are further combined with the principals of medical sciences aiming to streamline the healthcare services in the country.

The health care expenditure is likely to witness an increase due to the rise of awareness and population growth. Furthermore, spreading awareness of medical advancements have led to an increase in the number of people seeking biomedical solutions for their health issues. This will eventually witness a rise in the employment graph of biomedical engineers. These facts are evident to prove that the growth rate of biomedical engineers is likely to be much faster than the average pace for all the existing occupations.

The study of biomedical engineering involves a broad array of diagnostic and therapeutic applications. This branch of engineering and sciences is a fascinating multidisciplinary area of study that entails the application of engineering techniques in order to assist practitioners like doctors and physicians in their healthcare practices. Study of this branch also helps them in the rehabilitation of disabled patients.

Program Outcome: Upon completion of the B. Tech. Biomedical Engineering programme, students will be ae to:

Successfully practice biomedical engineering to serve state and regional industries, hospitals, government agencies, or national and international industries. Work professionally in one or more of the following areas: biomedical electronics, medical instrumentation, medical imaging, biomedical signal processing, rehabilitation engineering, and neuro engineering. Achieve personal and professional success with awareness and commitment to their ethical and social responsibilities, both as individuals and in team environments.

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcome:

The Biomedical Sciences MSc provides opportunities for students to develop and broaden their knowledge and research skills and better prepare for future employment or specialist postgraduate research. Biomedical Sciences MSc graduates significantly enhance their employability by developing their subject-specific knowledge in the field of biomedical science and their analytical and research skills. Students gain an appreciation of how important biomedical science is to global healthcare and can approach international employers with confidence. In addition, the programme enhances student presentational and key skills enabling students to compete effectively in the job market.

PSO1: Bio- Analysis: Apply mathematical analysis for human paradigm, to problems, thereby to interface engineering and life science.

PSO2: Data Interpretation and Problem Solving: Make measurements on and interpret data from physiological systems and decipher the problems associated with the interaction between living and non-living materials and systems.

PSO3: Collaborative and Multidisciplinary work: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.

Eligibility Criteria:

B.Tech in Bio-Medical Engineering (B.Tech BME) is an undergraduate course of engineering practices and design in medical and healthcare business. The minimum eligibility for this course requires passing class 12th/ Higher Secondary Examination Biology, Maths with a minimum of 50% marks for general students and 46% for SC/ST students.

Credit Distribution (Year Wise) :

S.No.	Criteria	I	II	III	IV	Total
1.	Core Biomedical (BMC)		28	19	24	71
2.	Departmental Elective (BMD)		0	12	9	21
3.	Mandatory (MCC)		0	0	0	0

4.	**Applies Sciences (BAS)**		6	0	0	6
5.	**General Elective (ECC/CSC)**		3	12	3	18
6.	**Humanities (HSS)**		6	0	0	6
	Total		**43**	**43**	**36**	**116**

Changes: Addition of **Biology for engineers** and Remedial Mathematics III in III Sem; Biomedical Sensor and Transducers in IV Sem and Remedial Mathematics III in IV Sem; Addition of Minor Project from III-VII Semester; Addition of Mandatory courses (Essence of Indian Traditional Knowledge; Cyber Security; Indian Constitution)

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SCHOOL OF BIOLOGICAL ENGINEERING & LIFE SCIENCES
DEPARTMENT OF BIOMEDICAL and BIOINFORMATICS ENGINEERING
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TEACHING SCHEME
(B. TECH. - BIOMEDICAL ENGINEERING)

SCHEME OF TEACHING – B. TECH. (BM) SECOND YEAR (Third Semester)

S. No.	Subject	Subject Code	Credit	L	T	P
1.	Management Concept and Practices	HSS-308	3	3	0	0
2.	Biology for Engineers	BAS-311	3	3	0	0
3.	Remedial Mathematics III	BAS-309	3	3	0	0
4.	Human Anatomy and Physiology	BMC-301	4	3	1	0
5.	Elements of Biochemistry	BMC-302	3	3	0	0
6.	Basic Biomedical Engineering	BMC-303	3	3	0	0
7.	Anatomy and Physiology Lab.	BMC-351	1	0	0	2
8.	Biochemistry Lab.	BMC-352	1	0	0	2
9.	Minor Project-I	BMC -371	1	0	0	2
10.	Essence of Indian Traditional Knowledge	MCC-301	0	3	0	0
		Total	22			

SCHEME OF TEACHING – B. TECH. (BM) SECOND YEAR (Fourth semester)

S. No.	Subject	Subject Code	Credit	L	T	P
1.	Entrepreneurship	HSS-403	3	3	0	0
2.	Network and Systems	ECC-408	3	3	0	0
3.	Linear Integrated Circuits	BMC-401	4	3	1	0
4.	Biomedical instrumentation-I	BMC-402	4	3	1	0
5.	Biomedical Sensor and Transducers	BMC- 403	3	3	0	0
6.	Linear Integrated Circuits Lab.	BMC- 451	1	0	0	2
7.	Biomedical instrumentation Lab. - 1	BMC- 452	1	0	0	2
8.	Biomedical Sensor and Transducers Lab	BMC -453	1	0	0	2
9.	Minor Project-II	BMC -471	1	0	0	2
10.	Environmental Sciences	MCC- 401	0	3	0	0
		Total	21			

SCHEME OF TEACHING – B. TECH. (BM) Third YEAR (Fifth semester)

S. No.	Subject	Subject Code	Credit	L	T	P
1.	Biomedical Image Processing	BMC-501	4	3	1	0
2.	Genetics Engineering and its Applications	BMC-502	3	3	0	0
3.	Biomaterials (Elective-I)	BMD-501	3	3	0	0
4.	Biomechanics (Elective-II)	BMD-502	3	3	0	0
5.	Fundamentals of Signals and Systems	ECC-507	3	3	0	0
6.	Digital Electronics	ECC-508	3	3	0	0
7.	Biomedical Image Processing Lab	BMC-551	1	0	0	2
8.	Minor Project-III	BMC-571	1	0	0	2
9.	Cyber Security	MCC- 501	0	3	0	0
		Total	21			

SCHEME OF TEACHING – B. TECH. (BM) Third YEAR (Sixth semester)

S. No.	Subject	Subject Code	Credit	L	T	P
1.	Biomedical Signal Processing	BMC-601	4	3	1	0
2.	Biomedical Instrumentation-II	BMC-602	3	3	0	0
3.	Nanomedicine (Elective-III)	BMD-601	3	3	0	0
4.	Microprocessor and its Application (Elective-IV)	BMD-602	3	3	0	0
5.	Control System	ECC-607	3	3	0	0
6.	Wireless Communication and Telemedicine	ECC-608	3	3	0	0
7.	Signal Processing Lab.	BMC-651	1	0	0	2
8.	Biomedical Instrumentation Lab. -II	BMC-652	1	0	0	2
9.	Minor Project-IV	BMC-671	1	0	0	2
10.	Indian Constitution	MCC-601	0	3	0	0
		Total	22			

SCHEME OF TEACHING – B. TECH. BM Fourth YEAR (Seventh Semester)

S. No.	Subject	Subject Code	Credit	L	T	P
1.	Biomedical Instrumentation-III	BMC-701	3	3	0	0
2.	Hospital Management	BMC-702	3	3	0	0
3.	Quality Control in Biomedical Engineering (Elective-V)	BMD-701	3	3	0	0
4.	Biomedical Ethics and IPR (Elective-VI)	BMD-702	3	3	0	0
5.	Embedded System in Biomedical Engineering (Elective-VII)	BMD-703	3	3	0	0
6.	Artificial Intelligence and Neural Network	CSC-708	3	3	0	0
7.	Biomedical Instrumentation Lab-III	BMC-751	1	0	0	2
8.	Hospital Management Case studies	BMC-752	1	0	0	2
9.	Minor Project-V	BMC-771	1	0	0	2
10.	Technical Report Writing	MCC-708	0	3	0	0
		Total	21			

S. No.	Subject	Subject Code	Credit	L	T	P
1.	Seminar, Project Work and Internship (BMC_ 61/71/81)	BMC-	15			
		Total	15			

SCHEME OF TEACHING – B. TECH. BM Fourth YEAR (Eight Semester)

Course code	**HSS-308**				
Category	**HUMANITIES**				
Course title	**MANAGEMENT CONCEPT AND PRACTICES**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	Management by objectives (MBO) is a strategic management model that aims to improve the performance of an organization by clearly defining objectives that are agreed to by both management and employees.				
Outcomes	Describe the primary functions of management and the roles of managers.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Definition of Management –** Nature- Science or Art – Management and Administration – Development of Management Thought – Contribution of Taylor and Fayol – Functions of Management – Types of Business Organisation.	**6 Hrs**
Unit-2	**Planning -**Nature & Purpose – Steps involved in Planning – Objectives – Setting Objectives – Process of Managing by Objectives – Strategies, Policies & Planning Premises- Forecasting – Decision-making.	**6Hrs**
Unit-3	**Nature and Purpose –** Formal and informal organization – Organization Chart – Structure and Process–Departmentation by difference strategies – Line and Staff authority – Benefits and Limitations–De-Centralization and Delegation of Authority – Staffing – Selection Process - Techniques .	**6Hrs**
Unit-4	**Scope –** Human Factors – Creativity and Innovation – Harmonizing Objectives – Leadership – Types of Leadership Motivation – Hierarchy of needs – Motivation theories – Motivational Techniques – Job Enrichment – Communication – Process of Communication – Barriers and Breakdown – Effective Communication – Electronic media in Communication.	**6Hrs**

Unit-5	**System and process of Controlling –** Requirements for effective control–The Budget as Control Technique–Information Technology in Controlling – Use of computers in handling the information– Productivity –Problems and Management –Control of Overall Performance – Direct and Preventive Control– Reporting–The Global Environment–Globalization and Liberalization–International Management and Global theory of Management.	**6Hrs**
References	1. Harold Kooritz& Heinz Weihrich "Essentials of Management", Tata McGraw-Hill, 1998. 2. Joseph L Massie "Essentials of Management", Prentice Hall of India, (Pearson) Fourth Edition, 2003. 3. Tripathy PC And Reddy PN, "Principles of Management", Tata McGraw-Hill, 1999. 4. Decenzo David, Robbin Stephen A, "Personnel and Human Reasons Management", Prentice Hall of India, 1996 5. JAF Stomer, Freeman R. E and Daniel R Gilbert, Management, Pearson Education, Sixth Edition, 2004. 6. Fraidoon Mazda, " Engineering Management", Addison Wesley,-2000	

Course code	**BAS-311**				
Category	**APPLIED SCIENCES**				
Course title	**BIOLOGY FOR ENGINEERS**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	To introduce students to modem biology with an emphasis on evolution of biology as a multi-disciplinary field, to make them aware of application of engineering principles in biology, and engineering robust solutions inspired by biological examples.				
Outcomes	• Learn Common Features of Biology and Living Things • Examines common features of living things • Basic Compounds in the Structure of Living Things				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Basic cell biology:** Introduction: Methods of Science-Living Organisms: Cells and Cell theory Cell Structure and Function, Genetic information, protein synthesis, and protein structure, Cell metabolism-Homoeostasis- Cell growth, reproduction, and differentiation.				**6 Hrs**
Unit-2	**Biochemistry and molecular aspects of life:** Biological Diversity --Chemistry of life: chemical bonds--Biochemistry and Human biology--Protein synthesis—Stem cells and Tissue engineering.				**6Hrs**
Unit-3	**Enzymes and industrial applications:** Enzymes: Biological catalysts, Proteases, Carbonic anhydrase, Restriction enzymes, and Nucleoside monophosphate kinases—Photosynthesis.				**6Hrs**
Unit-4	**Mechanochemistry:** MolecularMachines/Motors,Cytoskeleton,Bioremediation,Biosensors .				**6 Hrs**
Unit-5	**Nervous system, immune system, and cell signaling:** Nervous system--Immune system- General principles of cell signalling.				**6Hrs**
Reference	1. Jeremy M. Berg, John L. Tymoczko and LubertStryer, “Biochemistry,”				

s	W.H. Freeman and Co. Ltd., 6th Ed., 2006. 2. Robert Weaver, "Molecular Biology," MCGraw-Hill, 5th Edition, 2012. 3. Jon Cooper, "Biosensors A Practical Approach" Bellwether Books, 2004. 4. Martin Alexander, "Biodegradation and Bioremediation," Academic Press, 1994. 5. Kenneth Murphy, "Janeway's Immunobiology," Garland Science; 8th edition, 2011. 6. Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, "Principles of Neural Science, McGraw-Hill, 5th Edition, 2012. 7. S. ThyagaRajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "Biology for Engineers," Tata McGraw-Hill, New Delhi, 2012.

