CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

FOR

BACHELOR OF TECHNOLOGY (B.Tech.)

(4 Year Undergraduate Degree Programme)

IN

BIOMEDICAL ENGINEERING

[w. e. f. 2020-21]

FACULTY OF ENGINEERING AND TECHNOLOGY

SRM UNIVERSITY DELHI-NCR, SONEPAT

Plot No.39, Rajiv Gandhi Education City, P.S. Rai, Sonepat

Haryana-131029

SRM UNIVERSITY DELHI-NCR, SONEPAT (HARYANA)

VISION

SRM University Delhi-NCR, Sonepat, Haryana aims to emerge as a leading world-class university that creates and disseminates knowledge upholding the highest standards of instruction in Medicine & Health Sciences, Engineering & Technology, Management, Law, Science & Humanities. Along with academic excellence and skills, our curriculum imparts integrity and social sensitivity to mould our graduates who may be best suited to serve the nation and the world.

MISSION

- To create a diverse community campus that inspires freedom and innovation.
- Promote excellence in educational & skill development processes.
- Continue to build productive international alliances.
- Explore optimal development opportunities available to students and faculty.
- Cultivate an exciting and rigorous research environment.

DEPARTMENT OF BIOMEDICAL ENGINEERING

VISION

The department of Bio-Medical Engineering is where the boundaries between disciplines fade for defining excellence in research and education. It focuses on producing graduates who apply scientific knowledge and engineering principles to contribute usefully to society by developing biomedical technology needed for the upgrade and maintenance of the national healthcare system. By converging the engineering expertise in analytical and experimental methods to biological and medical sciences, we aim at unveiling the unseen in biology and innovations in technology that can be translated to clinical health care.

MISSION

1. Provide solid fundamental knowledge in life sciences, bioengineering and medical technology.
2. All-round development of students through versatile education and their sustained engagement with local, national and global communities.
3. Produce graduates for leadership roles in a rapidly-changing environment.
4. Bring together a broad spectrum of faculty expertise under a single umbrella to focus on Interdisciplinary research.
5. Prepare students for careers in post-graduate schools, Biomedical Engineering practice in Industry and even opportunities unforeseen
6. Develop awareness of the wealth of possibilities available to Biomedical Engineering graduates.
7. Nurture lifelong inspired learners from across the globe in line with our cultural ideal of ‘Learn, Leap and Lead’.

PROGRAM REQUIREMENT

General Education Requirements

Basic Science and Engineering Requirements: Engineering Science (ES) through regular/online mode

Disciplinary Requirements comprising of:

BME Core courses (through regular/online mode)

BME Electives (through regular/online mode)

BME Open Electives (through regular/online mode)

Practical and Research component:

1. Regular Practical and Research
2. Summer Internships
3. Specialized courses through the Study Abroad program
4. Minor and Major Project
5. Industry internship through the semester.

SEMESTER-I

Code	Category	Course	L	T	P	C
Theory						
20MA1011	B	Basic Mathematics	3	2	0	4
20CY0101	B	Chemistry	3	0	0	3
20BT0101	C	Fundamental Biology	3	0	0	3
20CS1112	E	Programming in C	3	0	0	3
20PH0101	B	Physics	3	0	0	3
20LE0101	H	Technical English - I	1	0	2	2
Practical						
20PH0103	B	Physics Lab	0	0	2	1
20PD0101	B	Chemistry Lab	0	0	2	1
20CS0150	E	Programming in C Lab	0	0	2	1
20PD0101	H	Personality Development - I	1	0	0	1
20GE0107	H	Yoga	0	0	2	1
Total			17	2	8	23
Total Contact Hours			27			

SEMESTER-II

Code	Category	Course	L	T	P	C
Theory						
20MA0104	B	BioStatistics	3	2	0	4
20GE0104	B	Environmental Studies	2	0	0	2
20BM0102	E	Biomedical Circuits & Network	3	0	0	3
20CS0201	E	Data Structure using C++	3	0	0	3
20BM0140	C	Physics Application in BME	3	0	0	3
20LE0102	H	Technical English - II	1	0	2	2
20GE0108	H	Value Education - I	1	0	0	1
Practical						
20CS0213	E	Data Structure & Algorithm Lab	0	0	2	1
20BM0112	E	Circuit Analysis Lab	0	0	2	1
20ME0103	E	Engineering Graphics Lab	1	0	2	2
20PD0102	H	Personality Development – II	1	0	0	1
Total			18	2	8	23
Total Contact Hours			28			

SEMESTER-III

Code	Category	Course	L	T	P	C
Theory						
20LE0205/ 20LE0201	H	French/German Language – I	2	0	0	2
20MA1201	B	Application of Mathematics in BME	3	1	0	4
20BM0203	E	Signals and Systems	3	0	0	3
20BM0201	C	Human Anatomy & Physiology	3	0	0	3
20BM0205	E	Electron Devices and Circuits	3	0	0	3
20BT0201	C	Microbiology	4	0	0	4
Practical						
20BM0215	E	Devices and Circuits Laboratory	0	0	2	1
20BT0211	C	Microbiology Lab	0	0	2	1
20PD0201	H	Personality Development – III	0	0	2	1
20BM0213	P	Industrial Training-I	1	0	1	1
Total			19	1	7	23
Total Contact Hours			27			

SEMESTER-IV

Code	Category	Course	L	T	P	C
Theory						
20LE0206/ 20LE0202	H	French/German Language – II	2	0	0	2
20BT1004	C	Biochemistry	3	0	0	3
20BT0202	C	Immunology	4	0	0	4
20BM0204	E	Linear Integrated Circuits	3	0	0	3
BMXXXX	D	Dept. Elective-1 (Medical Physics)	3	0	0	3
CSXXXX	O	Open Elective-1(Digital System)	3	0	0	3
Practical						
20BM0214	E	Integrated Circuits Laboratory	0	0	2	1
20BT0212	C	Immunology Lab	0	0	2	1
20BT1010	C	Biochemistry Lab	0	0	2	1
CSXXXX	O	Digital System Lab	0	0	2	1
20PD0202	H	Personality Development – IV	0	0	2	1
Total			18	0	10	23
Total Contact Hours			28			

SEMESTER-V

Code	Category	Course	L	T	P	C
Theory						
20BM0301	C	Biomaterials and Artificial organs	3	0	0	3
CSXXXX	O	Open Elective-2 (Digital Signal Processing and Its Applications)	3	0	0	3
20MA0301	B	Numerical Methods in BME	3	1	0	4
20BT0301	C	Molecular Biology & Genetics	4	0	0	4
20BM0303	E	Biomedical Instrumentation	4	0	0	4
BMXXXX	D	Dept. Elective-2 (Bio Fluid Dynamics & Mechanics)	3	0	0	3
Practical						
20BM0313	E	Biomedical Instrumentations Lab	0	0	2	1
CSXXXX	O	DSP Lab	0	0	2	1
20BT0311	C	Molecular Biology Lab	0	0	2	1
20PD0301	H	Personality Development – V	0	0	2	1
20BM0313	P	Industrial Training-II	1	0	1	1
Total			21	1	9	26
Total Contact Hours			31			

SEMESTER-VI

Code	Category	Course	L	T	P	C
Theory						
BMXXXX	O	Open Elective-3 (Nuclear Medicine)	3	0	0	3
20BM0304	C	Genomics & Proteomics	3	0	0	3
20BM0302	E	Therapeutic Instrumentation	3	0	0	3
20BI0302	C	Introduction to Bioinformatics	3	0	0	3
20BM0306	E	Microprocessors and Microcontrollers	3	0	0	3
BMXXXX	D	Dept Elective-3 (Hospital Safety & Management)	3	0	0	3
Practical						
20BI0312	C	Basic Bioinformatics Lab	0	0	2	1
20BM0316	E	Microprocessors and Microcontrollers Lab	0	0	2	1
20BM0314	C	Genomics & Proteomics Lab	0	0	2	1
20BM0312	E	Therapeutic Instrumentation Lab	0	0	2	1
20PD0302	H	Personality Development – VI	0	0	2	1
Total			18	0	10	23
Total Contact Hours			31			

SEMESTER-VII

Code	Category	Course	L	T	P	C
Theory						
BMXXXX	D	Dept. Elective-4 (Chemoinformatics & Drug Designing)	3	0	0	3
20BM0401	E	Digital Image Processing	3	0	0	3
20BI0401	C	Perl Programming &Bioperl	3	0	0	3
20BM0403	C	Nanotechnology in Medicine	3	0	0	3
20BM0405	E	Rehabilitation Engineering	3	0	0	3
CSXXXX	O	Open Elective-4 (Telemedicine)	3	0	0	3
Practical						
BM0413	D	CIDD Lab	0	0	2	1
20BI0411	C	Perl Lab	0	0	2	1
20BM0411	E	Digital Image Processing Lab	0	0	2	1
BT0415	P	Minor Project Lab	0	0	2	1
Total			18	0	8	22
Total Contact Hours			26			

SEMESTER-VIII

Code	Category	Course	L	T	P	C
BM0402	P	Major Project/ Practical Hours	0	0	12	6
BM0412	P	Presentation	0	0	8	4
Total			0	0	20	10
Total Contact Hours			20			

SUMMARY OF CREDITS

Category	SEM I	SEM II	SEM III	SEM IV	SEM V	SEM VI	SEM VII	SEM VIII	Total Credits
Humanities & Social Sciences Subjects (H)	4	4	3	3	1	1	-	-	**16**
Basic Sciences Subjects (B)	12	6	4	-	4	-	-	-	**26**
Engineering Science Subjects (E)	4	10	7	4	5	8	7	-	**45**
Core Professional Subjects (C)	3	3	8	9	8	8	7	-	**46**
Department Elective Subjects (D)	-	-	-	3	3	3	4	-	**13**
Open Elective Subjects (O)	-	-	-	4	4	3	3	-	**14**
Project/Seminar/Internship Subjects (P)	-	-	1	-	1	-	1	10	**13**
Mandatory Subjects (M)	-	-	-	-	-	-	-	-	**-**
Total Credits	**23**	**23**	**23**	**23**	**26**	**23**	**22**	**10**	**173**

EVALUATION SCHEME

INTERNAL EVALUATION (THEORY)

Assessment	Internal Assessment -I	Internal Assessment-II	Internal Assessment-III	Internal Assessment-IV	Internal Assessment-V	Total
Marks	10	10	10	10	10	50

INTERNAL EVALUATION (PRACTICAL)

Assessment	Daily Assessment/Observation	Programs performed during Lab hours	Programs performed during Internal practical Examinations	ViVa- Voce	Total
Marks	10	10	10	20	50

EXTERNAL EVALUATION (THEORY)

Assessment	End Semester Examination	Total
Marks	100	Will be scaled in 50

EXTERNAL EVALUATION (PRACTICAL)

Assessment	Record File	Programs performed during External Practical Examinations	Written Work	Viva- Voce	Total
Marks	10	20	10	10	50

Note:

1. The evaluation Scheme may change as per the university guidelines.
2. Evaluation scheme of Industrial training may vary department wise.
3. Evaluation scheme project/minor projectmay vary department wise.
4. Department are advised to add the evaluation scheme in their respective curriculum.