Course code	**BAS-309**				
Category	**APPLIED SCIENCES**				
Course title	**REMEDIAL MATHEMATICS III**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• Recognize that mathematics permeates the world around us • Appreciate the usefulness, power and beauty of mathematics • Enjoy mathematics and develop patience and persistence when solving problems				
Outcomes	• Become confident in using mathematics to analyse and solve problems both in school and in real-life situations • Develop the knowledge, skills and attitudes necessary to pursue further studies in mathematics • Develop abstract, logical and critical thinking and the ability to reflect critically upon their work and the work of others				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Linear Algebra and calculus :** Matrix algebra, systems of linear equations, Eigenvalues and Eigenvectors. Calculus: Mean value theorems, theorems of integral calculus, partial derivatives, maxima and minima, multiple integrals, Fourier series, vector identities, line, surface and volume integrals, Stokes, Gauss and Green's theorems.				**6 Hrs**
Unit-2	**Differential equations:** First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of parameters, Cauchy's and Euler's equations, initial and boundary value problems, solution of partial differential equations: variable separable method.				**6Hrs**
Unit-3	**Analysis of complex variables:** Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent's series, residue theorem, solution of integrals.				**6Hrs**

Unit-4	**Probability and Statistics:** Sampling theorems, conditional probability, mean, median, mode and standard deviation, random variables, discrete and continuous distributions: normal, Poisson and binomial distributions. Tests of Significance, statistical power analysis, and sample size estimation. Regression and correlation analysis.	**6 Hrs**
Unit-5	**Numerical Methods:** Matrix inversion, solutions of nonlinear algebraic equations, iterative methods for solving differential equations, numerical integration.	**6Hrs**
References	1. Higher Engineering Mathematics –B S Grewal. 2. Advanced Engineering Mathematics – HK Dass. 3. Advanced Engineering Mathematics – Erwin Kreyszig. 4. Engineering and Mathematics general aptitude – G.K Publications.	

Course code	**BMC-301**				
Category	**CORE BIOMEDICAL**				
Course title	**HUMAN ANATOMY AND PHYSIOLOGY**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	• To understand the internal environment of human body and homeostasis mechanism. • To provide the basic knowledge of different types of tissues. • To provide the knowledge of structure and functioning of nervous system, cardiovascular system, respiratory system, digestive system and musculoskeletal system. • To provide the knowledge of physiological parameters of normal health and factors affecting various physiological processes in the body.				
Outcomes	• Describe internal environment of human body and explain the fundamental concept of homeostasis. • Explain the structure and functioning of various types of tissues. • Describe the structure and explain the functioning of various nervous system, cardiovascularsystem, respiratory system, digestive system and musculoskeletal system. • Demonstrate and analyze various physiological parameters in normal and abnormal conditions.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Introduction human body -cell, blood:**Overview of organ systems, Basic terminologies (Directional, regional, planes, feedback) - Cell: Different types of cells, Cell Structure and its organelles - Functions of each component in the cell - Membrane – transport across membrane - Origin of cell membrane potential - Action potential and propagation - Blood-Composition-RBC, WBC and Platelets.				**8 Hrs**
Unit-2	**Cardiovascular and respiratory systems:**Structure of heart - Circulation types - Cardiac cycle- Volume and pressure changes - ECG - Heart sounds - Blood pressure -Regulation of BP - Parts of				**8 Hrs**

	respiratory system , Mechanics of respiration - Carbon dioxide and oxygen transport - Regulation of respiration - Volumes and capacities of lung, Types of hypoxia.	
Unit-3	**Nervous system and musculoskeletal system:**Nerve cell anatomy -Functions of nervous system - Brain anatomy and hemispheres Meninges - Cerebro Spinal Fluid-Circulation and Absorption-Spinal cord anatomy - Reflex action-PNS - Skeletal System -Functions -Anatomy of long bone –Formation, growth and repair - Structural and functional classification of joints - Functions of muscular system –Types of muscles - Sliding Filament Model - Neuromuscular junction - Physiology of muscle contraction.	**8 Hrs**
Unit-4	**Digestive and excretory system:** Digestive system-Organization -Movements of GI tract - Digestion at various parts (Mouth to Large Intestine) - Accessory organs of Digestion(Salivary glands, Liver, Pancreas, Gall Bladder)– Defecation - Excretory System - Functions of urinary system - Microanatomy and functions of nephron - Physiology of urine formation – Micturition.	**6 Hrs**
Unit-5	**Special organs and endocrine glands:** Eyes-retina Layers, Visual Pathway - Internal ear-Physiology-Auditory Pathway - Sense of Taste - Sense of Smell, touch - Endocrine glands-different glands and their hormones - Pituitary, Thyroid Parathyroid glands-Secretions - Maintenance of Calcium homeostasis - Maintenance of glucose homeostasis.	**10 Hrs**
References	Arthur.C.Guyton, John E Hall, “Textbook of Medical Physiology”, W.B. Saunders Company, Twelfth edition, 2006.	

Course code	**BMC-302**				
Category	**CORE BIOMEDICAL**				
Course title	**ELEMENTS OF BIOCHEMISTRY**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	By the end of the course, the students should be able to demonstrate advanced knowledge and understanding in the following core areas of proteins, enzymes, saccharides and fatty acids.				
Outcomes	The course aims to provide an advanced understanding of the core principles and topics of Biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of selected aspects by means of a stem/branch lecture series.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction:** Prokaryotes, Eukaryotes, Microscopy, Cellular fractionation. Membrane lipids, Membrane protein and carbohydrate, Membrane transport: small molecules, Membrane transport: macromolecules, Signal transduction.	**8 Hrs**
Unit-2	**Proteins:** Amino acids, Acids and bases, Protein structure, Myoglobin and haemoglobin, Collagen, Protein purification, Chromatography of proteins, Electrophoresis of proteins, Protein sequencing and peptide synthesis. The genetic code, Translation in prokaryotes, Translation in eukaryotes, Protein targeting, Protein glycosylation	**8 Hrs**
Unit-3	**Enzymes:** Introduction to enzymes, Thermodynamics, Enzyme kinetics, Enzyme inhibition, Regulation of enzyme activity. The immune system, Antibody structure, Polyclonal and monoclonal antibodies, Antibody synthesis, Antibodies as tools	**8 Hrs**
Unit-4	**Saccharides:** Monosaccharides and disaccharides, Polysaccharides and oligosaccharides, Glycolysis, Gluconeogenesis, Pentose phosphate pathway, Glycogen metabolism, Control of glycogen metabolism	**8 Hrs**
Unit-5	**Fatty acids:** Structures and roles of fatty acids, Fatty acid breakdown, Fatty acid synthesis, Triacylglycerols, Cholesterol, Lipoproteins. Citric acid cycle, Electron transport and oxidative	**8 Hrs**

	phosphorylation. Vitamins.	
References	1. Lehninger's Principle of Biochemistry**:** Nelson, L. D. and M. M Cox, Macmillan, Worth Publication Inc. 2. Biochemistry – StryerLubert , W.H. freeman and co , New York , 3. Fundamental of Biochemistry**:** Voet&Voet, John Wiley and Sons. 4. Biochemistry**:** Powar and Chatwal, Himalaya Publishing House 5. Biochemistry**:** Satyanarayana U., Books and Allied Pvt. Ltd. Calcutta.	

Course code	**BMC-303**				
Category	**CORE BIOMEDICAL**				
Course title	**BASIC BIOMEDICAL ENGINEERING**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• Gain the knowledge of basic of human anatomy. • Acquire the knowledge of transducer applications to access the biological signals. • Access the performance of various biomechanics principal. • Acquire the basics of measurement system. • Acquire basic knowledge of modelling.				
Outcomes	• Memorize basic human anatomy and biomedical engineering. • Knowledge of mechanics. • Illustrate instrumentation system. • Contrast different imaging instruments. • Explain the technology in the measurement field.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction:** Introduction to Biomedical Engineering, Roles Played by Biomedical Engineers, Professional Status of Biomedical Engineering. Introduction: Anatomy and Physiology, Cellular Organization, Tissues, Major Organ Systems and Homeostasis.	**6Hrs**
Unit-2	**Bio mechanics:** Introduction to Biomechanics, Basic Mechanics, Mechanics of Materials, Viscoelastic Properties, Cartilage, Ligament, Tendon, and Muscle, Clinical Gait Analysis, Cardiovascular Dynamics. Introduction: Rehabilitation Engineering and Assistive Technology, Principles of Rehabilitation Engineering, Introduction of Biomaterials in Medicine: From Prosthetics to Regeneration, Tissue-Biomaterial Interactions, Tissue Engineering.	**6Hrs**
Unit-3	**Bioinstrumentation:** Introduction to basic Bioinstrumentation System, Bioinstrumentation Design, Introduction to Biomedical	**6 Hrs**

	Sensors, Basic Biophysics, Equivalent Circuit Model for the Cell Membrane Hodgkin–Huxley Model of the Action Potential. Introduction to Origin, Characteristics and Acquisition of Biosignals	
Unit-4	**Medical Imaging:** Instrumentation and Imaging Devices, Radiographic Imaging Systems, Introduction of Diagnostic Ultrasound Imaging, Magnetic Resonance Imaging (MRI), Biomedical Optical Imaging, Fundamentals of Light Propagation in Biological Tissue, Physical Interaction of Light and Physical Sensing, Biochemical Measurement Techniques Using Light, Fundamentals of Therapeutic Effects of Lasers	**6Hrs**
Unit-5	**Physiological modelling:** Fundamentals of Physiological Modeling, An Overview of Eye Movement Model, Introduction of Biomedical Informatics and Computational Biology Technologies. Biomedical Morality and Ethics: A Definition of Terms, Regulation of Medical Device Innovation Marketing Medical Devices, The Role of the Biomedical Engineer in the FDA Process.	**6Hrs**
References	1. R. S. Khandpur, Handbook of Bio-Medical Instrumentation, Tata McGraw Hill, India, 2005. 2. L.a. Geddes, L.e. Baker, Principles of Applied Biomedical Instrumentation, 3rd edn., Wiley India Pvt. Ltd, New Delhi, 2008. 3. J. D. Bronzino, Biomedical Engineering & Instrumentation, CRC Publication, Boca Raton, FL, 2006. 4. A. C. Guyton and E. Hall, Textbook of Medical Physiology, 11th edn., Elsevier. 2005. 5. D. V. Rai, R. C Sobti and R. Bahadur, Emerging Trends in Biomedical Science and Health. I.K. International, Chandigarh, India, 2009.	

Course code	**BMC-351**				
Category	**CORE BIOMEDICAL**				
Course title	**ANATOMY AND PHYSIOLOGY LAB.**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	1	0	0	2	
Pre-requisites (if any)	Nil				
Objectives	To inculcate the students with the basic knowledge of the human body and their functioning.				
Outcomes	Students will get the knowledge of theHuman body -cell, blood, Cardiovascular And Respiratory Systems etc. and would be able to use its knowledge for Instruments Development.				
	LIST OF EXPERIMENTS Anatomy and Physiology of Major Human body Systems: **1.** Skeleton System **2.** Cardiovascular System **3.** Respiratory System **4.** Nervous System **5.** Musculoskeletal System **6.** Digestive system **7.** Excretory System **8.** Sensory Organ				
References	Departmental Lab reference manual				

Course code	**BMC-352**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOCHEMISTRY LAB.**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	1	0	0	2	
Pre-requisites (if any)	Nil				
Objectives	• Learn fundamental approaches for experimentally investigating biochemical problems, • Learn the theoretical foundations for the methods used • Understand the applicability of the biochemical methods to realistic situations.				
Outcomes	Biochemistry Majors will be able to demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules, metabolic pathways, and the regulation of biological/biochemical processes.				
	LIST OF EXPERIMENTS 1. Units of volume, weight, density and concentration measurements and their range in biological measurements. Demonstration of proper use of volume and weight measurement devices. 2. Preparation of different types of buffer. 3. Qualitative method for carbohydrates-distinguishing reducing from non-reducing sugar and keto- from aldol- sugar. 4. Quantitative and chromatographic method for amino acids estimation using ninhydrin reagent for distinguishing amino from amino acid. 5. Protein estimation by Biuret, Bradford and Lowry method. 6. Extraction of chloroplast pigments, anthocyanin, carotenoids estimation and qualitative analysis by paper chromatography. 7. Estimation of sugars by enthrone method. 8. Determination of enzyme activity and effect of different factors. 9. Determination of permeability of β-canines across the membrane. 10. Determination of K_m and $V_{max.}$				
References	Departmental Lab reference manual				

Course code	**MCC-301**				
Category	**MANDATORY**				
Course title	**ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	0	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• **To get a knowledge in Indian Philosophical Foundations.** • To Know Indian Languages and Literature and the fine arts in India & Their Philosophy. • To explore the Science and Scientists of Medieval and Modern India				
Outcomes	• Understand philosophy of Indian culture. • Distinguish the Indian languages and literature among difference traditions. • Learn the philosophy of ancient, medieval and modern India. • Acquire the information about the fine arts in India. • Know the contribution of scientists of different eras. • The essence of Yogic Science for Inclusiveness of society.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Introduction to traditional knowledge:** Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, the physical and social contexts in which traditional knowledge develop, the historical impact of social change on traditional knowledge systems. Indigenous Knowledge (IK), characteristics, traditional knowledge vis-à-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge vis-à-vis formal knowledge				**6Hrs**
Unit-2	**Protection of traditional knowledge:** the need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.				**6Hrs**
Unit-3	**Legal frame work and TK:A:** The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); B: The Biological Diversity Act 2002 and Rules				**6Hrs**

	2004, the protection of traditional Knowledge bill, 2016. Geographical indicators act 2003.	
Unit-4	**Traditional knowledge and intellectual property:** Systems of traditional knowledge, protection, Legal concepts for the protection of traditional knowledge, Certain non IPR mechanisms of traditional knowledge protection, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, global legal FORA for increasing protection of Indian Traditional Knowledge.	**6Hrs**
Unit-5	**Traditional knowledge in different sectors:** Traditional knowledge and engineering,Traditional medicine system, TK and biotechnology, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation andsustainable development of environment, Management of biodiversity, Food security of the country and protection of TK.	**6Hrs**
References	1. Traditional Knowledge System in India, by Amit Jha, 2009. 2. Traditional Knowledge System and Technology in India by Basanta Kumar Mohanta andVipin Kumar Singh, Pratibha Prakashan 2012. 3. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002 4. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino	

Course code	**HSS-403**				
Category	**HUMANITIES**				
Course title	**ENTREPRENEURSHIP**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• Entrepreneurship and Innovation minors will develop and cultivate endurance. • Students increase their awareness and deliberately practice the skills and disciplines necessary to increase confidence and agency; foster self-efficacy and self-advocacy. • Improve communication and problem-solving skills, manage strong impulses and feelings; and identify personal purpose.				
Outcomes	• Entrepreneurship and Innovation minors will be able to sell themselves and their ideas. Students master oral and visual presentation skills and establish a foundation of confidence in the skills necessary to cause others to act. • Entrepreneurship and Innovation minors will be able to find problems worth solving. Students advance their skills in customer development, customer validation, competitive analysis, and iteration while utilizing design thinking and process tools to evaluate in real-world problems and projects.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Introduction:** Concept and need of Entrepreneurship, Definition of Entrepreneur, Entrepreneurship innovation, Creativity, Business idea, Entrepreneurship as a career, Entrepreneurship as a style of management, the changing role of the entrepreneur, Entrepreneurial traits.				**8 Hrs**
Unit-2	**Influences:**Influences on entrepreneurship development, External influences entrepreneurship development, Socio-cultural, political, economical, personal entrepreneurial success and failure: reasons and remedies, women entrepreneurs, Challenge to women entrepreneurs, achievements of women entrepreneurs.				**10Hrs**

Unit-3	**Business plan:** The business plan as an entrepreneurial tool; elements of businessman ;objectives ;market analysis; development of product/idea; marketing, finance, organization and management ;ownership; critical risk contingencies of the proposal ;scheduling and milestones.	**10Hrs**
Unit-4	**Reports:** Technical,financial,marketing personnel,and management feasibility reports; financial schemes offered by various financial institution, like commercial Banks, IDBI, ICICI, SIDBI, SFCs.	**6Hrs**
Unit-5	**Government Role:**Role of central government and state government in promoting entrepreneurship with various incentives, subsidies, grants, etc.	**6Hrs**
References	1. Khanka,S.S.,EntrepreneurialDevelopment,S.Chand, New Delhi. 2. HisrichD.robert ,Michael P.Peters, dean A.Shepherd, Entrepreneurshipand Small Business Management ,PHI,4th Ed . 3. Patel ,V.G.,The Seven Business Crises and How To Beat Them ,Tata McGraw-Hill, New Delhi, 1995. 4. Holt H. David, Entrepreneurship : New Venture Creation, Prentice – Hall of India, New Delhi.	

Course code	**ECC- 408**				
Category	**ELECTIVE**				
Course title	**NETWORK AND SYSTEMS**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• To analyse the Circuits in time and frequency domain • To study network Topology, network Functions, two port network • To synthesize passive network by various methods				
Outcomes	• Apply their knowledge in analysing Circuits by using network theorems. • Apply the time and frequency method of analysis. • Find the various parameters of two port network. • Apply network topology for analyzing the circuit • Synthesize the network using passive elements				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Graph Theory:** Graph of a Network; Definitions, Tree, co-tree, link, basic loop & basic cut set; Incidence matrix; Cut set matrix; Tie-set matrix; Duality; Loop & Node methods of analysis (using branch matrix).	**6Hrs**
Unit-2	**Network Theorems:** Superposition theorem; Thevenin's theorem; Norton's theorem; Maximum power transfer theorem; Mill man's theorem; Reciprocity theorem; Tellegen's theorem; Compensation theorem.	**6Hrs**
Unit-3	**Filter:** Passive and Active filter fundamentals; Low pass, high pass, (constant K type) filters; Analysis and synthesis of the following filters using operational amplifier, low pass, high pass, band pass, band reject, all pass.	**6Hrs**
Unit-4	**Two Port Network:** Type of ports; Representation of networks; Two port network parameters - Z-Parameters, Y-Parameters, hybrid-Parameters, transmission-Parameter; Inter-relationships between the parameters; Inter-connections of two port networks.	**6Hrs**

Unit-5	**Network Synthesis:** Hurwitz Polynomials; Positive Real Functions**;** Definition & properties of LC, RC, RL; Driving point immittance function using Foster &Cauer form of LC, RC, and RL Networks.	**6Hrs**
References	1. M.E. Van Valkenburg, Network Analysis, Prentice Hall of India, 3rd edition, 2008. 2. Samarajit Ghosh, Network Theory: Analysis and Synthesis Prentice Hall of India, 2010 Edition. 3. A. Chakravorty, Network Analysis & Synthesis, Khanna publishers, 2010 Edition. 4. C.L Wadhwa, Network Analysis and Synthesis New Age International, 2009. 5. Donald E. Scott: An Introduction to Circuit analysis: A System Approach McGraw Hill. 6. A Ramakalyan, Linear Circuits: Analysis and Synthesis Oxford University Press, 2009 7. D. Roy Choudhary, Networks & systems New Age International, 2nd edition, 2010.	

Course code	**BMC-401**				
Category	**CORE BIOMEDICAL**				
Course title	**LINEAR INTEGRATED CIRCUITS**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	• To understand the concepts, working principles and key applicationsof linear integrated circuits. • To perform analysis of circuits based on linear integratedcircuits. • To design circuits and systems for particular applications using linear integratedcircuits.				
Outcomes	• Understand the fundamentals and areas of applications for the integrated circuits. • Understand the differences between theoretical, practical & simulated results in integratedcircuits. • Demonstrate the ability to design practical circuits that perform thedesired operations. • Analyze important types of integratedcircuits. • Select the appropriate integrated circuit modules to build a given application.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Operational amplifiers:** Basic differential amplifier analysis, Single ended and double ended configurations, Op-amp configurations with feedback, Op-amp parameters, Inverting and Non Inverting configuration, Comparators, Adder.	**8 Hrs**
Unit-2	**Operational amplifier applications:** Integrator, Differentiator, Voltage to frequency & Frequency to voltage converters.Oscillators: Phase shift,Wien bridge, Quadrature, square wave, triangular wave, saw-tooth oscillators. Voltage controlledoscillators.	**8Hrs**
Unit-3	**Active filters:** Low pass, high pass, band pass and band reject filters,All pass filter, Switched capacitor filter, Butterworth filter design, Chebyshev Filter design.	**8Hrs**
Unit-4	**Phase-locked loops:** Operating Principles of PLL, Linear Model of PLL, Lock range, Capture range, Applications of	**8Hrs**

	PLL as FM detector, FSK demodulator, AM detector, frequency translator, phase shifter, tracking filter, signal synchronizer and frequency synthesizer, Building blocks of PLL, LM 565 PLL	
Unit-5	**Linear ic's**: Four quadrant multiplier & its applications, Basic blocks of linear IC voltage regulators, Three terminal voltage regulators, Positive and negative voltage regulators. The 555 timer as astable and mono-stablemultivibrators. Zero crossing detector, Schmitt trigger.	**8Hrs**
References	1. Ramakant A.Gayakwad, "Op-Amps and Linear Integrated Circuits", 4th Edition, Prentice Hall,2000. David A. Bell, "Operational Amplifiers and Linear ICs", 3rd edition, OUP, 2013. 2. Sedra and Smith, "Microelectronic Circuits", Oxford University press, 5th Edition. 3. Roy Choudhury and Shail Jain, "Linear Integrated Circuits", 4th Edition, New Age International Publishers, 2014. 4. Robert F. Coughlin, Frederick F. Driscoll, "Operational-Amplifiers and Linear Integrated Circuits", 6th Edition, Prentice Hall, 2001. 5. Sergio Franco, "Design with operational amplifier and analog integrated circuits", McGraw Hill, 1997	

Course code	**BMC-402**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL INSTRUMENTATION-I**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Basic knowledge of physics and Biology				
Objectives	• To understand the generalized structure of biomedical instrumentation and its development process. • To study the concepts behind the origin of electricity in human beings. • To analyze the working principles of electrodes and their applications in biomedical engineering concepts. • To apply different concepts to design of bio-potential amplifiers for various healthcare applications. • To study the non-electrical & sensory measurements in human body and their importance in clinical diagnostics.				
Outcomes	• Students would be acquainted with the basic electrophysiology of human body. • Students would be able understand the use of different types of electrode. They can interpret theECG and identify the abnormality.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	Specifications of bio-medical instrumentation system, Man-Instrumentation system Components, Problems encountered in measuring a living system. Basics of Anatomy and Physiology of the body.	**8 Hrs**
Unit-2	**Bioelectric potentials:** Resting and action potentials, propagation of action potential, The Physiological potentials – ECG, EEG, EMG, ERG, EOG and Evoked responses.	**8 Hrs**
Unit-3	**Electrodes and transducers:** Electrode theory, Biopotential Electrodes – Surface electrodes, Needle electrodes, Microelectrodes. Biomedical Transducer.	**8 Hrs**
Unit-4	**Cardiovascular measurements:** Electrocardiography –ECG amplifiers, Electrodes and Leads,ECG recorders –Single channel, Three channel, Vector Cardiographs,ECG System for Stresses testing,Holter recording, Blood pressure measurement,	**8Hrs**

	Heart sound measurement. Pacemakers and Defibrillators.	
Unit-5	**Patient care & monitoring:** Elements of intensive care monitoring, displays, diognosis, Calibration & Reparability of patient monitoring equipment, Prosthetic Devices and Therapies:Hearing Aids, Myoelectric Arm, Diathermy, Laser applications in medicine.	**8Hrs**
References	1. Khandpur R.S.- Biomedical Instrumentation- TMH 2. Venkata Ram, S.K.-Bio-Medical Electronics &Instrumentation (Revised) - Galgotia. 3. Cromwell- Biomedical Instrumentation and Measurements- PHI 4. Webster,j.g. –Bio- Instrumentation ,Wiley (2004) 5. Ananthi,S. –A Text Book of Medical Instruments-2005-New Age International 6. Carr&Brown –Introduction to Biomedical Equipment Technology – Pearson **7.** Pandey & Kumar-Biomedical Electronics and Instrumentation. – Kataria	

Course code	**BMC- 403**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL SENSOR AND TRANSDUCERS**				
Scheme and Credits	**CR.**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• Gain the knowledge of working principle and construction details of Biomedical Transducers. • Acquire the knowledge of transducer applications to access the biological signals. • Access the performance of various Biomedical Transducers. • Acquire the basics of measurement system.				
Outcomes	• Memorize basic measurement system. • Classification and construction details of Transducers. • Illustrate piezo electric and photoelectric transducers. • Contrast different biochemical and biological sensors. • Explain the technology in the measurement field.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Science of measurement:** Measurement System – Instrumentation – Classification and Characteristics of Transducers – Static and Dynamic – Errors in Measurements – Calibration – Primary and secondary standards.				**6Hrs**
Unit-2	**Classification of transducers:**Temperature transducers: Resistance temperature detector (RTD), Thermistor, Thermocouple, chemical thermometry, Displacement transducers: potentiometer, resistive strain gauges, inductive displacement, capacitive displacement transducer, Pressure transducer: variable capacitance pressure transducers, strain gauge transducers, semiconductor transducers, catheter tip transducers, Flow transducer.				**6Hrs**
Unit-3	**Photoelectric and piezo electric sensors:**Phototube, scintillation counter, Photo Multiplier Tube (PMT), photovoltaic, photoconductive cells, photo diodes, phototransistor, Piezo-electric active transducer and Ultrasound transducer.				**6Hrs**
Unit-4	**Biochemical transducers:**Electrode theory: electrode-tissue interface, metal-electrolyte interface, electrode-skin interface,				**6Hrs**

	electrode impedance, Biopotential electrodes: microelectrodes, body surface electrodes, needle electrodes, electrodes for ECG, EEG, and EMG. Reference electrodes: hydrogen electrodes, silver-silver chloride electrodes, Calomel electrodes, Ion electrodes: specific ion electrodes, pH electrode, O2 electrode, CO2 electrode.	
Unit-5	**Biological sensors:**Sensors / receptors in the human body, Chemoreceptor: hot and cold receptors, barro receptors, sensors for smell, sound, vision, Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immune sensors, Basic principles of Nano sensors & BIOMEMS, basic idea about Smart sensors.	**6Hrs**
References	1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007. 2. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004 1. 3. Braun R.D., Introduction to Instrumental Analysis, Mc Graw –Hill Singapore, 2006. 4. Frank G. Kerry Industrial Gas Handbook: Gas Separation and Purification, Taylor and francis group, 2007. 5. Principles of Instrumental Analysis 5th Edition – Douglas A. Skoog, F. James Holler, Timothy A. Niemen, Thomason Brooks/ Cole	