PROGRAM OBJECTIVE

- To develop extensive knowledge in various areas of Biomedical Engineering.
- To avail interaction of students with leading scientists, technocrats and entrepreneurs to gain broader perspective of industry and research.
- To initiate a level of attitude in research that will provide solutions to environmental, industrial, agricultural and health-based problems.
- To create an opportunity for learners interested in Biomedical Engineering, with a potential to innovate.
- To enable learner for careers of constructive service in academia, government, industry and health related fields.

PROGRAM OUTCOME

The curriculum and syllabus for B.Tech BME program conform to outcome based teaching learning process. In general, ELEVEN STUDENT OUTCOMES have been identified and the curriculum and syllabus have been structured in such a way that each of the courses meets one or more of these outcomes. Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviours that students acquire as they progress through the program. Further each course in the program spells out clear instructional objectives which are mapped to the student outcomes.

The student outcomes are:

- An ability to apply knowledge of Mathematics, Science, and Engineering
- An ability to design and conduct experiments, as well as to analyse and interpret data
- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- An ability to function on multidisciplinary teams
- An ability to identify, formulates, and solves engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in global, economic, environmental, healthcare and societal context
- A recognition of the need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

LIST OF OPEN ELECTIVES

Code	Category	Course	L	T	P	C
Open Elective-I						
		Digital System	3	0	0	3
		Internet Programing	3	0	0	3
		Cancer Biology	3	0	0	3
Open Elective-II						
		Digital Signal Processing and Its Applications	3	0	0	3
		Introduction to Python	3	0	0	3
		Introduction to R	3	0	0	3
Open Elective-III						
		Nuclear Medicine	3	0	0	3
		Radiotherapy basics & Application	3	0	0	3
		Ethical Issues & IPR	3	0	0	3
Open Elective -IV						
		Telemedicine	3	0	0	3
		Troubleshooting of Medical Instruments	3	0	0	3
		Robotics & Automation in Medicine	3	0	0	3

LIST OF MODULE ELECTIVES

Code	Category	Course	L	T	P	C
Departmental Elective-I						
		Medical Physics	3	0	0	3
		Electrophysiology of Human System	3	0	0	3
		Optical Instrumentation	3	0	0	3
Departmental Elective-II						
		Bio Fluid Dynamics & Mechanics	3	0	0	3
		Data Science	3	0	0	3
		Biomedical Laser Instrumentation	3	0	0	3
Departmental Elective-III						
		Hospital Safety & Management	3	0	0	3
		Neural Network	3	0	0	3
		Gene Therapy	3	0	0	3
Departmental Elective-IV						
		Chemoinformatics & Drug Designing	3	0	0	3
		AI & Medical Informatics	3	0	0	3
		System Biology	3	0	0	3

SEMESTER I

		L	T	P	C
20MA1011	**BASIC MATHEMATICS**	**3**	**2**	**0**	**4**
Course Category: B	**Pre-requisite**				
	Co-requisite				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To impart knowledge and skills in solving mathematical problems as applied to the respective branches of Bio Engineering
- The laboratory training in addition to theory is included so that the students will acquire the skills to qualify for a broad range of positions in research, industry, consultancy, education and public administration, or for further education in a doctoral program.

UNITS	Course contents	Contact Hours
Unit-I	MATRICES: Introduction to Matrices,Rank of matrix, Consistency of a system of 'm' linear equations in 'n', Inconsistency of a system of 'm' linear equations in 'n' unknowns, Cayley- Hamilton theorem& It's applications, Eigen Values , Eigen vectors for a matrices, Properties of Eigen values and Eigen vectors.	9
Unit-II	TRIGONOMETRY: Basic Trigonometric concepts, DeMoivre's theorem and its applications, Expansion of $\sin^n\theta$and$\cos^n\theta$in terms of sinθ&cosθ, Expansion of $\tan^n\theta$interms of tanθ, Expansion of $\sin^n\theta$ in terms of sines and cosines of multiples of θ, Expansion of $\cos^n\theta$ in terms of sines and cosines of multiples of θ, Hyperbolic functions.	9
Unit-III	DIFFERENTIAL CALCULUS: Introduction to Differentiation, Derivatives of simple functions, Successive Differentiation, Introduction to Leibnitz theorem, Leibnitz theorem's Applications.	9
Unit-IV	INTEGRAL CALCULUS: Introduction to integration, Methods of integration, Introduction to Definite integrals, Properties of Definite integrals, Reduction formulae for sin n x,cosn x (without proof)-Problems, Reduction formulae for sin m xcosn x (without proof)-Problems.	9
Unit-V	APPLICATIONS OF DIFFERENTIAL CALCULUS & INTEGRAL CALCULUS: Differential calculus: Tangent, Differential calculus: Normal, Differential calculus: Radius of curvature, Differential calculus: Velocity, Differential calculus: Acceleration, Integral calculus: Length & Area.	9

LEARNING OUTCOME:

At the end of the course, student will be able to

- To apply matrix knowledge to Engineering problems.
- To improve their ability in trigonometry.

- To be familiar with Differential calculus.
- To expose to the concepts integral calculus.
- To have an understanding the applications of differential and integral calculus.

Learning Resources:

1. Kreyszig.E, "Advanced Engineering Mathematics", 8th edition, John Wiley & Sons, Singapore, 2012
2. K. Ganesan, SundarammalKesavan, K. S. Ganapathy Subramanian, V. Srinivasan, Matrices and Calculus, Gamma Publications, 7th Edition, 2015.
3. Grewal B.S, Higher Engineering Mathematics, Khanna Publications, 44th Edition, 2017.
4. Bali N.P., Goyal M, Watkins C, Advanced Engineering Mathematics: A Complete Approach., Advanced Engineering Mathematics, Laxmi Publications, New, Delhi.2018
5. Kandasamy P et al. Engineering Mathematics, Vol. I (4th revised edition), S. Chand & Co., New Delhi, 2000.
6. Kreyszig.E, "Advanced Engineering Mathematics", 8th edition, John Wiley & Sons, Singapore, 2012
7. Venkataraman M.K., Engineering Mathematics – I Year (2nd edition), National Publishing Co., Chennai, 2000.
8. Dass H. K., Advanced engineering Mathematics, Sultan Chand Publication, Delhi, 2013.

20CY0101	CHEMISTRY	L	T	P	C
		3	0	0	3
Course Category: B	Pre-requisite: NIL				
	Co-requisite: NIL				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To enable the students to acquire knowledge of the principles of chemistry for engineering applications.
- To bring adaptability to new developments in engineering chemistry and a knowledge of contemporary issues relevant to engineering.
- To make them apply the knowledge of fundamental chemistry for identification, solution and analysis of 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.
- To impart knowledge and skills in solving mathematical problems as applied to the respective branches of Bio Engineering.

UNIT	Course contents	Contact Hours
Unit-I	*Water Treatment:*Impurities in Water, Hardness of Water-Softening Methods (Lime-Soda Process, Zeolite, Ion-Exchange Methods), Boiler feed Water-Sludge and scale formation, Caustic embrittlement, priming and foaming, boiler corrosion, Desalination of Brackish Water-Electrodialysis and Reverse Osmosis, Water for Domestic Use-Chlorination, Ozonization, UV treatment, Analysis of Water-Alkalinity, Hardness (EDTA Method), Dissolved Oxygen (Winkel's method).	9
Unit-II	PhaseEqullibrium and Fuels:-Terminologies-Phase, Components, Degree of Freedom, Phase Rule (W. Gibbs), One Component system-Water only (Area, Curve, Triple Point), Two component System and Reduced phase Rule, Eutectic System, Pb-Ag System (Area, Lines), KI-H_2O System (Area, Lines), Technical applications: freeze drying, solders, safety plugs and freezing mixtures. Fuel and their classification, Caloric value, Cracking, Fuel for Internal Combustion Engine-Knocking, Octane Number, Diesel Engine Fuels-Cetane Rating, Non-Conventional Source-Solar Energy, Biomass, Biogas.	9
Unit-III	Polymers:-Terminologies-Functionality, Degree of Polymerization, Classification of polymer, Molecular Weight of Polymer (Mw, Mn), Polymerization- Addition (ionic, free-radical), Co-ordination (Ziegler-Natta), Plastics- PE, Polystyrene, PVC, Teflon, PMMA, Polyesters, Epoxy Resins, Polyamide (Nylon-66, Nylon-6), Phenolic Resins (Bakelite), Amino Resins (Urea-Formaldehyde), Elastomer-Synthetic Rubber, Silicon Rubber.	9
Unit-IV	Corrosion:-Corrosion: Basic concepts - mechanism of chemical, electrochemical corrosion, Types of Electrochemical corrosion - galvanic corrosion - differential aeration corrosion - pitting corrosion - stress	9

	corrosion, Factors Affecting Corrosion-Metal, Environment, Corrosion control: Cathodic protection - sacrificial anodic method - corrosion inhibitors. Protective coatings: surface preparation for metallic coatings - electro plating (copper plating) and electroless plating (Nickel plating) - chemical conversion coatings - anodizing, phosphating & chromate coating..	
Unit-V	Engineering Materials:-High energy materials (HEMs)-Introduction; classification (explosives, propellants, pyrotechnics); requirements of HEM: sensitivity, detonation performance, oxygen balance; Important explosives (structure, preparation, properties): Lead azide, DDNP, dynamites, TNT, PETN, RDX, and plastic explosives.	9

LEARNING OUTCOME:

The students should be conversant with

- The role of applied chemistry in the field of engineering.
- The knowledge of water quality parameters and the treatment of water.
- The principles involves in corrosion and its inhibitions.
- Important analytical techniques, instrumentation and the applications.
- Knowledge with respect to the phase equilibrium of different systems.

LEARNING RESOURCES:

1. PrasantaRath , "Engineering Chemistry", 2015, Cenage Learning India Private Ltd.,
2. Shashi Chawla "A text book of Engineering Chemistry", Dhanpat Rai & Co.
3. S.S. Dara, A Text book of Engineering Chemistry, 10th Edition, S. Chand & Company Ltd., New Delhi, 2003
4. Jain. P. C. and Monika Jain, "Engineering Chemistry", Danpat Rai publishing company (P) Ltd, New Delhi, 2010.