<table>
<tr><td>Course code</td><td colspan="5">BMC-451</td></tr>
<tr><td>Category</td><td colspan="5">CORE BIOMEDICAL</td></tr>
<tr><td>Course title</td><td colspan="5">LINEAR INTEGRATED CIRCUITS LAB</td></tr>
<tr><td rowspan="2">Scheme and Credits</td><td>CR</td><td>L</td><td>T</td><td>P</td><td rowspan="2"></td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>2</td></tr>
<tr><td>Pre-requisites (if any)</td><td colspan="5">• Basic Electrical &Electronics Engineering practices lab
• Linear Integrated circuits</td></tr>
<tr><td>Objectives</td><td colspan="5">• To apply operational amplifiers in linear and nonlinear applications.
• To acquire the basic knowledge of special function ICs.
• To use SPICE software for circuit design.</td></tr>
<tr><td>Outcomes</td><td colspan="5">• Differentiate IC and Discrete components, understand manufacturing process of IC and analyze how monolithic components are being developed.
• Identify different configurations of op-amp analyze the parameters of op-amp and observe the frequency response of operational-amplifier.
• Understand & demonstrate different applications based on operational-amplifier.
• Demonstrate the applications of waveform generators, timers and voltage regulators.</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td></td><td colspan="4">LIST OF EXPERIMENTS

1. Designing of Non inverting Amplifier
2. Inverting Amplifier
3. Multi vibrator: Monostable
4. Filters: Low Pass, High Pass, Band Pass, Band Reject, Notch
5. Differential Amplifier
6. Instrumental Amplifier
7. Power Supply</td><td></td></tr>
<tr><td>References</td><td colspan="5">Departmental Lab reference manual</td></tr>
</table>

Course code	**BMC-452**				
Category	**Core Biomedical**				
Course title	**BIOMEDICAL INSTRUMENTATION LAB-1**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	1	0	0	2	
Pre-requisites (if any)	Nil				
Objectives	Objective of this course is to provide profound knowledge and erudition of cath Lab equipment.				
Outcomes	Students would be able to develop the Basic circuit of the ECG and PMS, its analysis calibration and maintenance.				
	LIST OF EXPERIMENTS 1. Basic Circuit of Electro Cardio Gram 2. Calibration and Maintenance of ECG system 3. Analysis of ECG 4. Basic Circuit of PMS 5. Calibration and Maintenance of PMS 6. Different Types of Electrode used to electrophysiology				
References	Departmental Lab reference manual				

Course code	**BMC-453**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL SENSOR AND TRANSDUCERS LAB**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	1	0	0	2	
Pre-requisites (if any)	Nil				
Objectives	▪ Gain the knowledge of working principle and construction details of Biomedical Transducers. ▪ They would be able to understand the application of sensor/Transducer/ Electrode on the basis of their properties. ▪ Access the performance of various Biomedical Transducers. ▪ Acquire the basics of measurement system.				
Outcomes	• Understanding basic biomedical sensors and transducers. • Classification and construction details of Transducers. • Explain the technology in the measurement field. • Analysis of the response curves of the sensors. • Evaluate the correlation between sensor data to the physiological signals.				
	LIST OF EXPERIMENTS 1. Multipoint Electrode 2. LVDT 3. Strain Gauge 4. Photoelectric Transducer 5. Non-polarized and Polarized Electrode 6. RTD/Thermistor/ Thermocouple.				
References	Departmental Lab reference manual				

Course code	**MCC- 401**				
Category	**MANDATORY**				
Course title	**ENVIRONMENTAL SCIENCES**				
Scheme and Credits	**CR.**	**L**	**T**	**P**	
	0	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• To acquire clear understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective. • To know the core concepts natural resources and environmental pollution so as to protect the environment through environmental education. • Imparting basic knowledge about the environment and its allied problems. • Motivating public to participate in environment protection and environment improvement. • Acquiring skills to help the concerned individuals in identifying and solving environmental problems.				
Outcomes	• Describe the various types of Eco-systems. • Define important scientific/ecological terms. • Describe important ecological processes. • Use the scientific method to design an ecological study in the lab and/or field. • Demonstrate knowledge of the important ecological principles operating at different levels of organization.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Natural Resources-** Renewable and Non-renewable Resources, Forests, water, minerals, Food and land (with example of one case study.	**6Hrs**
Unit-2	**Biodiversity and its conservation-**Biodiversity at global, national and local levels; India as a mega-diversity nation; Threats to biodiversity (biotic, abiotic stresses), and strategies for conservation.	**6Hrs**

Unit-3	**Environmental Pollution**-Types of pollution- Air, water (including urban, rural, marine), soil, noise, thermal, nuclear; Pollution prevention Piezo-electric active transducer and Ultrasound transducer.	**6Hrs**
Unit-4	**Environmental Biotechnology-** For environmental protection, biological indicators, biosensors, bioremediation, phytoremediation, biopesticides, biofertilizers.	**6Hrs**
Unit-5	**Social Issues and Environment-** Climate change- Reasons, Greenhouse effect, Global warming. Legal issues- Environmental legislation (Acts and issues involved), Environmental ethics.	**6Hrs**
References	1.Gilbert M. Masters, (2004),Introduction to Environmental Engineering and Science, 2nd Ed., Pearson 2.Benny Joseph, (2006), Environmental Science and Engineering, Tata McGraw Hill, New Delhi 3.Rajagopalan.R., (2005), Environmental Studies – from crisis to cure, Oxford University Press 4. DarmendraS.Senger., (2007), Environmental Law, Prentice Hall of India (P) Ltd, New Delhi 5.Hans-JoachinJoerdening and Josef Winter., (2005)), Environmental Biotechnology; Concepts and Applications, Willy-VCH Verlag	

Course code	**BMC-501**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL IMAGE PROCESSING**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	Objective of this course is to aware the students with biomedical image processing				
Outcomes	Students would be conferred with the profound knowledge of biomedical image processing				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction:** Fundamental steps in DIP, Component of a DIP System, Image Sensing and Acquisition, sampling and quantization, Basic relationships between Pixels Image Enhancement, Background, Basic Grey level Transformation, Histogram Processing, Enhancement Using Arithmetic/ Logic Operations, spatial filters.	**8 Hrs**
Unit-2	**Medical images obtained with ionizing radiation and non-ionizing radiation:** Medical imaging modalities, Images from x-rays, Images from γ-rays, Ultrasound imaging, Magnetic resonance imaging, Picture archiving and communication systems (PACS).	**8 Hrs**
Unit-3	**Color Image Processing:**ColorFundamentals, Color Models (RGB, CMY, CMYK, HSI Color Model, Conversion from RGB to HSI, Conversion from HSI to RGB, Pseudo Color Image Processing, Color Transformations, Color Segmentation.	**8 Hrs**
Unit-4	**Image Compression:** Fundamentals, Redundancy (Coding, Interpixel, Psycho visual, Fidelity Criteria), Image Compression Model, elements of information theory, Huffman Coding, Arithmetic Coding.	**6 Hrs**

Unit-5	**Image Segmentation and Medical applications of imaging:** Introduction, Detection of Discontinuities (Point, Line, Edge, Gradient Operator, The Laplacian), Thresholding, Region-based Segmentation, Tumor imaging and treatment, Angiography, Bone strength and osteoporosis.	**10 Hrs**
References	1. Rafael C. Gonzalez Richard E Woods, Digital Image Processing, Prentice Hall. 2. Geoff Dougherty, Digital Image Processing for Medical Applications, Cambridge UniversityPress. 3. Anil K Jain, Fundamentals of Digital Image Processing, Prentice-Hall.	

Course code	**BMC-502**				
Category	**CORE BIOMEDICAL**				
Course title	**GENETICS ENGINEERING AND ITS APPLICATIONS**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• The objective of the course is to familiarize the students with the basic • concepts in genetic engineering; • To acquaint the students to versatile tools andtechniques employed in genetic engineering and recombinant DNA technology. • To appraise them about applications genetic engineering.				
Outcomes	• The students will have knowledge of tools and strategies used in genetic engineering. • Understanding of applications of recombinant DNA technology and genetic engineering. from academic and industrial perspective. • Can use and apply the knowledge of genetic engineering in problem solving andin practice.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Genome organization:** Genome organization in prokaryotes and eukaryotes, DNA content and C-value paradox, methods to measure DNA content variation, Various types of DNA sequences – simple sequences, repetitive sequences, nonsense sequences, tandem gene clusters, satellites Variety of DNA structures: double helix, Z-DNA, B-DNA, Mechanism of DNA replication: prokaryotes and eukaryotes.	**6Hrs**
Unit-2	**Mechanism of transcription:** Mechanism of transcription: prokaryotes and eukaryotes, Operon and operon concept, Eukaryotic gene structure and expression, Mechanism of translation: prokaryotes and eukaryotes, Control of gene expression, RNA processing and editing, transcriptional, post transcriptional, translational and post transnational controls, Gene mutation: point mutation and transposable elements, DNA	**6Hrs**

	repair and recombination.	
Unit-3	**Pedigrees and organization of the human genome**: Mendelian pedigree patterns, Complications to the basic pedigree patterns, Factors affecting gene frequencies, Nonmendelian characters, General organization of the human genome, Organization and distribution of human genes, Human multigene families and repetitive coding DNA, Extragenic repeated DNA sequences and transposable elements.	**6Hrs**
Unit-4	**Gene expression in humans**: An overview of gene expression in human cells, Control of gene expression by binding of trans-acting protein factors to cis-acting regulatory sequences in DNA and RNA, Alternative transcription and processing of individual genes, differential gene expression and DNA methylation, Long-range control of gene expression and imprinting, unique organization and expression of Ig and TCR genes.	**6Hrs**
Unit-5	**Mutation and DNA repair**: An overview of mutation, polymorphism, and DNA repair, Simple mutations, Genetic mechanisms which result in sequence exchanges between repeats- Pathogenic mutations, The pathogenic potential of repeated sequences, DNA repair. Molecular pathology: from gene to disease, Molecular pathology: from disease to gene, Molecular pathology of chromosomal disorders, Gene tracking, Population screening, Cancer genetics, Complex diseases: theory and results.	**6Hrs**
References	1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D., 1989, Molecular Biology of The Cell, 2nd ed., Garland Publishing, Inc., New York. 2. Darnell, J., Lodish, H., Baltimore, D., 1990, Molecular Cell Biology, Scientific American Books, New York. 3. Freifelder, D., Malacinski, G.M., 1987, Essentials of Molecular Biology, John and Bartlett Publishers, London	

Course code	**BMD-501**				
Category	**DEPARTMENTAL ELECTIVE**				
Course title	**BIOMATERIALS**				
Scheme and Credits	**CR.**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	Aim of this course is to explain the application of different types of the Biomaterialcan be used in orthotics and Prosthetics Designing and how to check their strength.				
Outcomes	After completion of this course students would be able to understand the mechanism of Biomaterial interaction Biocompatibility Testing and in the development of different application.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Biomaterials:** Definition, Classification, properties and biocompatibility. Biological responses (extra and intra-vascular system). Controlling and Assessing Cell–Biomaterial Interactions at the Micro and Nano-scale. Surface properties of materials, physical properties of materials, mechanical and thermal properties.	**6Hrs**
Unit-2	**Types of biomaterials:**Metallic Biomaterials, Ceramic Biomaterials, Polymeric Biomaterials, Composite Biomaterials, Biodegradable Polymeric Biomaterials, Tissue-Derived Biomaterials (Collagen and Chitin-based biomaterials), Polymeric hydrogels, Soft Tissue Replacements, Hard Tissue Replacements, Standards of implant materials.	**6Hrs**
Unit-3	**Characterization:**Types of implants in surgical uses and probability of implant failures. Characterization of biomaterials, drug delivery applications, tissue engineering from both orthopaedic and vascular perspective. Definition of biocompatibility, blood compatibility and tissue compatibility.	**6Hrs**

Unit-4	**Toxicity tests:** acute and chronic toxicity studies, sensitization, carcinogenicity, mutagenicity and special tests. ETO, gamma radiation, autoclaving. Effects of sterilization on material properties. In vitro testing (Mechanical testing), In-vivo testing (animals) and Ex-vivo testing: in vitro testing simulating the in vivo conditions.	**6 Hrs**
Unit-5	**Artificial Organs:** Artificial Heart, Prosthetic Cardiac Valves, Limb prosthesis, Externally Powered limb Prosthesis and Dental Implants.	**6Hrs**
References	1. **J. B. Park**, **Biomaterials Science and Engineering**, Plenum Pub. Corp., New York, London, 1984. 2. B. D. Ratner, A. S. Hoffman, FJ. Schoen, JE. Lemons. An Introduction to Materials in Medicine, 2nd edn., Elsevier Academic Press, London, 2004. 3. T. S. Hin, Engineering Materials for Biomedical Applications, World Scientific Publishing Co. Pte. Ltd. 2004 4. D. V. Rai, R. C Sobti and R. Bahadur, Emerging Trends in Biomedical Science and Health. I.K. International, Chandigarh, India, 2009. 5. B. Basu, D.S. Katti, and A. Kumar, Advanced Biomaterials: Fundamentals, Processing, and Applications, Wiley-American Ceramic Society, 2009.	

Course code	**BMD-502**				
Category	**DEPARTMENTAL ELECTIVE**				
Course title	**BIOMECHANICS**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Human Anatomy and physiology				
Objectives	• You will understand advanced knowledge of human skeleton system. • You will understand key aspects of mechanics related to human performance. • Develop self-learning initiatives and integrate learned knowledge • Apply analytical skills to assess and evaluate the need of the end-user • Conduct patient/technology evaluation via the use of modern mechanics				
Outcomes	• Explain fundamentals of human bones and structures. • Explain various principles of mechanics. • Describe applications of mechanics in human body analysis especially skeleton and Cardiovascular system. • Explain biomechanics for other biomedical applications. • Understand GAIT analysis for different organs of the human body.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Fundamentalsof mechanics:**Newton"s law- mechanical behavior of bodies in contact, work, power and energy relationship – Angular kinematics of human movement-measuring angles, angular kinematic relationships –relationships between linear and angular motion – Angular kinetics of human movement-resistance to angular acceleration, angular momentum – Equilibrium and human movement-equilibrium, center of	**6Hrs**

	gravity, stability and balance – Kinematic concepts for human motion-forms of motion and joint movement terminology – Kinetic concepts for human motion-basic concepts related to kinetics .- mechanical loads on the human body .	
Unit-2	**Bone and cartilage:**Bone structure & composition, blood circulation in bone – mechanical properties of bone, viscoelastic properties of bone – Maxwell & Voight models – viscoelastic properties of articular cartilage – Anisotropy and composite models for bone – Bone growth and development – Bone response to stress – Osteoporosis – causes, diagnosis, treatment – Elasticity and strength of bone .	**6Hrs**
Unit-3	**Biofluid mechanics:**Newtonian viscous fluid, non viscous fluid – Rheological properties of blood – Structure and composition of blood vessel – Remodeling of blood vessels – Nature of fluids, Propulsion in fluid medium – Mechanical properties of arterioles, capillary vessels and veins – Bio-viscoelastic solids.	**8Hrs**
Unit-4	**Mechanics of skeletal muscle:**Structure of skeletal muscle – muscle fibers, motor units – Structure of skeletal muscle-fiber types, fiber architecture – Sliding element theory of skeletal muscle.- Skeletal muscle function – Contraction of skeletal muscle and hill"s three element model – Factors affecting muscular force generation – Muscular strength, power and endurance – Muscle injuries.	**6Hrs**
Unit-5	**Mechanics of shoulder, spine and hip:**Structure of the shoulder – Movements of shoulder complex – Loads on the shoulder – Structure of the spine – Movements of the spine – Muscles and loads on the spine – Structure and movements of the hip – Loads on the hip.	**6Hrs**
References	1. K. B. Sahay, R. K. Saxena, Biomechanics. John Wiley & Sons, India, 1989. 2. D. Schneck and J.D. Bronzino, Biomechanics : principles and applications. CRC Press, India, 2003. 3. D. Knudson, Fundamentals of Biomechanics. Springer Science, USA, 2007. 4. J. M. Hausdorff, Gait Disorders Evaluation and Management. Taylor & Francis, USA, 2005. 5. D. V. Rai, R Bahadur, Trends in Medical physics and Biomedical instrumentation. New Era international, India, 2009.	

Course code	**ECC-507**				
Category	**ELECTIVE**				
Course title	**FUNDAMENTALS OF SIGNALS AND SYSTEMS**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• To introduce students the concept and theory of signals and systems needed in electronics and telecommunication engineering fields. • To introduce students to the basic idea of signal and system analysis and its characterization in time and frequency domain.				
Outcomes	• Understand about various types of signals and systems, classify them, analyze them, and perform various operations on them. • Understand use of transforms in analysis of signals and system in continuous and discrete time domain. • Observe the effect of various properties and operations of signals and systems. • Evaluate the time and frequency response of Continuous and Discrete time systems which are useful to understand the behaviour of electronic circuits and communication system.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Introduction:** Definitions and concepts of different types of signals; Transformation of independent variable; Exponential and sinusoidal signals; unit impulse and unit step functions. Systems: Continuous-time and Discrete-time systems and basic system properties. Linear time invariant (LTI) systems: Introduction; Discrete-time LTI systems, the convolution sum; continuous – time LTI systems; the convolution integral; Properties of LTI systems.				**6Hrs**

Unit-2	**Fourier Series and Fourier Transform:** Fourier series: Introduction; response of LTI systems to complex exponentials; Fourier series representations of continuous-time periodic signals and discrete-time periodic signals; Convergence and properties. Continuous-time Fourier Transform: Representation of periodic signals; Fourier transform of periodic signals and their properties. Discrete-time Fourier transforms: Representation of aperiodic signals; Fourier transform of periodic signals; properties. Discrete Fourier Transforms (DFT): Frequency-domain sampling, properties of DFT; Circular convolution and linear convolutions.	**6Hrs**
Unit-3	**The Laplace Transform:** Introduction; Laplace Transforms; the region of convergence (ROC); Inverse Laplace transforms; Analysis and characterization of LTI systems using the Laplace transforms; Unilateral Laplace transform; properties of Laplace transform.	**6Hrs**
Unit-4	**The Z-transform:** Introduction; Z-transform; the region of convergence (ROC); Inverse Z-transform; properties of Z-transform; Analysis and characterization of LTI systems using Z-transforms, unilateral Z-transforms.	**6Hrs**
Unit-5	**Sampling and Random signals:** Sampling: Introduction, representation of continuous-time signals by its samples; Sampling theorem, interpolation; the effect of under sampling; aliasing, Discrete-time processing of continuous-time signals; Sampling of discrete-time signals. Random signals, Gaussian random process, noise, power spectral densities, random signals in linear systems.	**6Hrs**
References	1. Alan V. Oppenheim, A. S. Willsky ,Signals and Systems, PHI. 2. John G. Proakis& D. G. Manolakis, Digital Signal Processing, Pearson. 3. Salivahanan, S., Vallavaraj, A and GnanapriyuaC.,Digital Signal Processing, ,Tata Mc Graw Hill. 4. B.P. Lathi, Adel S. Sedra, Linear Systems and Signals, Oxford Univ Press	

Course code	**ECC-508**				
Category	**ELECTIVE**				
Course title	**DIGITAL ELECTRONICS**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• To understand number representation and conversion between different representation in digital electronic circuits. • To analyze logic processes and implement logical operations using combinational logic circuits. • To understand characteristics of memory and their classification. • To understand concept of Programmable Devices, PLA, PAL.				
Outcomes	• Develop a digital logic and apply it to solve real life problems. • Analyze, design and implement combinational logic circuits. • Classify different semiconductor memories. • Analyze, design and implement sequential logic circuits. • Analyze digital system design using PLD.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Introduction:** Types of Digital circuits and their characteristics, Number system: Direct conversion between bases, Negative numbers & BCD and their arithmetic's, Boolean algebra, Logic gates, Minimization of Boolean Functions: K-Map & Tabular method up to 6 variables, Error detecting & correcting codes, hamming codes.				**6Hrs**
Unit-2	**Combinational Logic Circuits:** Design Procedure, Adders, Subtractors, Code conversion, Multiplexers/ Demultiplexers, Encoder/ decoders, decimal adders & amplitude comparators. Decoder and driver circuits for 7-segment LED displays, D/A				**6Hrs**

	converter.	
Unit-3	**Sequential Logic Circuits:** Flip–Flops and their conversions, excitation table, state table & state diagram, Shift registers and their applications. Design of synchronous and asynchronous counters, Analysis Procedure of synchronous & asynchronous sequential circuits, Reduction of state & flow table, Race free state assignment.	**6Hrs**
Unit-4	**Logic Families-** RTL, DTL, TTL, ECL and CMOS **Memory & Programmable Logic-** RAM, ROM, PLA, PAL	**6 Hrs**
Unit-5	**DACs and ADCs:**D/A Converter – General considerations, Static non-idealities and Dynamic non-idealities; Current-steering DAC – Binary weighted DAC, Design issues, Effect of Mismatches. A/D converter – General considerations, static and dynamic non-idealities; Flash ADC, Successive Approximation ADC.	**6Hrs**
References	1. Digital Design by M Moris Mano, 2nd Edn.PHI 2. Introduction to Digital Microelectronic Circuits, by Gopalan, TMH. 3. Switching Circuit & Logic Design by Hill & Peterson, Wiley 4. Digital Circuit & Logic Design, by Holsworth.	

Course code	**BMC-551**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL IMAGE PROCESSING LAB**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	1	0	0	2	
Pre-requisites (if any)	Nil				
Objectives	Objective of this course is to aware the students with biomedical images				
Outcomes	Students would be conferred with the profound knowledge of biomedical images				
	1. Point processing in spatial domain a. Negation of an image b. Thresh holding of an image c. Contrast Stretching of an image 2. Bit Plane Slicing 3. Histogram Equalization 4. Histogram Specification 5. Zooming by interpolation and replication 6 Filtering in spatial domain a. Low Pass Filtering b. High Pass Filtering c. Median filtering 7. Edge Detection using derivative filter mask a. Prewitt b. Sobel c. Laplacian 8. Data compression using Huffman coding 9. Filtering in frequency domain a. Low pass filter b. High pass filter 10. Hadamard transform				
References	1. Rafael C. Gonzalez Richard E Woods, Digital Image Processing,				

	2nd Ed. 2. Geoff Dougherty, Digital Image Processing for Medical Application , Cambridge University Press 3. Anil K Jain, Fundamentals of Digital Image Processing.

Course code	**MCC-501**				
Category	**MANDATORY**				
Course title	**CYBER SECURITY**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	0	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• To conceptualize the cyber environment idiosyncrasies in terms of security and privacy; to impart state-of-the-art technologies of wireless network security; • To analyze the various categories of threats, vulnerabilities, countermeasures in the area of cyber networking; to familiarize students with the issues and technologies involved in designing a cyber system that is robust against attacks.				
Outcomes	• Highlight the need for security architecture and its relevance to systems, service continuity and reliability • Discuss the application of techniques such as defence in depth to demonstrate how controls can be selected, deployed and tested to minimize risk and impact • Differentiate between controls to protect systems availability and reliability; controls to protect information; and controls to manage human behaviour • Understand the trade-offs for functionality, usability and security • Understand the role of operations in monitoring,maintaining and evolving controls				
S. No.	**Unit details**				**Time Allotted**
Unit-1	Introduction to information systems, Types of information Systems, Development of Information. Systems, Introduction to information security, Need for Information security, Threats				**6Hrs**

	to Information Systems, Information Assurance, Cyber Security, and Security Risk Analysis.	
Unit-2	Application security (Database, E-mail and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Intrusion Detection, Access Control. Security Threats -Viruses, Worms, Trojan Horse, Bombs, Trapdoors, Spoofs, E-mail viruses, Macro viruses, Malicious Software, Network and Denial of Services Attack, Security Threats to E-Commerce-Electronic Payment System, eCash,Credit/Debit Cards. Digital Signature, public Key Cryptography.	**6Hrs**
Unit-3	Developing Secure Information Systems, Application Development Security, Information Security Governance & Risk Management, Security Architecture & Design Security Issues in Hardware, Data Storage & Downloadable Devices, Physical Security of IT Assets, Access Control,CCTV and intrusion Detection Systems, Backup Security Measures.	**6Hrs**
Unit-4	Security Policies, Why Policies should be developed, WWW policies, Email Security policies, Policy Review Process-Corporate policies-Sample Security Policies, Publishing and Notification	**6Hrs**
Unit-5	Requirement of the Policies. Information Security Standards-ISO, IT Act, Copyright Act, Patent Law, IPR. Cyber Laws in India; ITAct 2000 Provisions,Intellectual Property Law: Copy Right Law, Software License, Semiconductor Law and Patent Law.	**6Hrs**
References	1. Charles P. Pfleeger, Shari LawerancePfleeger, "Analysing Computer Security ", Pearson Education India. 2. V.K. Pachghare, "Cryptography and information Security", PHI Learning Private Limited, Delhi India. 3.Dr. Surya Prakash Tripathi, Ritendra Goyal, Praveen kumar Shukla ,"Introduction to Information Security and Cyber Law" Willey Dreamtech Press.	