20BT1003	FUNDAMENTAL BIOLOGY	L	T	P	C
		3	0	0	3
Course Category: C	Pre-requisite				
	Co-requisite				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To study the basic living structure and their functions.
- To focus on different physiological processes and introduce the concept of cell signaling and their role in diseases

UNIT	Course contents	Contact Hours
Unit-I	NATURE OF LIVING THINGS Definition of life, Miller's experiment, theories and evidences of origin of life, levels of biological organization, classification of living world, difference between prokaryotes and eukaryotes.	9
Unit-II	MOLECULAR ORGANIZATION OF CELL Difference between animal and plant cell, salient features of intracellular organelles, cell division and cell cycle.Evolutionary processes: Lamarckism, Darwinism, role of mutations and isolating mechanisms, adaptive radiation.	12
Unit-III	FUNDAMENTALS OF GENETICS Mendelian principles, pleiotropy, epistasis, linkage and crossing over.	6
Unit-IV	PHYSIOLOGY Animal Physiology:Hormones and their mode of action, types of asexual and sexual reproduction, stages of embryogenesis.Plant Physiology: Water relations (absorption, adsorption, imbibition, guttation, transpiration, diffusion and osmosis), plant growth regulators (auxins, cytokinins, gibberllins, abscisic acid and ethylene).	9
Unit-V	BIOLOGY OF PLANTS Morphology and anatomy of root, stem and leaves, reproduction in flowering plants.	9

LEARNING OUTCOME

Understanding of:

1. Nature of living things

2. Molecular organization of cell
3. Fundamentals of genetics

LEARNING RESOURCES

- Purves et al, Life: The Science of Biology
- R. Dulbecco, The Design of Life

20CS1112	PROGRAMMING IN C	L	T	P	C
		3	0	0	3
Course Category E	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To introduce programming language C as a tool to solve general and biological problems and to provide hands on training.

UNIT	Course contents	Contact Hours
Unit-I	INTRODUCTION Generation and Classification of Computers- Basic Organization of a Computer, Number System, Binary- Decimal Conversion Problems. Need for logical analysis and thinking, Algorithm, Pseudo code, Flow Chart.	9
Unit-II	C PROGRAMMING BASICS Problem formulation - Problem Solving - Introduction to ' C' programming -fundamentals - structure of a 'C' program - compilation and linking processes - Constants, Variables - Data Types - Expressions using operators in 'C' - Managing Input and Output operations - Decision Making and Branching - Looping statements - solving simple scientific and statistical problems.	9
Unit-III	ARRAYS AND STRINGS Arrays - Initialization - Declaration - One dimensional and Two dimensional arrays. String- String operations - String Arrays. Simple programs- sorting- searching - matrix operations.	9
Unit-IV	FUNCTIONS AND POINTERS Function - definition of function - Declaration of function - Pass by value - Pass by reference - Recursion - Pointers - Definition - Initialization - Pointers arithmetic - Pointers and arrays- Example Problems.	9
Unit-V	STRUCTURES AND UNIONS Introduction - need for structure data type - structure definition - Structure declaration - Structure within a structure - Union - Programs using structures and Unions - Storage classes, Pre-processor directives. Files: File creation – File processing – Opening and closing a file.	9

LEARNING OUTCOME

- Understand the program development life cycle, design algorithms to solve simple problems using computers, convert algorithms into C program and execute.
- Application of the programs in sequence analysis

LEARNING RESOURCES

1. Rajaraman, "*Fundamentals Of Computers*", PHI; 5th edition edition
2. Balagurusamy . "*Programming in ANSI C*", Tata McGraw-Hill Education, 2012.
3. Brian W. Kernighan, Dennis M. Ritchie, "*The C Programming Language*" , second edition, Prentice hall, 1988.

20PH0101	PHYSICS	L	T	P	C
		3	0	0	3
Course Category B	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To provide students with the knowledge of variety of important concepts of Physics and their applications in Engineering and Technology.

UNIT	Course contents	Contact Hours
Unit-I	OSCILLATIONS & ULTRASONIC WAVES Oscillations: Simple Harmonic Motion (SHM), Differential Equation of SHM and its Solutions, Conservation of Energy. Mass-string System. Damped Harmonic Oscillator-Over damped, Critically Damped, Under Damped motions, Relaxation Time, Forced vibrations. Resonance & Quality Factor. Ultrasonic Waves: Methods of production-Magnetostriction& Piezoelectric, Applications of Ultrasonic.	9
Unit-II	ELECTROMAGNETISM Mathematical Background: Gradient, Divergence, curl (Physical Significance), Irrotational& Solenoidal Field, Gauss Divergence and Stoke's Theorem, Important Vector Identities. Maxwell's Equations: Modification in Ampere's Circuital Law, Maxwell's Equation in Integral & Differential forms. Wave equation for Electromagnetic (EM) Waves-Propagation in free space, Characteristic Impedance, Poynting Vector (simple numericals), EM Energy Density.	9
Unit-III	INTERFERENCE & DIFFRACTION Interference: Superposition Principle, Division of Amplitude-Interference in Thin films, Application: Michelson's Interferometer, Interference in Wedge shaped Film, Application: Newton's Ring. Diffraction: Huygen's Wave Theory, Fraunhofer Vs Fresnel Diffractions, Fraunhofer Diffraction in Single & Multiple slits (Grating), Diffraction Vs Interference, Resolving power & Dispersive power of grating and prism.	9
Unit-IV	LASERS & FIBER OPTICS Lasers: Basic Theory- Einstein Coefficients, Properties of Laser, Population inversion, Pumping Schemes, Three and Four level Lasers. Principle, Construction and working of Helium-Neon (He-Ne) &Nd:YAG Lasers. Optical Fibers (OFs): Physical Structure and Principles, Modes, V-Number. Classification of Optical Fibers based on (a) Refractive Index-Step & Graded Index Fibers (b) Modes-Single & Multimode Fibers. Basic Application of OFs in Sensing & Communication. Hollow Core Photonic Crystal Fibers (Elementary	9

	Idea).	
Unit-V	MODERN PHYSICS & QUANTUM MECHANICS Qualitative review of different experiments, Planck's Hypothesis, de-Broglie waves, Dual Nature of Matter, Uncertainty principle, Matter waves, Significance of Wave Functions, Schrodinger Wave Equation, Operators in Quantum Mechanics, Particle in a One-Dimensional Box, The Potential Barrier Problem and Tunnelling Effect (Qualitatively).	9

LEARNING OUTCOME

- The student is expected to be familiar with broader areas of Physics such as mechanics of solids, optics, mechanical and electromagnetic waves oscillations and their relevance in Engineering.

LEARNING RESOURCES

1. H.K. Malik and A.K. Singh, Engineering Physics, McGraw Hill Education Private Limited, New Delhi, 2014.
2. N. Subrahmanyam and Brij Lal, Waves and Oscillations.
3. Beiser A, Concepts of Modern Physics, 5th Ed., McGraw Hill International, 2003.
4. AjoyGhatak, Optics, 5th Ed., Tata McGraw Hill, 2012.
5. David J. Griffiths, Introduction to Electrodynamics, Pearson Education Limited, London, 2015.
6. Arumugam, M., Engineering Physics, 2nd edition, Anuradha Publishers, Kumbakonam, 2003.
7. Gaur and Gupta, Engineering Physics, 7th edition, Dhandapani and Sons, New Delhi, 1997.
8. Thiruvadigal, J. D., Ponnusamy, S., Vasuhi, P. S. And Kumar, C., Physics for Technologists, 5th edition, Vibrant Publication, Chennai, 2007

LE0101	TECHNICAL ENGLISH - I	L	T	P	C
		1	0	2	2
Course Category H	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- The students need to prepare themselves for their career which may require them to listen to, read, speak, and write in English both for their professional as well as interpersonal communication in the globalized context.

UNIT	Course contents	Contact Hours
Unit-I	Nuances of English Language I • Basic Grammar. • Parts of speech and agreement (voice, tense, number). • Modals and Auxiliaries. • Phrasal Verbs	6
Unit-II	Nuances of English Language II • Preposition • Types of sentences (Interrogatives, Declaratives, Exclamatory and Imperative) • Direct and Indirect speech • Question Tags • Common mistakes in English (spelling mistakes, uncountable noun mistakes, irregular plural mistakes, irregular verb mistakes, collocation mistakes, mistakes in the use of articles, prepositions, subject-verb agreement etc)	6
Unit-III	Language and Regional Variation • Accent and Dialect • Dialectology • Regional Dialects • Style, Slang and Jargon	6
Unit-IV	Writing Skills • Effective writing practice – Vocabulary expansion • Effective sentences: role of acceptability, appropriateness, brevity & clarity in writing • Cohesion & coherence in writing • Writing of definitions, descriptions • Paragraph writing.	6
Unit-V	Academic Writing Skills • Reciprocal relationship between reading and writing • Thinking and Writing • Argument Writing Practice • Perspectives in Writing • Professional Writing	6

	• Narrative Writing	

LEARNING OUTCOME

- The Technical English course will empower the students to improve both abilities to communicate and your linguistic competence in the chosen language. A balance of Input (reading, listening) and output (speaking, writing) s abilities are created through open classes and self- study.

LEARNING RESOURCES

1. Practical English Grammar – A J Thomson and A V Martinet (OUP)
2. M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw-Hill, New Delhi, 2005.
3. Strunk, William, and E B. White, The Elements of Style. Boston: Allyn and Bacon, Pearson Edition, 1999.