Course code	**BMC-601**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL SIGNAL PROCESSING**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	4	3	1	0	
Pre-requisites (if any)	Nil				
Objectives	Aim of this subject is to explain the several types of the Biological signals and their processing in term of filtering, Compression and Extraction of information.				
Outcomes	Students would be able to interpret the signals and develop the system for its analysis				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Fundamentals of signal processing:**Sampling and aliasing , Signal reconstruction, Signal conversion systems, Circular convolution Correlation- Autocorrelation – Cross correlation, FFT -decimation in time algorithm, Decimation in Frequency algorithm.	**8 Hrs**
Unit-2	**Digital filter design:**Basics of filter, Design of IIR filter-impulse invariant method – Bilinear Transformation Method Warping and pre-warping effect, Frequency transformation, Characteristics of FIR filter, FIR filter design using windowing techniques- Rectangular window – Hamming window – Hanning window.	**8 Hrs**
Unit-3	**Wavelet and speech processing:**Introduction to wavelets, Time frequency representation, Discrete wavelet transform, pyramid algorithm, Comparison of Fourier transform and wavelet transform, Speech analysis – Cepstrum – Homomorphic filtering of speech signals.	**8 Hrs**
Unit-4	**Analysis of biosignals:**Automatic analysis and classification of ECG, P-wave detection, QRS complex detection, Correlation analysis of ECG signals, Signal averaged ECG, Analysis of Heart Rate variability, Synchronized averaging of PCG envelopes, envelogram, Analysis of PCG signal, Analysis of EMG signal.	**8Hrs**

Unit-5	**Advanced topics in BSP:**Analysis of non stationary signals-time variant system – Fixed segmentation-Short time Fourier transform, autocorrelation function method, Spectral error measure method, generalized likelihood ratio, Introduction to Adaptive filters, Adaptive segmentation.	**8Hrs**
References	1. John G. Proakis and Dimitris G.Manolakis, "Digital Signal Processing, Algorithms and Applications", PHI of India Ltd., New Delhi, fourth Edition, 2007. 2. Rangaraj.M.Rangayyan, "Biomedical signal processing", IEEE press, second edition, 2015	

Course code	**BMC-602**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL INSTRUMENTATION-II**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	To aware the students with basic instrumentation used for the bioelectrical potential testing to analysis the human physiology.				
Outcomes	• Students would be acquainted with the basic electrophysiology of human body. • Students would be able understand the use of different types of electrode. • They can interpret theECG and identify the abnormality.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Bioelectrodes and biochemical sensors:** Components of Medical Instrumentation – System Origin of Bio potential: Action Potential, Nernst Equation, Goldman equation, Hodgkin- Huxley model - Electrode electrolyte interface, Half-cell potential, Polarisable and Non-polarisable electrodes - Skin electrode interface – Bio-electrodes: Surface-, Micro-. Needle-electrodes - Equivalent circuits of electrodes – Biochemical-, and Transcutaneous- electrodes: pH, pO2, pCO2 - Ion sensitive Field effect Transistors.	**6Hrs**
Unit-2	**Bioamplifiers, bioelectric signals, pcg and their recording:** Bio amplifiers- Carrier Amplifier, - Isolation Amplifier - Differential amplifier - Chopper Amplifier - Instrumentation Amplifier - Bioelectric signals (ECG, EMG, EEG, EOG & ERG) and their characteristics - Electrodes for ECG, EEG and EMG - Einthoven triangle, Standard 12-lead configurations - ECG Machine - EMG machine – 10-20 electrodes placement system for EEG - EEG machine - Heart sound and characteristics, PCG.	**6Hrs**
Unit-3	**Patient monitoring systems and biotelemetry:** Measurement of Blood pressure – Direct Methods and Indirect Methods - Temperature - Respiration rate - Heart rate measurement -	**6Hrs**

	Oximetry -Pulse oximeter, Ear oximeter - Computerized patient monitoring system – Bedside, Central Monitoring system – Biotelemetry: Basics components, and its different types.	
Unit-4	**Cardiac measurements and assist devices:**Cardiac output Measuring techniques – Dye Dilution method, Thermo dilution method, BP method - Blood Flow measuring Techniques: Electromagnetic Type - Ultrasound Blood Flow meter, Laser Doppler Blood Flow meter - Cardiac Arrhythmias – Plethysmography - Cardiac Pacemakers – Defibrillator: AC-, and DC- types – HeartLung Machine (HLM) – Oxygenators.	**6Hrs**
Unit-5	**Analyticalequipments:**Chemical Fibro sensors, Fluorescence sensors - Blood cell counters - Coulter counter, Electrical Impedance Method , Optical Method - Colorimeter, Spectro photometer, Flame photometer – Chromatography - Mass Spectrometer – Biochemical and Bioanalytical equipments Electrical hazard – Micro- and Macroshock - Patient safety procedures.	**6Hrs**
References	1. Geoddes L.A and Baker L.E, "Principles of Applied Biomedical Instrumentation", John Wiley, 3 rd Edition, 1975, Reprint 1989. 2. Khandpur R.S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003. 3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Prentice-Hall India, 2 nd Edition, 1997	

Course code	**BMD-601**				
Category	**DEPARTMENTAL ELECTIVE**				
Course title	**NANOMEDICINE**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• To introduce participants to the emerging field of nanomedicine and to give an overview of present and future applications of nanotechnologies and nanomaterials in medicine and healthcare and their limitations • To provide an understanding of the scientific and regulatory obstacles to implementation of nanomedicines • To provide an environment in which participants from a range of backgrounds can learn from eminent scientists in the field and can share their ideas in discussions with subject specialists • To enable participants to make informed decisions about applications of nanotechnologies in their own field of work				
Outcomes	• Understand how nanotechnological approaches can be used in biomedical therapies • Understand biomaterials and interaction of biomaterials with cells, body fluids and tissues • Understand basic stem cell biology and corresponding requirement for tissue engineering • Understand the toxicological aspects of nanosized surfaces and particles • Find, refer and evaluate available information				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Nanomaterials:**Introduction of nanoscale structure of materials, natural and manmade nanomaterial, some important nano materials, species, cellular nano machine and nano building block of life, various nanosizes of cellular species, DNA and protein as molecular nanomachines,Introduction of nanomedicine.				**6Hrs**
Unit-2	**Nanomaterials:** Different types of Nanoparticles, Biocompatible Nanomaterials and Nanodevices Promising for Biomedical Applications, Methods and Applications of				**6Hrs**

	Metallic Nanoshells in Biology and Medicine, Micro- and Nano-electromechanical Systems.	
Unit-3	**Fluidics**: Microfluidics and Nanofluidics, Nanotechnology on a Chip, Microscopy for Nanoparticle Characterization, Biomedical Applications of Self-Assembly of Nanoparticles.	**6Hrs**
Unit-4	**Nanoparticles applications:** Nanoparticles in Medical Diagnostics and Therapeutics, Magnetic Nanoparticles as Contrast Agents for Medical Diagnosis. Nanopharmaceuticals, Role of Nanotechnology in Biological Therapies, Nanodevices for Medicine and Surgery	**6Hrs**
Unit-5	**Nanomedicine applications:** Nanotechnologies related to Oncology, neurology, cardiology, Orthopedics (Novel Bionanomaterials for Orthopedics), microbiology, Regenerative Medicine & Tissue Engineering, and Nano-Ophthalmology, Research and Education in Nanomedicine, Future of Nanomedicine.	**6Hrs**
References	1. Hornyak, G. Louis, Tibbals, H. F., Dutta, Joydeep. Fundamentals of Nanotechnology. CRC Press, 2010 2. Charles P. Poole Jr., Frank J. Owens, Introduction to Nanotechnology. John Wiley & Sons, 2003 3. David E. Reisner, Bionanotechnology: Global Prospects, CRC Press. 2008. 4. D. V. Rai, R. Bahadur, Trends in Medical physics and Biomedical instrumentation, New Era international, India. 2009 5. D. V. Rai, R. C Sobti and R. Bahadur, Emerging Trends in Biomedical Science and Health. I.K. International, Chandigarh, India, 2009.	

Course code	**BMD-602**				
Category	**DEPARTMENTAL ELECTIVE**				
Course title	**MICROPROCESSOR AND ITS APPLICATION**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• To develop background knowledge and core expertise of microcontroller. • To know the importance of different peripheral devices and their interfacing to microcontrollers. • To know the design aspects of microcontrollers. • To write assembly language programs of microcontrollers for various applications.				
Outcomes	• Draw and describe architecture of 8085 and 8086 microprocessor. • Interface various peripheral devices to the microprocessor. • Write assembly language program for microprocessor. • Design microprocessor based system for various applications.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction:** History and Evolution of Microprocessor, Organization of a microprocessor based system, Types of microprocessor, operation of microprocessor, Application of Microprocessor.	**6 Hrs**
Unit-2	**8085 Microprocessor:** Features of 8085 Microprocessor, Pin diagram, Need of multiplexing and demultiplexing, Architecture of 8085 microprocessor, addressing modes, Instruction set, Timing Diagram, Assembly Language programming, Interrupts, Memory organization and interfacing.	**6Hrs**
Unit-3	**8086 Microprocessor:** Features, Pin diagram, minimum and maximum mode system, demuliplexing, architecture, Addressing modes, memory organization, Interrupts, Instruction set, Timing diagram, Assembly language programming, difference between 8085 and 8086.	**6Hrs**
Unit-4	**I/O and Data transfer techniques:** Basic interfacing concepts, I/O interfacing, Basic concept in programmable	**6Hrs**

	device, Microprocessor controlled data transfer data transfer techniques, DMA controlled data transfer techniques, serial input output interfacing(8251) and data communication	
Unit-5	**Programmable and data converters interfacing devices:** Programmable peripheral interfacing (8255A). Programmable interval Timer (8253/8254), Programmable keyboard display interfacing (8279), Programmable interrupt controller (8259A), direct memory access controller (8257), Basic concept in data converters, D/A converter, A/D converters, ADC IC (0808/0809).	**6Hrs**
References	1. R. Singh and B.P. Singh, Microprocessor Interfacing and Application, New Age International Publishers. 2. D.V. Hall, Microprocessors Interfacing, THM (2nd Edition). 3. R.S. Gaunkar, Microprocessor Architecture, Programming and application with 8085/8080, penram publication. 4. Richard Aston, Principles of Biomedical Instrumentation and Measurement, Prentice Hall India, 2000	

Course code	**ECC-607**				
Category	**ELECTIVE**				
Course title	**CONTROL SYSTEM**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• To introduce different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form to interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis. • To employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions and identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system. • Formulate different types of analysis in frequency domain to explain the nature of stability of the system.				
Outcomes	• Categorize different types of system and identify a set of algebraic equations to represent and model a complicated system into a more simplified form. • Characterize any system in Laplace domain to illustrate different specification of the system using transfer function concept. • Interpret different physical and mechanical systems in terms of electrical system to construct equivalent electrical models for analysis. • Employ time domain analysis to predict and diagnose transient performance parameters of the system for standard input functions. • Formulate different types of analysis in frequency domain to explain the nature of stability of the system. • Identify the needs of different types of controllers and compensator to ascertain the required dynamic response from the system.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Introduction:** Open loop & Closed loop control system, Basic components of control system, Feedback characteristics,				**6Hrs**

	Transfer function, Block diagram algebra, Signal flow graph, Mason's gain formula	
Unit-2	**Plots for stability:** Concept of stability, time response analysis; Routh Hurwitz criterion, Root locus plot, frequency response analysis; Polar plot, bode plot, gain margin & phase margin.	**6Hrs**
Unit-3	**Servo control:** Error detectors, Potentiometers, Synchros, Actuators, Servo motors, Tachogenerators, AC and DC servomotors.	**6Hrs**
Unit-4	**Time response and digital control:** Time response of first order and second order system with unit step and unit impulse signal, Static and dynamic error coefficients, P,PI and PID controllers. Introduction to PLC and DCS control system, SCADA system. Feed forward Control system with multiple loops.	**6Hrs**
Unit-5	**Computer applications:**Polygraph Machine, Computer aided ECG analysis, Computerized catheterisation laboratory, Computerized patient monitoring system, clinical laboratory automation.	**6Hrs**
References	1. Ogata, K., Modern Control Engineering , 4th edition, Prentice Hall India, 2003 2. Khandpur, R.S., Handbook of Biomedical Instrumentation , Tata McGraw Hill, India, 2005 3. Bhattacharya, S. K., Control system Engineering , 2nd edition, Pearson Education, New Delhi, India, 2008 4. Johnson, Curtis, Process Control Instrumentation Technology , 8th edition, Prentice Hall India, New Delhi, India 2005 5. Nagarath I J & Gopal M., Control system Engineering , 4th edition, New Age Publications, 2003	