SEMESTER II

20MA0104	BIOSTATISTICS	L	T	P	C
		3	2	0	4
Course Category B	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- The objective of the course is to make the students familiar with basic of probability and their applications in biomedical engineering. It underlines different concepts and theories that has significance and relevance in details and enable the student to account for while designing their systems and practices**.**

UNIT	Course contents	Contact Hours
Unit-I	DESCRIPTIVE STATISTICS Quantitative and Qualitative Variables, Frequency Tables, Histograms, Bar Chart, Pie Chart, Box Plot, Measures of central tendency: Mean, Median and Mode, Measures of dispersion: Range, Standard Deviation and Variance, Measures of Position: Quartiles and Percentiles.	12
Unit-II	BASIC PROBABILITY Probability theory-Definition of Probability, Mutually Exclusive Events, Independent vs Dependent events, Experiment, Outcomes, Events and Sample Space, Conditional Probability, Total Probability and Baye's theorem, - Random Variables, discrete random variables; probability mass functions; continuous random variables, probability density functions, Expectation.	12
Unit-III	PROBABILITY DISTRIBUTIONS Bernouli distribution, Binomial distribution, Poisson distribution, Geometric distribution, uniform Distribution, Exponential distribution, Normal distributions.	12
Unit-IV	CORRELATION AND REGRESSION Correlation and regression. Correlation model, correlation coefficient, multiple correlation. Simple linear regression, multiple regression.	12
Unit-V	TESTING OF HYPOTHESIS Type I error and Type II error and power of test. Hypothesis testing for- population means, difference of two population means, population proportions, difference between two population proportions, population variance, ratio of two population variances. Chi square test: test of goodness of fit, independence and heterogeneity.	12

LEARNING OUTCOME

- Students will be able to explain all descriptive statistics.
- Students will be able to explain basic statistical concepts of probability.
- Students will be able to explain basics of probability, discrete & continuous distribution.
- Students will be able to explain correlation and regression analysis.
- Students will be able to explain testing of hypothesis.

LEARNING RESOURCES

1. Seymour Lipschutz, John Schiller, "Introduction to Probability and Statistics", Tata McGraw Hill, 2017.
2. Wayne W. Daniel, "Biostatistics- A foundation for analysis in health sciences", John Wiley & Sons; 11th Edition, EMEA edition , 2019.
3. Fundamental of Mathematical Statistics by S.C. Gupta and V.K Kapoor, Saurabh Jain 2017.
4. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, "Probability & Statistics for Engineers & Scientists", 9th Edition, Prentice Hall, 2017.
5. Prem S. Mann, "Introductory Statistics", John Wiley & Sons; Global edition, 2017.

20GE0140	ENVIRONMENTAL STUDIES	L	T	P	C
		2	0	0	2
Course Category B	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To gain knowledge on the importance of environmental education and ecosystem.
- To acquire knowledge about environmental pollution- sources, effects and control measures of environmental pollution.
- To understand the treatment of wastewater and solid waste management.
- To acquire knowledge with respect to biodiversity, its threats and its conservation and appreciate the concept of interdependence.
- To be aware of the national and international concern for environment for protecting the environment

UNIT	Course contents	Contact Hours
Unit-I	THE MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: Definition, scope and importance, Need for public awareness.	5
Unit-II	NATURAL RESOURCES: RENEWABLE AND NON-RENEWABLE RESOURCES Natural resources and associated problems. Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people. Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.	10
Unit-III	ECOSYSTEMS Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems: ponds, streams, lakes, rivers, oceans, estuaries.	10

Unit-IV	BIODIVERSITY AND ITS CONSERVATION Introduction, definition: genetic, species and ecosystem diversity, Biogeographical classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, National and local levels, India as a mega-diversity nation, Hot-spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity	10
Unit-V	ENVIRONMENTAL POLLUTION Definition, Causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards; Solid waste management: Causes, effects and control measures of urban and industrial wastes; Role of an individual in prevention of pollution, Pollution case studies; Disaster management: Foods, earthquake, cyclone and landslides	10

LEARNING OUTCOME

- The course provides a comprehensive knowledge in environmental science, environmental issues and the management.

LEARNING RESOURCES

1. Kamaraj.P&Arthanareeswari.M, "*Environmental Science – Challenges and Changes"*, 4th Edition, Sudhandhira Publications, 2010.
2. Sharma.B.K. and Kaur, "*Environmental Chemistry",* Goel Publishing House, Meerut, 1994.
3. De.A.K., "*Environmental Chemistry"*, New Age International, New Delhi, 1996.
4. Helen P Kavitha, "*Principles of Environmental Science*", Sci-tech Publications, 2008.

20BM0102	BIOMEDICAL CIRCUITS AND NETWORKS	L	T	P	C
		3	0	0	3
Course Category E	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To enable the students to acquire knowledge about the basics of circuit analysis, network theorems and AC circuits.

UNIT	Course contents	Contact Hours
Unit-I	METHODS OF ANALYSING CIRCUITS WITH INDEPENDENT SOURCES Introduction: Tree and Co-Tree, Twigs and Links, Incidence Matrix, Link Current, Tie Set Matrix, Cut Set and Tree Branch Voltages, Mesh and Super mesh analysis, Mesh equation by Inspection method, Nodal & Super Nodal Analysis, Nodal Equations by Inspection Method, Source Transformation Technique, Analyzing simple biomedical circuits	12
Unit-II	NETWORK THEOREMS Star-Delta Transformation, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Superposition Theorem, Compensation Theorem, Reciprocity theorem, Millman's theorem, Tellegen's theorem, Duals and Duality, Applying theorems in biomedical circuits.	12
Unit-III	AC CIRCUITS AND COUPLED CIRCUITS Power & Power factor, Series resonance-Q factor, Bandwidth, Parallel resonance-Q factor, Bandwidth, Self Inductance- Mutual Inductance - Coefficient of coupling, dot rule- effective inductance of coupled coils in series and parallel.	12
Unit-IV	TRANSIENT ANALYSIS Concept of complex frequency, Representation of network elements in time-, and frequency domain, Free and forced responses of RL, RC, RLC circuits with DC- and Sinusoidal- excitation	12
Unit-V	TWO PORT NETWORKS & ELEMENTS OF REALIZABILITY THEORY Network functions of one port and two port networks, Poles and Zeros of network functions, Two port Parameters: z, y, h, ABCD, Causality and Stability analysis of network functions, Hurwitz polynomial, Positive Real Functions.	12

LEARNING OUTCOME

- To understand the basic methods of circuit analysis using Mesh & Nodal Analysis
- To understand the various Network theorem and apply them in biomedical circuits
- To get an insight into solution of RLC circuits as well as Analysis of coupled circuits
- To understand the concept of complex frequency and Total responses of RL, RC & RLC circuits
- To analyze the two Port network parameters and Stability of Network

LEARNING RESOURCES

1. Hayt, Kemmerley& Durbin, "*Engineering circuit Analysis"*, Tata McGraw Hill, 7th Edition 2008
2. Sudhakar A and Shyammohan S P, "*Circuits and Networks- Analysis and Synthesis"*, Tata McGraw Hill, 4th Edition 2010
3. Franklin F. Kuo, "Network Analysis and Synthesis", John Wiley & Sons, 2nd Edition Reprint 2009
4. Arumugam&Premkumar, "Electric Circuit Theory", Khanna Publishers, First Edition 2002
5. Mahmood Nahvi& Joseph Edminister, "Schaum's Outline of Electric circuits", McGraw-Hill Education, 5th edition 2011

20CS0201	DATA STRUCTURES USING C++	L	T	P	C
		3	0	0	3
Course Category E	**Pre-requisite:** Programming With C				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To enable the students to select appropriate data structure as applicable to specific problem definition.
- To equip the students with the knowledge to handle various operations like searching, insertion, deletion, traversing mechanism on various data structures and use various linear and non linear data structures

UNIT	Course contents	Contact Hours
Unit-I	**INTRODUCTION TO DATA STRUCTURES** – Abstract data types – Arrays – Static, Dynamic and Generic arrays. Strings – Fixed and variable size – static and dynamic strings.	8
Unit-II	**LINKED LISTS** – Dynamic storage management – singly and doubly linked list – Stack – Application of stack – Fixed, variable and Generic stack – queues – queue based on Dynamic linked list – Trees – Binary Trees – Graphs – Warshall's Algorithms – Shortest paths.	10
Unit-III	**OBJECTS ORIENTED PROGRAMMING** – objects and classes – methods, messages, encapsulation, abstraction, inheritance, polymorphism, dynamic building. Traditional approach Versus object orientation; benefits of object orientation – flexibility in software development – reusability – extensibility – maintainability.	10
Unit-IV	**OBJECTS AND CLASSES** – specifying classes – using – C++ objects and data types – constructors and destructors – object as function arguments – structures and classes. Array fundamentals – array as class member data – array of objects. Structures – simple structure – accessing structure member – structure within structure – structure and classes – Function overloading – Inline function – Virtual function and polymorphism.	10
Unit-V	**OPERATOR OVERLOADING** – overloading unary operator – overloading binary operator – data conversion. Inheritance – derived class and base class – derived class constructors – public and private inheritance – level of inheritance. C++ graphics – text – mode graphics functions – graphics – mode graphics functions – colors – rectangles and lines – polygons and inheritance – text in graphics mode – Addresses and pointers, Simple file operations: streams – string I/O – character I/O.	7

LEARNING OUTCOME

- To introduce various techniques for representation of the data in the real world.
- To develop applications using data structure.
- To teach the basic concepts of protection and management of data.
- To improve the logical ability of the students.

LEARNING RESOURCES

1. N.S. Kutti and P.Y. Padhye ,"Data Structures in C++" ,Prentice Hall of India Pvt., Ltd., New Delhi 2001.
2. Liberty & Keogh, "C++: An introduction to programming", Prentice Hall of India Pvt., Ltd., New Delhi 2002.
3. Bjarne Stroustrup, " The C++ Programming Lenguage", Addison Wesley by publication, New york 1994.
4. Jean – Paul Tremblay and Paul G.Sorenson, "An Introduction to Data Structures with Applications", Tata McGraw Hill 1998.
5. E. Balagurusamy, "Object oriented Programming with C++", Tata McGraw Hill, New Delhi, 1996.