Course code	**ECC-608**				
Category	**ELECTIVE**				
Course title	**WIRELESS COMMUNICATION AND TELEMEDICINE**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• Learn the key principles for telemedicine and e- health care. • Understand telemedicine technology. • Know telemedicine standards, mobile telemedicine and it applications.				
Outcomes	• Explain the basic principles of healthcare in telemedicine. • Discuss the role of telecommunication in Healthcare. • Discuss the ethical & legal issues involved in telemedicine. • Explain the different types of data storage and communication standards usedin telehealth system. • Discuss the various applications of telemedicine.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Introduction To Telemedicine:** History of Telemedicine, Block diagram of telemedicine system, Definition of telemedicine, Tele health , Tele care, origins and Development of Telemedicine, Scope, Benefits and limitations of Telemedicine.	**6Hrs**
Unit-2	**Types of Information, Networks and wireless communication**: Audio, Video, still Images, text and data, Fax. PSTN, POTS, ATN, ISDN, Internet, GSM, satellite and Micro Wave. Different modulation techniques, Types of antennas depending on requirements, Integration and Operational issues: system integration, Store-and-forward operation, real-time Telemedicine.	**6Hrs**
Unit-3	**Data Exchanges**: Network Configuration, Circuit and packet switching, H.320 series (Videophone based ISBN) T.120, h.324 (Video phone based PSTN), Video Conferencing.	**6Hrs**
Unit-4	**Data Security and Standards:** Encryption, Cryptography,	**6Hrs**

	Mechanisms of encryption, Phases ofEncryption. Protocols,TCP/IP, ISO-OSI, Standards to followed DICOM, HL7.Ethical and legal aspects of Telemedicine**,** Confidentiality and Law, patient rights and consent,access to medical Records, Consent treatment, jurisdictional Issues, Intellectual property rights.	
Unit-5	**Applications to Telemedicine:** Tele radiology: Basic parts of Teleradiology system: Image Acquisition system, Display system,Communication network, Interpretation. Tele Pathology: Multimedia databases, color images ofsufficient resolution: Dynamic range, spatial resolution, compression methods, Interactivecontrol of colour, controlled sampling, security and confidentiality tools. Telecardiology, Teleoncology, Telesurgery.	**6Hrs**
References	1. Olga Ferrer-Roca, M.SosaLudicissa, Handbook of Telemedicine, IOS press 2002. 2. A.C.Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002. 3. Bernard Fong, Telemedicine Technologies: Information Technologies in Medicine and Tele health, published in 2010 by Wiley 4. Marlene M. Maheu, E-Health, Tele health, and Telemedicine: A Guide to Startup and Success (Jossey-Bass Health Series), published in 2001 by Jossey-Bass 5. Adam Darkins, Margaret Cary, Telemedicine and Tele health: Principles, Policies, Performance and Pitfalls, published in 2000 by Springer Publishing Company	

Course code	**BMC-651**				
Category	**CORE BIOMEDICAL**				
Course title	**SIGNAL PROCESSING LAB**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	1	0	0	2	
Pre-requisites (if any)	Nil				
Objectives	Aim of this subject is to explain the several types of the Biological signals and their processing in term of filtering, Compression and Extraction of information.				
Outcomes	Students would be able to interpret the signals and develop the system for its analysis				
	List of Experiments: 1. EMG signal acquisition, amplification and filtering through BIOPAC MP36 system. 2. ECG signal acquisition, amplification and filtering through BIOPAC MP36 system. 3. EEG signal acquisition, amplification and filtering through BIOPAC MP36 system. 4. Sampling and Waveform Generation in MATLAB 5. Design a low pass filter and plot graph of gain versus frequency. 6. Design a high pass filter and plot graph of gain versus frequency. 7. Design a band pass filter and plot graph of gain versus frequency 8. Develop a MATLAB program to perform synchronized averaging for a noisy signal. 9. Write a MATLAB program to compute RMS value at each instant for the EMG signal. 10. Acquisition of EMG signal using EMG amplifying system and calculation of nerve conduction velocity.				
References	Departmental Lab reference manual				

Course code	**BMC-652**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL INSTRUMENTATION-II LAB**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	1	0	0	2	
Pre-requisites (if any)	Nil				
Objectives	Biomedical Instrumentation is a core subject in Biomedical Engineering and the main objective is aware the students with basic instrumentation used for the Laboratory testing.				
Outcomes	Students would be aware with the repairing maintenance and calibration of the Analytical equipment's				
	List of Experiments: 1. Designing of Instrumentation Amplifier for Bioelectrical signal Recording. 2. Recording and Analysis of Bioelectrical Signals 3. Recording of Body Composition using Electrical Impedance Method 4. Operating, Maintenance and Calibration of Colorimeter 5. Operating, Maintenance and Calibration of UV spectrophotometer 6. Operating, Maintenance and Calibration of Flame Photometer 7. Operating, Maintenance and Calibration of Bio analytical equipment's				
References	Departmental Lab reference manual				

Course code	**MCC-601**				
Category	**MANDATORY**				
Course title	**INDIAN CONSTITUTION**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	0	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• To create awareness among students about the Indian Constitution. • To acquaint the working conditions of union, state, local levels, their powers and functions. • To create consciousness in the students on democratic values and principles articulated in the constitution. • To expose the students on the relations between federal and provincial units. • To divulge the students about the statutory institutions.				
Outcomes	• Know the background of the present constitution of India. • Understand the working of the union, state and local levels. • Gain consciousness on the fundamental rights and duties. • Be able to understand the functioning and distribution of financial resources between the centre and states. • Be exposed to the reality of hierarchical Indian social structure and the ways the grievances of the deprived sections can be addressed to raise human dignity in a democratic way.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Evolution of the Indian Constitution:** 1909 Act, 1919 Act and 1935 Act. Constituent Assembly: Composition and Functions; Fundamental features of the Indian Constitution.				**6Hrs**
Unit-2	**Union Government:** Executive-President, Prime Minister, Council of Minister **State Government:** Executive: Governor, Chief Minister, Council of Minister				**6Hrs**

	Local Government: Panchayat Raj Institutions, Urban Government	
Unit-3	**Rights and Duties:** Fundamental Rights, Directive principles, Fundamental Duties	**6Hrs**
Unit-4	**Relation between Federal and Provincial units:** Union-State relations, Administrative, legislative and Financial, Inter State council, NITI Ayog, Finance Commission of India.	**6Hrs**
Unit-5	**Statutory Institutions:** Elections-Election Commission of India, National Human Rights Commission, National Commission for Women.	**6Hrs**
References	1. Abhay Prasad Singh & Krishna Murari, Constitutional Government and Democracy in India, Pearson Education, New Delhi, 2019 2. D.D. Basu, Introduction to the constitution of India, Lexis Nexis, New Delhi 3. Subhash Kashyap, Our Parliament, National Book Trust, New Delhi 4. Peu Ghosh, Indian Government &Politics, Prentice Hall of India, New Delhi 5. B.Z. Fadia& Kuldeep Fadia, Indian Government &Politics, Lexis Nexis, New Delhi	

Course code	**BMC-701**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL INSTRUMENTATION-III**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	Objective is too aware the students with electrotherapy. Pulmonary, sensory instruments.				
Outcomes	Students would be aware with the functioning and maintenance and the calibration of the above mentioned equipment's.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Pulmonary analyzers and aid equipments:**Regulation of Breathing - Pulmonary gas flow measurements - Pulmonary volume measurements - Respiratory gas analyzers – Nitrogen Gas Analyzer, Oxygen Analyzer - Humidifier, Nebulizer – Ventilators - IPPB Unit - Anaesthesia machine.	**6Hrs**
Unit-2	**Physiotherapy and electrotherapy equipment's:**Tissue response -Short ware diathermy - Microwave diathermy - Ultrasonic therapy Unit - Electrotherapy - FES, TENS - Bladder stimulator - Lithotripter system - Extra corporeal Shock wave therapy.	**6Hrs**
Unit-3	**Instruments dealing with kidney and bones:**Regulation of Water and Electrolyte Balance – Artificial Kidney – Hemo dialysis - Crafts for dialysis - Peritoneal dialysis - Dialyzers – different types - BMD Measurements – SXA – DXA - Quantitative ultrasound bone densitometer.	**6Hrs**
Unit-4	**Sensory instrumentation:**Mechanism of Hearing, Sound Conduction System - Basic Audiometer, Pure toneaudiometer, Audiometer system Bekesy – Hearing Aids - Ophthalmoscope – Tonometer - Measurement of Basal Skin response and Galvanic skin response - Instruments for testing Motor responses - Experimental Analysis of Behaviour - Biofeedback Instrumentation.	**6Hrs**
Unit-5	**Special equipment's:**Endoscopy – Laparoscopy - Cryogenic Equipment - Automated drug delivery system – Components of drug infusion system – Implantable infusion systems.	**6Hrs**

References	1. Geoddes L.A and Baker L.E, "Principles of Applied Biomedical Instrumentation", John Wiley, 3 rd Edition, 1975, Reprint 1989. 2. Khandpur R.S, "Hand-book of Biomedical Instrumentation", Tata McGraw Hill, 2nd Edition, 2003. **3.** Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurement", Prentice-Hall India, 2 nd Edition,1997

Course	**BMC-702**

code					
Category	**CORE BIOMEDICAL**				
Course title	**HOSPITAL MANAGEMENT**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	Objective of this course is to aware the students with hospital management				
Outcomes	Students would be conferred with the profound knowledge of hospital management				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Overview of hospital administration:**Distinction between Hospital and Industry, Challenges in Hospital Administration – Hospital Planning – Equipment Planning – Functional Planning - Current Issues in Hospital Management - Telemedicine - Bio-Medical Waste Management.	**6Hrs**
Unit-2	**Human resource management in hospital:**Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer.	**6Hrs**
Unit-3	**Marketing research & consumer behaviour:**Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations – Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - Types of buying decision behaviour - The buyer decision process - Model of business buyer behaviour – Major types of buying situations - global marketing in the medical sector - WTO and its implications.	**6Hrs**
Unit-4	**Hospital information systems & supportive services:**Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information	**6Hrs**

	Systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy– Food Services - Laundry Services.	
Unit-5	**Quality and safety aspects in hospital:**Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – Environment Management Systems. NABA, JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care – Medical Audit – Hazard and Safety in a hospital Setup.	**6Hrs**
References	1 Nicholas Cram & Selby Holder, "Basic Electronic Troubleshooting for Biomedical Technicians", TSTC Publishing, 2nd Edition 2010. 2 World Health Organisation, "Maintenance & Repair of Laboratory, Diagnostic imaging & Hospital Equipment", Geneva,1994.	

Course code	**BMD-701**				
Category	**DEPARTMENTAL ELECTIVE**				
Course title	**QUALITY CONTROL IN BIOMEDICAL ENGINEERING**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• Review components of a QA program and show how they apply to DR. • Understand how some conventional tests should be modified for a digital radiographic system integrated into an electronic image management system. • Identify key references and standards that can be useful in QA of DR.				
Outcomes	• Learn the fundamental concepts of quality management in biomedical field. • Learn the use of advanced tools in biomedical quality control field.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Fundamentals of quality management:** Definition of Quality, Dimensions of Quality, Quality Planning - Quality costs. - Analysis Techniques of quality Cost - Basic concepts of Total Quality Management, Historical Review. - Principles of TQM, Leadership – Concepts, Role of Senior Management - Quality Council, Quality Statements - Strategic Planning - Deming Philosophy - Barriers to TQM Implementation.				**6Hrs**
Unit-2	**Quality management principles:** Customer satisfaction – Customer Perception of Quality - Customer Complaints, Service Quality, Customer Retention - Employee Involvement – Motivation, Empowerment - Teams and Team Work - Recognition and Reward, Performance Appraisal, Benefits - Continuous Process Improvement – Juran Trilogy - PDSA Cycle, 5S, Kaizen - Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development - Performance Measures – Basic Concepts, Strategy, Performance Measure				**6Hrs**
Unit-3	**Statistical process control:** Seven Tools of Quality: I, II, and III - Concept of Six Sigma: I and II - New Seven Management				**6Hrs**

	tools: I and II - Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample - Normal Curve, Control Charts for variables and attributes, Process capability	
Unit-4	**TQM tools:** Benchmarking – Reasons to Benchmark - Benchmarking Process – Quality Function Deployment (QFD) – House of Quality - QFD Process - Benefits - Taguchi Quality Loss Function - Total Productive Maintenance (TPM) – Concept, Improvement Needs - FMEA – Stages of FMEA	**6Hrs**
Unit-5	**Regulatory organizations in medicine:** Need for ISO 9000 and Other Quality Systems - ISO 9000:2000 Quality System – Elements, Implementation of Quality System - Quality Auditing - Need for Accreditation of hospitals - FDA Regulations- Joint Commission – Regulatory Bodies of India- Medical Council of India - Pharmacy Council Of India, Indian Nursing Council - Dental Council of India, Homeopathy Central Council	**6Hrs**
References	1. Rose J.E, "Total Quality Management", Kogan Page Ltd., 1993. 2. Cesar A. Cacere& Albert Zana, "The Practise of clinical Engineering". Academic Press, Newyork, 1997.	