20BM0140	PHYSICS APPLICATIONS IN BME	L	T	P	C
		3	0	0	3
Course Category C	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To acquire basic understanding of advanced materials, their functions and properties for technological applications
- To emphasize the significance of materials selection in the design process
- To understand the principal classes of bio-materials and their functionalities in modern medical science
- To get familiarize with the new concepts of Nano Science and Technology
- To educate the students in the basics of instrumentation, measurement, data acquisition, interpretation and analysis

UNIT	Course contents	Contact Hours
Unit-I	ELECTRONIC AND PHOTONIC MATERIALS: Electrical properties of materials and classification of insulators, conductors and semiconductors. Basic concepts of energy bands and band gap. Explanation of electrical behaviour of insulalors, conductors and semiconductors. Intrinsic and extrinsic semiconductors. Junction diode and light emitting diode. Light dependent resistor [ldr]. Basic concepts of ionic conductors.	9
Unit-II	MAGNETIC MATERIALS AND DIELECTRIC MATERIALS: Dia-,para-, ferro-and antiferro-magnetic materials. Magnetic hysteresissloop, applications of fm and afm [ferrite] materials; Polar and non-polar dielectrics, ferro-electric [fe] and piezo-electric materials, applications of fe and piezo-electric materials	9
Unit-III	NANO-TECHNOLOGY AND MODERN ENGINEERING MATERIALS: Basic concepts of nano materials, top-up and bottom-down approaches in synthesiss of nano materials, chemical vapour deposition [cvd], graphene and carbon nano tubes , introduction to sem, tem and afm microscopy; Modern engineering materials; high $t_c$superconductors, smart materials ,polymers , advanced materials and their applications.	9

Unit-IV	INTRODUCTION TO BIOMATERIALS: Bio-materials: Classification of biomaterials (based on tissue response) –Comparison of properties of some common biomaterials – Metallic implant materials (stainless steel, cobalt-based and titanium-based alloys) – Polymeric implant materials (Polyamides, polypropylene, Acrylic resins and Hydrogels.	9
Unit-V	APPLICATIONS OF BIOMATERIALS & MEDICAL NANOTECHNOLOGY: Tissue replacement implants – Soft and hard tissue replacements – Skin implants; Tissue Engineering of Skin, Bone Tissue Engineering, Cartilage Tissue Engineering, Neuronal Tissue Engineering, Cardiovascular Tissue Engineering. Biomaterials for organ replacement (Bone substitutes) – Applications in Medical Nanotechnology-Introduction to Biosensors.	9

LEARNING OUTCOME

- The course introduces several advanced concepts and topics in the rapidly evolving field of material science. Students are expected to develop comprehension of the subject and to gain scientific understanding regarding the choice and manipulation of materials for desired engineering applications.

LEARNING RESOURCES

1. Muhammad Maqbool, *"An Introduction to Medical Physics"*, Springer International Publishing, 2017.
2. B.H Brown, R.H Smallwood, D.C. Barber, P.V Lawford, D.R Hose,"*Medical Physics and Biomedical Engineering*", 1st edition CRC Press, 1998.
3. LoredanaMarcu, Eva Bezak, Barry Allen, "Biomedical Physics in Radiotherapy for Cancer", 2012th Edition
4. H. Eugene Stanley, "Biomedical Physics and Biomaterials Science", MIT Press.

20LE0104	TECHNICAL ENGLISH - II	L	T	P	C
		1	0	2	2
Course Category H	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- The paper aims at giving the students an opportunity to develop writing skill, concentrating on the various techniques involved in the competitive examinations.

UNIT	Course contents	Contact Hours
Unit-I	Technical Writing Skills • Report Writing • Article Writing • Curriculum Vitae – Resume Writing • Email Writing • Abstract and Synopsis Writing • Reviewing	6
Unit-II	Language for specific Speech events • Drafting an Invitation • Drafting the Minutes of a Meeting • Addressing a Gathering (Welcome Address) • Formal Speech (Occasions) Public Speech (Topics) • Proposing Vote of Thanks	6
Unit-III	Presentation Skills • Oral Presentation Skills • PowerPoint Presentation • Poster Presentation • Body Language	6
Unit-IV	Language and communication • Reading Strategies: Skimming, Scanning, Inferring, • Predicting and Responding to Content • Guessing from Context • Note Making • Vocabulary Extension • Speed Reading Practice • Use of Extensive Reading Texts.	6

Unit-V	Acquisition of Corporate Communication/ Speaking Skills • Group Discussion • Stage Dynamics • Role Play • Interview • Mock Interview	6

LEARNING OUTCOME

- The students will be able to express themselves in a meaningful manner to different levels of people in their academic and social domains.
- The students will have knowledge of the various uses of English in their professional environment and they will be able to communicate themselves effectively in their chosen profession.

LEARNING RESOURCES

1. M. Ashraf Rizvi, Effective Technical Communication, Tata McGraw-Hill, New Delhi, 2005.
2. Strunk, William, and E B. White, The Elements of Style. Boston: Allyn and Bacon, Pearson Edition, 1999.
3. Garner, Bryan A, HBR Guide to Better Business Writing, Hardvard Business Review Press, Boston, Massachusetts, 2013.
4. Shirley Taylor (1999), 'Communication for Business', Longman, New Delhi.
5. Robert Gannon (2000), 'Best Science Writing: Readings and Insights', University Press, Hyderabad.
6. Richard A. Boning (1990), 'Multiple Reading Skills', McGraw Hill, Singapore.
7. Albert J. Harris, Edward R.Sipay (1990), 'How to Increase Reading Ability', Longman.
8. David Martin (1994), 'Tough Talking', University press, Hyderabad.

20GE0108	VALUE EDUCATION - I	L	T	P	C
		1	0	0	1
Course Category H	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To provide guiding principles and tools for the development of the whole person recognizing that the individual is comprised of Physical, Intellectual, Emotional and Spiritual dimensions.

UNIT	Course contents	Contact Hours
Unit-I	INTRODUCTION Definition, Relevance, Types of values, changing concepts of values	3
Unit-II	INDIVIDUAL AND GROUP BEHAVIOUR Personal values – Self – Strengths (self-confidence, self-assessment, self- reliance, self-discipline, determination, self-restraint, contentment, humility, sympathy and compassion, gratitude, forgiveness) Weaknesses (Influences -- Peer pressure, familial and societal expectations, media)	3
Unit-III	SOCIETIES IN PROGRESS Definition of society; Units of society; Communities – ancient and modern – Agents of change – Sense of survival, security, desire for comfort and ease sense of belonging, social consciousness and responsibility	3
Unit-IV	ENGINEERING ETHICS Definition - Societies for engineers – Code of Ethics – Ethical Issues involved in cross border research --Ethical and Unethical practices – case studies – situational decision making.	3
Unit-V	SPIRITUAL VALUES What is religion? -- Role of religion – Misinterpretation of religion – moral policing – Consequences -- Religion as spiritual quest – Aesthetics and religion	3

LEARNING OUTCOME

- To help individuals think about and reflect on different values.
- To deepen understanding, motivation and responsibility with regard to making personal and social choices and the practical implications of expressing them in relation to themselves, others, the community and the world at large.
- To inspire individuals to choose their own personal, social, moral and spiritual values and be aware of practical methods for developing and deepening.

LEARNING RESOURCES

1. Department of English and Foreign Languages SRM University, "*Rhythm ofLife",* SRM Publications, 2013.
2. Values (Collection of Essays). Published by: Sri Ramakrishna Math, Chennai-4. 1996.

SEMESTER- III

LE0205	FRENCH LANGUAGE- I	L	T	P	C
		2	0	0	2
Course Category H	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- The course develops oral and written skills of understanding, expressing and exchanging Information/ interacting.
- The course develops the ability to construct sentences and frame questions.
- French language provides a competitive edge in career choices.

UNIT	Course contents	Contact Hours
Unit-I	**Sujets:** • L'Alphabet • Le Prounciation • Les Nombres • Décrirevotre pays, ville, • Les Professions • Parler de choses • L'Heure • Les Repas et les boissons	10
Unit-II	**Grammaire**: • Le Nom et le pluriel des noms • Les Articles • Les AdjectifsDémonstratifs • Les AdjectifsPossessifs • Les AdjectifsQualificatifs • Les Verbes(Regular,irregular, pronominaux) • Les PronomsSujets • Les Prepositions • L'interrogation	10
Unit-III	**Lexique-I:** • Se présenter • Présenterquelq'un • Les nationalités • Les Pays • Les Nombres • Parler des jours de la semaine • Les mois de l'année	10

	• Les Professions • Les Couleurs • Les Contraires • Les phrase avec l'heure	

LEARNING OUTCOME

- To read and write short, simple texts.
- To understand a dialogue between two native speakers and also to take part in short, simple conversations using the skills acquired.
- Fluency in reading and writing.

LEARNING RESOURCES

1. Version originale 1will be the main text book used for this course.
2. Nathan verbs conjugasion
3. Larrouse French to English Dictionary
4. Beside, material prepared by the teachers and material taken from other sources will also be used.

20LE0201	GERMAN LANGUAGE - I	L	T	P	C
		2	0	0	2
Course Category H	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- With the rising globalization for the last few decades, it is becoming increasingly necessary to interact with people of different countries throughout the world. Persons in the field of higher studies, research, business, etc. have often to deal with people from across the world who speak different languages. Hence, most of the universities and institutes of higher learning in all the countries have made it compulsory for the students of higher studies and research to learn at least one foreign language.

UNIT	Course contents	Contact Hours
Unit-I	Topics: Alphabet Aussprache Zahlen Zeit Vocabulary: Zahlen Zeitangaben (Uhrzeit, Tag, Wochentage, Monate, usw)	10
Unit-II	Topics: ÜberPersonensprechen (Name, Land, Stadt, Sprache, Alter, Beruf, Familie, usw.) Grammar: PersonalpronomenimNominativ Konjugation von regelmäßigenVerbenimPräsens (wohnen, lernen, arbeiten, usw.) Konjugation von unregelmäßigenVerbenimPräsens (sein, haben, heißen, lesen, sprechen, usw.) Possessivpronomen Wortposition, Aussagen, W-Fragen, Ja-Nein-Fragen Vocabulary: Deutsche Familiennamen und Vornamen Namen von Ländern, Städten und Sprachen Berufsbezeichnungen Familienmitglieder	10

Unit-III	Topics: Grammar: (Nominativ) Vocabulary:	ÜberSachensprechen Essen und Trinken BestimmterArtikel, UnbestimmterArtikel, kein Singular und Plural PersonalpronomenimAkkusativ BestimmterArtikel, UnbestimmterArtikel, kein (Akkusativ) Adjektivendungen (Nominativ und Akkusativ) PräpositionenmitAkkusativ Sachen des täglichenLebens (Haus, Möbel, Schreibwaren, Lebensmittel, usw.) EinigeallgemeineAdjektive und Adverbien, Gegenteile, Farben	10

LEARNING OUTCOME

- The outcome of the course is to provide basic knowledge of the German language to the participants.
- After doing this course, the students should be in a position to converse in German for basic requirements of everyday life, like meeting people, shopping, travelling, going to restaurants, etc.
- They should be able to read and understand simple texts of general nature and, with the help of dictionaries, simple material from their field of specialization. With some more effort and practice, they would be able to extract useful information regarding their profession from the internet.

LEARNING RESOURCES

1. Rosa-Maria Dallapiazza, u.a.: Tangram aktuell 1 (Lektion 1-4, Lektion 5-8, Übungsheft und Glossar). Max HueberVerlag
2. Wolfgang Hieber: Lernziel Deutsch, Teil 1. Max HueberVerlag
3. Korbinian Braun, u.a.: Deutsch alsFremdsprache IA, Grundkurs. Ernst Klett Stuttgart
4. Christiane Lemcke, u.a.: Moment mal, Teil 1: Langenscheidt
5. Ulrike Albrecht, u.a.: Passwort Deutsch 1. Ernst KlettSprachen
6. Rolf Brüseke: StartenWir! A1. München: HueberVerlag

20MA1201	APPLICATIONS OF MATHEMATICS IN BME	L	T	P	C
		3	1	0	4
Course Category B	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To impart analytical ability in solving mathematical problems as applied to Biomedical Engineering.

UNIT	Course contents	Contact Hours
Unit-I	PARTIAL DIFFERENTIAL EQUATIONS Formation – Solution of standard types of first order equations – Lagrange's equation– Linear homogeneous partial differential equations of second and higher order with constant coefficients - Classification of second order linear partial differential equations including the reduction to the above types.	12
Unit-II	FOURIER SERIES Dirichlet's conditions – General Fourier series – Half range Sine and Cosine series – Parseval's identity – Harmonic Analysis.	12
Unit-III	ONE DIMENSIONAL WAVE & HEAT EQUATION Boundary and initial value problems - Transverse vibrations of elastic string with fixed ends – Fourier series solutions – One dimensional heat equation - Steady and transient states – problems – Excluding thermally insulated ends.	12
Unit-IV	FOURIER TRANSFORMS Statement of Fourier integral theorem(proof omitted) – Fourier transform pairs – Fourier Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity – Integral equations.	12
Unit-V	GRAPH THEORY Graphs; Isomorphism-Walk; Path; Circuit; Shortest Path: Dijkstra's Algorithm; Tree; Properties of Tree; Binary Tree; Matrix Representation of Graphs (Adjacency and Incidence Matrices)	12

LEARNING OUTCOME

- To know to formulate and solve partial differential equations.
- To have thorough knowledge in Fourier series.
- To be familiar with applications of partial differential equations.

- To gain good knowledge in the application of Fourier transform.
- To gain good knowledge in graph theory concepts.

LEARNING RESOURCES

1. Kreyszig.E, Advanced "*Engineering Mathematics"*,10th edition, John Wiley & Sons, Singapore, 2012.
2. Veerajan T., Discrete "*Mathematics"* with Graph Theory and Combinatorics",10th edition,Tata McGraw Hill Companies,2010.
3. Grewal B.S, Higher "*EnggMaths"*, Khanna Publications, 42nd Edition,2012..
4. Miller I.R. and Freund J.E., Probability and Statistics for Engineers, Prentice Hall, 5th edition,1995
5. Kandasamy P etal. "*Engineering Mathematics"*, Vol. II & Vol. III (4th revised edition), S.Chand& Co., New Delhi, 2000
6. Narayanan S., Manicavachagom Pillay T.K., Ramanaiah G., Advanced "*Mathematics for Engineering students"*, Volume II & III (2nd edition), S.Viswanathan Printers and Publishers, 1992.
7. Venkataraman M.K., "*Engineering Mathematics"* - Vol.III - A & B (13th edition), National Publishing Co., Chennai, 1998.

20BM0203	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3
Course Category E	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- The main objective of learning this course on biomedical signals and systems for biomedical engineering students is to acquire knowledge for analyzing the continuous time discrete time signals & systems and its biosignal applications.

UNIT	Course contents	Contact Hours
Unit-I	Elementary Continuous time signals (CT signals), Step, Ramp, Pulse, Impulse, Exponential -Elementary Discrete time signals (DT signals)- Step, Ramp, Pulse, Impulse, Exponential, -representation of discrete-time signals-basic operation on signals-classification of signals- classification of systems, CT systems and DT systems, linear and nonlinear, time-variant and time in variant systems, static and dynamic systems, causal and non-causal systems, static and dynamic systems.	12
Unit-II	Representation of Fourier series, Continuous time periodic signals, properties of Fourier series, Dirichlet's conditions, Trigonometric Fourier series and Exponential Fourier series, Complex Fourier spectrum. Deriving Fourier transform from Fourier series, Fourier transform of arbitrary signal, Fourier transform of standard signals, Fourier transform of periodic signals, properties of Fourier transforms, Fourier transforms involving impulse function and Signum function.	12
Unit-III	Natural response-Forced response- total response-Impulse responseconvolution integral, Impulse response of interconnected systems-causalitystability- step response-correlation Review of Laplace transforms-Partial fraction expansion- Inverse Laplace transform-Concept of region of convergence (ROC) for Laplace transformsconstraints on ROC for various classes of signals- Properties of Laplace transforms -relation between Laplace transform and Fourier transformLaplace transform of certain signals using waveform synthesis-Computation of impulse response and transfer function using Laplace transform.	12
Unit-IV	Sampling theorem – Graphical and analytical proof for Band Limited Signals, effect of under sampling – Aliasing. Fundamental difference between continuous and discrete time signals, discrete time signal representation using complex exponential and sinusoidal components, Periodicity of discrete time using complex exponential signal, discrete-time Fourier transform and its properties, Discrete Fourier Transform Concept of Z- Transform of a discrete sequence. Distinction between Laplace, Fourier and Z transforms. Region of convergence in Z-Transform, constraints on ROC for various classes of signals, Inverse Z-transform, properties of Z-	12

	transforms. Computation of impulse response and transferfunction using z-transform.	
Unit-V	Random signal-characterization of random signal-stationary and nonstationary random signal – Ergodic and non-ergodic- Ergodicity in the mean –Ergodicity in the autocorrelation- relationship Between two random signals-properties of autocorrelation and cross correlation functions-power spectral density-cross spectral density -white noise -spectral density and the Complex frequency plane- LTI system with random input signals- The mean square value- Cross correlation between input and output- autocorrelation between input and output- Spectral density at the system output- Cross correlation density between input and output.	12

LEARNING OUTCOME

The student can able to:

- Classify the continuous time signals and systems and discrete-time signals and systems
- Analyze the continuous time signals using fourier series and fourier transforms
- Compute the convolution and correlation of discrete time systems.
- Understand the concepts of z-transform and discrete Fourier transform
- Analyze the discrete time IIR and FIR systems by using suitable structures and bio signal applications.

LEARNING RESOURCES

1. P.RameshBabu&R.AnandaNatrajan, Signals and Systems, Third edition, Scitech Publications (India) Pvt. Ltd.,2007
2. Allan V.Oppenheim, “Signals and systems”, Prentice Hall of India
3. Robert A.Gael and Richard A Roberts, “Signals and Linear systems”, John Wiley and sons.
4. Roger E.Ziemer, “Signals and Systems Continuous and discrete”, McMillan.

20BM0201	HUMAN ANATOMY & PHYSIOLOGY	L	T	P	C
		3	0	0	3
Course Category C	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- Understand basic human body functions and life processes
- Familiarize the concepts of cardiac and nervous systems
- Gain knowledge about functions of respiratory and musculoskeletal systems
- Understand the structure and functions of digestive systems and excretory systems
- Attain the knowledge about ear, eye and endocrine systems.

UNIT	Course contents	Contact Hours
Unit-I	Structure and function of Cell & cellular components – Membrane Potential – Action Potential – Generation and Conduction. Blood Cell – Composition – Fluid and electrolytic balance - Blood Groups – Estimation of RBC, WBC and platelet. Overview of Immune system – Immune response – models of immuneresponse – Autoimmune diseases.	12
Unit-II	Cardiovascular system – Heart and vascular system – ECG – Blood Pressure – Homeostasis –Cardiac output – Coronary and Peripheral Circulation – Heart Sounds. Nervous System – Structure and functions of Neurons, Synapse, Reflex action and Receptors – Velocity of Conduction of Nerve Impulses – Nervous control of Heart.	12
Unit-III	Musculo-Skeletal System – Muscle Tissue, Structure of Skeletal Muscle, Types of Muscle, Types of Joints, Major Muscles of Limbs and their actions. Respiratory system - Physiological aspects of respiration - Exchange of gases – Regulation of Respiration. Disturbance of respiration function. Pulmonary function test – Artificial respiration – Cardio-pulmonary Resuscitation.	12
Unit-IV	Gastro Urinal system, Digestion and absorption – Movement of GI tract – Structure and function of kidneys and Nephron – Mechanism of Urine formation – Urine Reflex – Skin and Sweat Gland – Temperature regulation.	12
Unit-V	Optics of Eye – Retina - Photochemistry of Vision – Accommodation Neurophysiology of Vision – EOG. Structure and functions Internal Ear - Mechanism of Hearing – Auditory pathway, Hearing Tests.	12

LEARNING OUTCOME

- The learning outcome of this course on human anatomy and physiology for engineers for biomedical engineering students is
- Acquaint students to various parts of the human body, their anatomical position and their functions.

LEARNING RESOURCES

1. SujitK.Chaudhuri – Concise Medical Physilogy – New Central Book agency, 1997
2. Arthur.C.Guyton – Textbook of Medical Physiology – Prism Book (p) Ltd. 1996.
3. CL.Ghai – A textbook of Practical physiology – 5th Ed Jaypee Medical Publishers, 2003
4. SaradaSubramanyam, K.MadhavanKutty and H.D.Singh – Text book of 'Human Physiology – S.Chand& Company, 1996.

20BM0205	ELECTRONIC DEVICES AND CIRCUITS	L	T	P	C
		3	0	0	3
Course Category E	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

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UNIT	Course contents	Contact Hours
Unit-I	JUNCTION DIODE CHARACTERISTICS : Review of semi conductor Physics – n and p –type semi conductors, Mass Action Law, Continuity Equation, Hall Effect, Open-circuited p-n junction, The p-n junction as a rectifier (forward bias and reverse bias), The current components in p-n diode, Law of junction, Diode equation, Energy band diagram of p-n diode, Volt-ampere characteristics of p-n diode, Temperature dependence of V-I characteristic, Transition and Diffusion capacitances, Breakdown Mechanism in Semi Conductor Diodes, Zener diode characteristics.	12
Unit-II	BIPOLAR JUNCTION AND FIELD EFFECT TRANSISTORS: Construction, principle of operation, V-I characteristics, symbol, equivalent circuit, parameter calculations, applications, and specifications of BJT, FET and MOSFETS. Enhancement and Depletion mode MOSFET, Salient features of differentconfiguration of BJT and FET- VVR operation of FFT-Comparison of BJT, JFETand MOSFET. devices.	12
Unit-III	RECTIFIERS, FILTERS AND REGULATORS : Half wave rectifier, ripple factor, full wave rectifier, Harmonic components in a rectifier circuit, Inductor filter, Capacitor filter, L- section filter, π- section filter, Multiple L-section and Multiple π-□section filter and comparison of various filter circuits in terms of ripple factors, clippers, clampers, voltage multipliers.Simple circuit of a regulator using zener diode. Series and Shunt voltage regulators- Analysis and design- Protection circuits for voltage regulators.	12
Unit-IV	SPECIAL SEMICONDUCTOR DEVICES: Tunnel diode and characteristics-PIN diode- Varactor diode- Schottky diode- Gunn diode- Laser diode- photo conductive sensors- photo voltaic sensors- Light Emitting Diode (LED)- Liquid Crystal Display (LCD)- Charge coupled device (CCD)- Silicon Control Rectifier (SCR)- two transistor equivalent, DIAC, TRIAC, Applications of SCR, DIAC, TRIAC, Unijunction Transistor (UJT).	12
Unit-V	BIASING AND STABILISATION : BJT biasing- DC equivalent model-Criteria for fixing operating point- Methods of Bias stabilization, fixed bias, emitter bias , voltage divider bias, DC bias with voltage feedback – Temperature compensation using diode biasing, thermistor and sensistor compensation Thermal run away-Thermal stability, Biasing of JFET and	12

	MOSFET-uses of heat sink. AMPLIFIERS: Small signal low frequency transistor amplifier circuits: hparameter representation of a transistor, Analysis of single stage transistor amplifier using h-parameters: voltage gain, current gain, Input impedance and Output impedance. Comparison of transistor configurations in terms of AI , Ri , Av , Ro.	