Course code	**BMD-702**				
Category	**DEPARTMENTAL ELECTIVE**				
Course title	**BIOMEDICAL ETHICS AND IPR**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• Understand the process of IPR • Understand education and management while serving the human society. • Gain the knowledge Biomedical ethics and its role for the human society. • Understanding Engineering Wisdom in Practical Bioethics. • Know the role of ethics in the biomedical processes.				
Outcomes	• Memorize basic medical ethical system. • Classification of Major Bioethical Areas. • Illustrate Ethics of Scale. • Knowledge of IPR filling process. • Explain the Bioethical Success and Failure.				

S. No.	**Unit details**	**Time Allotted**
Unit-1	**Biomedical Ethics:** Principles, rules and moral decisions of biomedical ethics, respect for autonomy, voluntariness information and informed consent, competency, non-maleficence, the rule of the double effect, befecience, paternalism, justice.	**6Hrs**
Unit-2	**Ethical Issues in Design and Manufacture of Medical Devices: -** Cost benefit analysis, professional restrictions and responsibility, rights of engineers, conflict of interest, codes of ethics for biomedical engineers, ethics of implant use and marketing.	**6Hrs**
Unit-3	**Basic Principles of IPR Laws**: History of IPR-GATT,WTO,WIPO & TRIPs, Role of IPR in Research & Development, Concept of property, Different forms of IPR – copyright, trade mark, Industrial Designs, Layout designs of Integrated circuits, Patents, Geographical Indications, Traditional Knowledge, Plant varieties, Trade secrets	**6Hrs**

Unit-4	**Safety and Standards:** Regulatory Authorities for medical device regulation in India (CDSCO), Global Harmonization Task Force for device regulation abroad, 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.	**6Hrs**
Unit-5	**Global issues:** 8 Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.	**6 Hrs**
References	1. John I. Gallin, Frederick P. Ognibene "Principles and Practice of Clinical Research", Academic Press, Third Edition, 2012. 2. Ezekiel J. Emanuel, Robert A. Crouch, John D. Arras, Jonathan D.Moreno, Christine Grady, "Ethical and Regulatory Aspects of Clinical Research", Johns Hopkins University Press, First Edition, 2003.	

Course code	**BMD-703**				
Category	**DEPARTMENTAL ELECTIVE**				
Course title	**EMBEDDED SYSTEMS IN BIOMEDICAL ENGINEERING**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Assembly and C language				
Objectives	The purpose of this course is to design biomedical system using one of the new engineering tools (Microcontrollers, Microprocessors, DSP etc.).				
Outcomes	• Understand the concept of embedded system design and its application in different design andproduct, Programming for Embedded System Design. • Understand architecture and functionalities of each block inside the processor • Get idea about working of processor and its application • Select appropriate microcontroller for design • Calculate memory requirement and other on-chip/off-chip peripheral requirement • Understand requirement of a project as well as inputs and outputs of the system • Make flowchart of different tasks and decisions • Understand multitasking environment and development tools • Design software for the target processor/controller • Interface peripherals with the board • Understand different communication protocols to make the system as a part of network				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Overview of Embedded System:** Embedded System, Categories of Embedded System ,Requirements of Embedded Systems, Challenges and Issues in Embedded Software Development, Applications of Embedded Systems in Consumer Electronics, Control System, Biomedical Systems, Handheld computers, Communication devices.				**6Hrs**
Unit-2	**Embedded Hardware & Software Development Environment:** Hardware Architecture, Micro- Controller Architecture, Communication Interface Standards, Embedded System Development Process, Embedded Operating systems, Types of Embedded Operating systems.				**6Hrs**

Unit-3	**Real Time & Database Applications:** Real-Time Embedded Software Development, Sending a Message over a Serial Link, Simulation of a Process Control System, Controlling an Appliance from the RT Linux System, Embedded Database Applications using examples like Salary Survey, Energy Meter Readings.	**6Hrs**
Unit-4	**Microchip** PIC16 family – PIC16F873 processor – features – architecture – memory organization – register file map – I/O ports – PORTA - PORTB – PORTC – Data EEPROM and flash program memory – Asynchronous serial port – SPI mode – I2C mode.	**6Hrs**
Unit-5	**Applications:** Real-Time Embedded Software Development, Sending a Message over a Serial Link, Simulation of a Process Control System, Controlling an Appliance from the RT Linux System, Embedded Database Applications, Embedded medical applications: Ophthalmology- Glaucoma screening device, Medical Imaging Acquisition User Interface, Drug delivery systems, Patient monitoring Systems.	**6Hrs**
References	1. Dreamtech Software Team, Programming for Embedded Systems-, Wiley Dreamtech 2002 2. Rajkamal, Microcontrollers- Architecture, programming, Interfacing and system Design, Pearson Education, 2005 3. John B Peatman, Design with PIC micro-controllers, published in 1997 by Prentice Hall	

Course code	**CSC-708**				
Category	**ELECTIVE**				
Course title	**ARTIFICIAL INTELLIGENCE AND NEURAL NETWORK**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Basic Math, Science and Computer programming.				
Objectives	• The primary objective of this course is to introduce the basic principles, techniques, and applications of Artificial Intelligence. • Investigate applications of AI techniques in intelligent agents, expert systems, artificial neural networks and other machine learning models.				
Outcomes	• Define the various searching techniques, constraint satisfaction problem and example problems- game playing techniques. • Classify AI techniques in applications which involve perception, reasoning and learning. • Demonstrate about AI techniques for knowledge representation, planning, uncertainty management and exploration methods. • Distinguish the knowledge of real world Knowledge representation, the modern view of AI as the study of agents that receive precepts from the environment and perform actions • Defend a real world problem for implementation and understand the dynamic behaviour of a system. • Formulate the machine learning techniques to design AI machine and enveloping applications for real world problems.				
S. No.	**Unit details**				**Time Allotted**
Unit-1	**Introduction:** Introduction to Artificial Intelligence, History, What is AI, Importance of AI, Issues, Simulation of sophisticated & Intelligent Behaviours in different area, problem solving in games, natural language, automated reasoning, visual perception, Search algorithms: Informed search, Uninformed search, Hill Climbing, Depth first search, Best first search, And or graph.				**6Hrs**
Unit-2	**Processing and understanding Natural Languages:** Understanding Natural Languages: Applications of Natural Languages, Natural Language processing, Parsing techniques: Rules of parsing, Top down parsing, Bottom up parsing, Transformational grammars, Context free grammar, Transition				**6Hrs**

	networks, Fillmore's grammars, Shanks Conceptual.	
Unit-3	**Knowledge Representation:** Graphs, Frames structures and related structures, Semantic Nets and Partitioned Nets, Scripts, Introduction to PROLOG, Production Rules, Knowledge Based systems, Inference engine, Forward deductions and backward deductions, Matching production rules against working memory.	**6Hrs**
Unit-4	**Expert System** Existing Expert Systems (DENDRAL, MYCIN), Architecture of expert system, Features of Expert system, Genetic algorithm, Fuzzy logic, Neural Networks, Intelligent Agents, Meta Knowledge, Expertise Transfer, Self Explaining System, User and expert systems.	**6Hrs**
Unit-5	**Pattern Recognition** Introduction to Pattern Recognition, Structured Description, Symbolic Description, Machine perception, Line Finding, Interception, Semantic & Model, Object Identification, and Speech Recognition. **Programming Language** Introduction to programming Language, LISP, PROLOG.	**6Hrs**
References	1. Elaine Rich, Kevin Knight and Shivashankar B.Nair, "*Artificial Intelligence*", Tata McGraw-Hill, Third edition, 2009. 2. Elamie, "*Artificial Intelligence"*, Academic Press, Third Edition, 2007. 3. Stuart Russell and Peter Norvig, ``*Artificial Intelligence: A Modern Approach*.", Prentice Hall, Third Edition, 2010. 4. Char Nick, "*Introduction to Artificial Intelligence"*, Addision Wesley, 2007. 5. Patrick Henry Winston and Berthold Horn, " *LISP"*, Addison Wesley, Third Edition, 2010. 6. Marcellous, "*Expert Systems Programming"*, Prentice Hall Inc., Third Edition,2009. 7. Dan W. Patterson, *"Artificial Intelligence and Expert Systems*",PHI Learning Private Limited, Third Edition, 2009.	

Course code	**BMC-751**				
Category	**CORE BIOMEDICAL**				
Course title	**BIOMEDICAL INSTRUMENTATION-III LAB**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	1	0	0	2	
Pre-requisites (if any)	Nil				
Objectives	Objective of this course is to aware the students with biomedical instrumentation				
Outcomes	Students would be conferred with the profound knowledge of biomedical instrumentation				
	List of Experiments: 1. Operating, Maintenance and calibration of Muscle Stimulator 2. Operating, Maintenance and calibration of TENS 3. Operating, Maintenance and calibration of IFT 4. Operating, Maintenance and calibration of Ultrasound Therapy 5. Operating, Maintenance and calibration of different Sensory equipment's.				
References	Departmental Lab reference manual				

Course code	**BMC-751**				
Category	**CORE BIOMEDICAL**				
Course title	**HOSPITAL MANAGEMENT CASE STUDIES**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	1	0	0	2	
Pre-requisites (if any)	Nil				
Objectives	The objectives of this course are to help the students understand the knowledge of basic concepts, principles of hospital management and its practical applications in the organization.				
Outcomes	• To develop knowledge and understanding of key theories, concepts and models and also to critically analyze the situations in the organizational setup. • It also helps in ensuring that the organizational goals and targets are met using minimum cost and waste. • Understanding the importance of looking after health , welfare and safety of staff • Apply and evaluate best practices for protecting the machinery and resources of the organization.				
	List of Experiments: 1. Operational Improvement and Increased Patient Satisfaction at An Urgent Care Center 2. Organizational Transformation at A Pediatric Emergency Department 3. Integrated Acute Care Lays the Groundwork for Sepsis Bundle Compliance 4. Inpatient Throughput Improvements 5. Hospitalist Impact on Patient Throughput 6. Improving ED Patient Throughput and Achieving Sustainable Outcomes 7. Practice Reduces Door-to-Provider Time, Increases Patient Satisfaction				
References	www.google.co.in				

Course code	**MCC-708**				
Category	**MANDATORY**				
Course title	**TECHNICAL REPORT WRITING**				
Scheme and Credits	**CR**	**L**	**T**	**P**	
	3	3	0	0	
Pre-requisites (if any)	Nil				
Objectives	• Understand professional writing by studying management communication contexts and genres, researching contemporary business topics, analyzing quantifiable data discovered by researching, and constructing finished professional workplace documents. • Recognize, explain, and use the formal elements of specific genres of organizational communication: white papers, recommendation and analytical reports, proposals, memorandums, web pages, wikis, blogs, business letters, and promotional documents. • Understand the ethical, international, social, and professional constraints of audience, style, and content for writing situations a.) among managers or co-workers and colleagues of an organization, and b.) between organizations, or between an organization and the public.				
Outcomes	• Write for a particular target audience, and adapt the same material for different audiences. • Formulate the purpose and goal of the writing, and develop an approach and methodof persuading the audience of your main points. • Order and structure the material and the flow of information in a manner to support your argument. • Given the purpose and the persuasive message, create a report outline, and knowhow the various sections are going to link together to support the persuasivemessage. • Recognise the value of writing in plain English. • Recognise the value of visual material in technical reports, and be to match the verbalmessage with a graphical message • Recognise the importance of layout, and the non-verbal messaging in the preparationof reports.				
S. No.	**Unit details**				**Time Allotted**

Unit-1	**Writing in perspective:** Writing in a Technical Context The Technical Writer in YOU!	**6Hrs**
Unit-2	**The technical writing process** The Technical Writing Process	**6Hrs**
Unit-3	**Arranging** Structure and Layout	**6Hrs**
Unit-4	**Writing, Reviewing and Editing** Language and Grammar Types of Reports Monitoring Project Progress Format for an Evaluation Presentation Checklist for Editing Work	**6Hrs**
Unit-5	**Ethical and Legal Considerations:** a. Society for Technical Communicators guidelines b. Dilemmas in the workplace c. Legal obligations of technical writers **Oral presentations:** a. Elements of effective presentations b. Oral presentation of student research projects.	**6Hrs**
References	1. " Technical Writing" by Basu. 2. " Handbook of Technical Writing" by Joanne Buckley and David A Mcmurrey. 3. " Technical Writing: Process and Product" by Gerson. 4. " Elements of Technical Writing (Elements of Series)" by Gary Blake and Robert W Bly.	