LEARNING OUTCOME

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LEARNING RESOURCES

1. J.Millman, C.C.Halkias, and SatyabrathaJit, “Electronic Devices and Circuits” Tata McGraw Hill, 2nd Ed., 2007.
2. R.L. Boylestad and Louis Nashelsky , Electronic Devices and Circuits , Pearson/Prentice Hall, 9th Edition,2006.
3. P. Ramesh Babu, “Electronic Devices and Circuits” Scitech Publications Pvt, Ltd., 2008
4. Nagrath, ““Electronic Devices and Circuits” PHI Learning, 2006

20GE0108	MICROBIOLOGY	L	T	P	C
		4	0	0	4
Course Category C	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To highlight the roles and characteristics of microorganisms
- To study in detail the growth of microorganisms and impact of environment on their growth
- To evaluate explicitly, the metabolic pathways, role of microbes in public health; insight into the physical and chemical control of microorganisms

UNIT	Course contents	Contact Hours
Unit-I	INTRODUCTION TO MICROBIOLOGY Basic of microbial existence: History of Microbiology, classification, and nomenclature of microorganisms Overview of Bacteria, Archea, fungi, Algae, Viruses & Protozoa. Microscopy: Microscopic examination of microorganisms-morphology and fine structure of bacteria.	12
Unit-II	MICROBIAL NUTRITION, GROWTH AND METABOLISM Nutritional requirements of bacteria: Culture media, Sterilization & Pure culture techniques. Growth, Growth curve and Different methods to quantitate bacterial growth. Metabolic diversity among microorganisms: Phototrophy, Chemolithotrophy, N2 fixation, Fermentation, Mycorrhiza. Biosynthesis of important molecules.	12
Unit-III	MICROBIAL PHYSIOLOGY AND GENETICS Fungi- Importance, characteristics, morphology, reproduction, physiology. Viruses: Structure, Classification, reproduction of bacterial, animal and plant viruses. Bacteriophages- General characteristics, Morphology and structure & Classification. Virioids and prions.	12
Unit-IV	MICROBIAL INFECTIONS, TRANSMISSION, AND THEIR MODE OF ACTION Sources of infection: Portals of entry and Exit of microbes. Infectious diseases caused by Bacteria: Leprocy, Tuberculosis & Cholera; By Viruses: Influenza, AIDS; By Protozoans: Malaria; By Fungi: Dermatomycosis. Antimicrobial agents/Antibiotics: Penicillins and Cephalosporins. Broad spectrum antibiotics: Antibiotics from Natural Sources. Antibacterial, Antifungal and Antiviral agents- Mode of action.	12
Unit-V	APPLIED MICROBIOLOGY Microbial applications in Agricultural: Biofertilizers, Industrial: Dairy Product-Cheese & fermented milks, Fermented beverages- Beer & Wine, pharmaceutical: Antibiotics and environmental application: Biodegradation, Bioremediation &wasre water treatment. Physical, chemical and biological	12

	control of microorganisms. Host-microbe interactions such as plant microbe interaction & animal-microbe interaction	

LEARNING OUTCOME

- Student can able to understand the fundamentals of microbiology through the study of the characteristics of microorganisms, multiplication, and growth in different media, metabolic pathways, and effects of microbe.
- Knowledge of basic microbiology principles will enable students to understand how they react under different conditions and how they cause different diseases and their control

LEARNING RESOURCES

1. Michael J. Pelczar, S. Chan, and Noel R. Krieg "*Microbiology*", McGraw Hill, 7thEdition, 2011.
2. Michael T. Madigan, John M. Martinko, Paul V. Dunlap, and David P. Clark "*Brock Biology of microorganisms*", Prentice Hall, 12thEdition, 2008.
3. Davis D. Bernard, Dulbecco Renato, Ginsberg S. Harold,andEisen N. Herman "*Microbiology*", Lippincott Williams,4thEdition, 1990.
4. Joklik et al, "*Zinsser Microbiology*"- Appleton & Lange, 20th edition, 1997.
5. Stanier Y. Roger,Adelberg A. Edward,and Ingraham John "*General Microbiology*", Prentice Hall, 5thEdition, 1986.
6. Geo Brooks, Karen C. Carroll, Janet Butel, and Stephen Morse "*Medical Microbiology*", McGraw-Hill Medical, 26thEdition, 2012.
7. Lansing M. Prescott, Donald A. Klein, and John P. Harley, "*Microbiology*", McGraw Hill, 11th Edition, 2011.

SEMESTER – IV

20LE0206	FRENCH LANGUAGE- II	L	T	P	C
		2	0	0	2
Course Category H	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- A strong awareness of the culture of the countries where the language is spoken.
- A passion for languages and a commitment to the subject.
- The ability to use language creatively and spontaneously.
- An Independence in their studies and the ability to draw upon a wide range of resources.
- Fluency in reading.
- Fluency and Imagination in writing.

UNIT	Course contents	Contact Hours
Unit-I	Sujets: • La France • Le Fromage, le vin • Les saisons • Les recettes • Indiquer un chemin • Demander la direction • Donner des indications • Le corps • Les elements du passé • Racontez un événment • Raconteur unejournée	10
Unit-II	Grammaire: • La negation • Le pronomtonique • Le future proche • L'imperatif • Le passé recent • Le future • Le passé compose • L'imparfait • Les nombresordinaux	10
Unit-III	Lexique: • Lesvêtements • Les animaux • Parler de prix • Le corps • Vocabulaire de la gare et du train • Le voyage • Les achats	10

LEARNING OUTCOME

- A language skills are as valuable as technical skills a Knowledge of French enables the graduates in career orientation.
- As a second International global Language after English there is a wider choice of job opportunities in the International employment market and also multinationals in India and an understanding of French culture through language.

LEARNING RESOURCES

1. Version originale 1will be the main text book used for this course.
2. Nathan verbs conjugasion
3. Larrouse French to English Dictionary
4. Beside, material prepared by the teachers and material taken from other sources will also be used.

20LE0202	GERMAN LANGUAGE-II	L	T	P	C
		2	0	0	2
Course Category H	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- The aim of the course is to provide basic knowledge of the German language to the participants.

UNIT	Course contents	Contact Hours
Unit-I	Topics: Einkaufen Tagesablauf Grammar: Trennbare und untrennbareVerben Dativ und Genitiv Modalverben Vocabulary: Kleidung Haushaltswaren Sachenzum Essen und Trinken Maßeinheiten Tiere	10
Unit-II	Topics: Reisen Ortsangaben und Richtungen Grammar: Imperativ PräpositionenmitDativ PräpositionenmitAkkusativ/Dativ Vocabulary: Verkehrsmittel Namen von Orten und Sehenswürdigkeiten Information über Deutschland, Österreich, die Schweiz	10
Unit-III	Topics: ÜberKörper und Krankheitensprechen Ereignisse der Vergangenheiterzählen Lebenslauf Grammar: Präteritum von sein, haben, werden und Modalverben Perfekt Vocabulary: Körperteile und Krankheiten Erweiterung des Wortschatzes von verschiedenenBereichen Ordinalzahlen Einigewichtige Termini des Fachbereichs von Studenten	10

LEARNING OUTCOME

- After doing this course, the students should be in a position to converse in German for basic requirements of everyday life, like meeting people, shopping, travelling, going to restaurants, etc.

- They should be able to read and understand simple texts of general nature and, with the help of dictionaries, simple material from their field of specialization. With some more effort and practice, they would be able to extract useful information regarding their profession from the internet

LEARNING RESOURCES

1. Rosa-Maria Dallapiazza, u.a.: **Tangram aktuell 1** (Lektion 1-4, Lektion 5-8, Übungsheft und Glossar). Max HueberVerlag
2. Wolfgang Hieber: **Lernziel Deutsch, Teil 1**. Max HueberVerlag
3. Korbinian Braun, u.a.: **Deutsch alsFremdsprache IA, Grundkurs**. Ernst Klett Stuttgart
4. Christiane Lemcke, u.a.: **Moment mal, Teil 1**: Langenscheidt
5. Ulrike Albrecht, u.a.: **Passwort Deutsch 1**. Ernst KlettSprachen
6. Rolf Brüseke: **StartenWir! A1**. München: HueberVerlag

20BT1004	BIOCHEMISTRY	L	T	P	C
		3	0	0	3
Course Category C	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- To provide an understanding of the functions of various biomolecules and their metabolism
- To study the structural and functional properties of carbohydrates, proteins, lipids and nucleic acids

UNIT	Course contents	Contact Hours
Unit-I	INTRODUCTION TO BIOCHEMISTRY Introduction-Chemical Bonds-pH-Buffers-Carbohydrates-Lipids-Proteins.	12
Unit-II	METABOLISM OF CARBOHYDRATES Introduction to Metabolism, Glycolysis, Citric acid cycle, Gluconeogenesis, Glycogen metabolism, Glycogenesis, Glycogenolysis, Biochemical aspects of Diabetes mellitus.	8
Unit-III	PROTEIN METABOLISM Introduction-Metabolism of amino acids-Transamination-Deamination-Metabolism of ammonia-Urea cycle-Biosynthesis of amino acids-Disorders of tyrosine (phenylalanine) metabolism.	9
Unit-IV	FATTY ACID METABOLISM AND NUCLEIC ACID METABOLISM Introduction-Fatty acid oxidation-Ketone bodies &Ketogenesis-Biosynthesis of Fatty acids-Eicosanoids-Cholesterol Biosynthesis-Lipoproteins-Disorders of Lipid metabolism-Nucleic acids: Biosynthesis of Purine and Pyrimidines-Degradation of purine nucleotides and pyrimidine nucleotides-Disorders of Purine and pyrimidine metabolism.	8
Unit-V	OXIDATIVE PHOSPHORYLATION Introduction-Bioenergetics, High energy compounds, Biological oxidation-Electron transport chain, Oxidative phosphorylation, Chemi-osmotic theory – Shuttle pathways – Glycerol phosphate Shuttle, Malate aspartate Shuttle –Shunt pathways.	8

LEARNING OUTCOME

- The student can able to apply the information of biomolecules by providing basic information on specific metabolic diseases and their disorders

LEARNING RESOURCES

1. Jain, J L, Jain, Nitin, Sunjay Jain, S. Chand Group "*Fundamentals of Biochemistry"*.
2. Satyanarayana& U. Chakrapani, *"Biochemistry"* Books and Allied (p) Ltd., UISBN: 8187134801.
3. David L. Nelson, Albert Lester Lehninger, Michael M. Cox *"Lehninger Principles of Biochemistry"*, Edition 5, illustrated, W. H. Freeman, 2008.
4. Jeremy M. Berg, John L. Tymoczko, LubertStryer, *"Biochemistry"* Edition 7, W. H. Freeman, 2012.

20BT0202	IMMUNOLOGY	L	T	P	C
		4	0	0	4
Course Category C	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- Aimed at introducing the science of immunology and a detailed study of various types of immune systems their classification, structure, and mechanism of immune activation.

UNIT	Course contents	Contact Hours
Unit-I	OVERVIEW OF THE IMMUNE SYSTEM Introduction: overview of the immune system-Lymphatic system, lymphoid organs, Cells of the immune system and their functions-Immune system. Innateand Acquired immunity: Cells and processes of Innate immunity—Cells and organs of the Acquired immunity- Anatomical and Physiological barriers; Innate Immune response and their recognition structures; Pathogen elimination. Immunogens and Antigens: Requirements for immunogenicity; major classes of antigens; antigen recognition by B and T lymphocytes	12
Unit-II	ANTIBODY STRUCTURE AND FUNCTIONS, B CELL FUNCTION Immunoglobulins: Structure and function-- Monoclonal antibodies. B Cellgeneration and differentiation: BCR--Antibody diversity: Genetic basis—Tdependentactivation of B cells-B-lymphocyte signal transduction.Cytokines and Complement system.	12
Unit-III	MAJOR HISTOCOMPATIBILITY COMPLEX AND ANTIGEN PRESENTATION Antigen- antibody interaction: Major Histocompatibility complex – types – structure and function; MHC restriction; Antigen Presenting Pathways	12
Unit-IV	MATURATION, ACTIVATION & DIFFERENTIATION OF T AND B LYMPHOCYTES T cell activation, maturation and differentiation: T-cell receptors--T-cell maturation, activation and differentiation-Cell mediated effector responses-Function of CD8+T cells and CD4+ cells.Effector Functions	12
Unit-V	IMMUNE SYSTEM IN HEALTH & DISEASE Hypersensitive reactions--Immune responses to infectious diseases—Tumour Immunology-Vaccines-Autoimmunity, Synthetic biology.	12

LEARNING OUTCOME

The students familiarize with the

- The immune system, their structure and classification, genetic control of Antibody production, cellular immunology, mechanism of activation in hypersensitive immune reaction
- The role of the immune molecules in infectious diseases, autoimmunity, and cancer will be discussed

LEARNING RESOURCES

1. Richard Coico, Geoffrey Sunshine, "*Immunology: A short course*" 6th Edition. Wiley-Blackwell,

2009.
2. Kenneth Murphy, "*Janeway'sImmunobiology*," 8th Edition, Garland, 2011
3. SudhaGangal and ShubhangiSontakke, "*Textbook of Basic and Clinical Immunology*", Orient Blackswan, 2013.
4. Thomas J. Kindt , Barbara A. Osborne , Richard A. Goldsby , " *Kuby Immunology*", WH Freeman, Sixth Edition, 2006.

20BM0204	LINEAR INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3
Course Category E	Pre-requisite: Nil				
	Co-requisite: Nil				
	Designed by: Department of Biomedical Engineering				

COURSE OBJECTIVE

- Design the basic building blocks of linear integrated circuits
- Design and develop the comparators and waveform generators
- Demonstrate the basic concepts and design of active filters and data converters
- Explain the theory and applications of timers
- Describe the basic concepts of PLL and voltage regulators

UNIT	Course contents	Contact Hours
Unit-I	INTEGRATED CIRCUITS: Classification, chip size and circuit complexity, Fundamentals of Monolithic IC technology, basic planar processes, Fabrication of a typical circuit, Active and passive components of ICs, fabrication of FET, Thin and thick film technology. OPERATION AMPLIFIER: basic information of Op-amp, ideal and practical Opamp, Op-amp characteristics, 741 op-amp and its features, modes of operation-inverting, non-inverting, differential mode.	12
Unit-II	OP-AMP APPLICATIONS : Basic application of Op-amp, instrumentation amplifier, ac amplifier, V to I and I to V converters, Precision rectifiers, log and antilog amplifiers, sample & hold circuits, multipliers and dividers, Differentiators and Integrators, Comparators, Schmitt trigger, Multivibrator, Triangular wave generator.	12
Unit-III	ACTIVE FILTERS, OSCILLATORS AND REGULATORS: Introduction-Low pass and High pass filters- Design of first and second order Butterworth lowpass and high pass filters Band pass, Band reject and all pass filters-Oscillator types and principle of operation – RC, Wien bridge oscillators triangular, saw-tooth, square wave and VCO- Introduction to voltage regulators, features of 723, Three Terminal IC regulators- DC to DC Converter- Switching Regulators-UPSSMPS.	12
Unit-IV	TIMERS & PHASE LOCKED LOOPS: Introduction to 555 timer, functional diagram, monostable and astable operations and applications, Schmitt Trigger. PLL - introduction, block schematic, principles and description of individual blocks of 565-PLL applications, Analog and digital phase detectors.	12
Unit-V	D-A AND A- D CONVERTERS: Introduction, basic DAC techniques, weighted resistor DAC, R-2R ladder DAC, Different types of ADCs - parallel comparator type ADC, counter type ADC, successive approximation ADC, dual slope ADC and Sigma delta ADC. DAC and ADC specifications. DAC 0800 and ADC 0804 pin diagram and applications	12

LEARNING OUTCOME

- The outcome enable the students to understand the fundamentals of linear integrated circuits and to implement and study in relation to the various medical related applications.

LEARNING RESOURCES

1. D. Roy Chowdhury, “Linear Integrated Circuits” New Age International (p) Ltd, 2nd Ed., 2003.
2. R.F. Coughlin & Fredrick F. Driscoll. Operational Amplifiers & Linear Integrated Circuits, PHI, 6th Edition, 2003
3. Ramakanth A. Gayakwad, Op-Amps & Linear ICs –PHI, 4th Edition 2004.

SEMESTER-V

		L	T	P	C
Subject Code- BM0201	**BIOMATERIALS AND ARTIFICIAL ORGANS**	**3**	**1**	**0**	**3**
Course category- C	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVE

1. To know about the different classes of materials used in medicine
2. To gain knowledge about the application of biomaterials in medicine
3. To understand the concept of biocompatibility and the methods of biomaterial testing
4. To know about the technologies of biomaterial processing, clinical trials, ethical issues and regulatory standards.
5. To gain knowledge in the existing designs of artificial organs.

UNIT	Course contents	Contact Hours
I- BIOMATERIAL PROPERTIES	Biomaterial-definition, Material characterization – Mechanical, thermal, Phase diagrams, Surface properties, Causes of failure - micro cracks, crazing, fatigue. Technologies of biomaterials processing - Surface coating methods.	7
II CLASSES OF BIOMATERIALS	Different classes of materials used in medicine - Polymers - Synthesis -Mechanical & Thermal properties - Polyesters - Polyacrylates - Polyanhyrides - Biodegradable Polymers - Hydrogels – Elastomer - Dendrimers. Metals - Stainless steel - Cobalt- Chromium alloy - Titanium alloys. Ceramics and Bioglasses- nonabsorbable bioceramics - biodegradable ceramics - bioreactive ceramics - deterioration of ceramics.	11
IIISOFT AND HARD TISSUE APPLICATIONS	Sutures, Wound dressings, artificial skin - Drug delivery devices - Cardiovascular medical devices, Orthopedic fixation devices – Internal – External - Joints, Total Hip Arthroplasty – Evolution-Design.	9
IV Material Response	Material and Tissue interaction, biological environment and host response -Inflammation, Wound Healing and Foreign Body Response - Failure mechanisms; corrosion, fracture, degradation of Implanted Materials – Polymers,Metals,ceramics	8
VBIOMATERIAL TESTING AND ARTIFICIAL ORGANS	Testing of biomaterials: In-vitro, In-vivo preclinical tests - biocompatibility – methods for improvement. eye and ear implants, artificial pancreas, ophthalmic implantation, dental implantation, insulin administration devices, extracorporeal artificial organs, neural prostheses.	10

LEARNING OUTCOME:

1. Understanding about the principles and biology underlying the design of implants and

artificial organs.

Learning Resources	
Text Book	9. Joon Bu Park, Roderic S. Lakes, "*Biomaterials*", Springer-Verlag, New YorkInc., 2010. 10. Ratner B.D and Hoffman A.S, "*Biomaterials Science: An Introduction to Materials in Medicine"*, Academic Press; 3 edition,November 8, 2012.
Reference Book and other materials	1. Chua P.K, Chena J Y, Wanga L.P, Huang N, "*Plasma-surface modification ofbiomaterials",* Materials Science and Engineering: R: Reports, Volume36, Number 5, 29 March 2002, pp. 143-206. 2. Sujata V. Bhat, 'Biomaterials', Narosa publishing house Pvt Ltd; 4th Edition, 2010.

		L	T	P	C
Subject Code- BM0301	**NUMERICAL METHODS IN BIOMEDICAL ENGINEERING**	**4**	**0**	**0**	**4**
Course category- B	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES:

1. To be familiar with numerical solution of equations
2. To get exposed to finite differences and interpolation
3. To be familiar with the numerical Differentiation and integration
4. To find numerical solutions of ordinary differential equations
5. To find numerical solutions of partial differential equations

UNIT	Course contents	Contact Hours
I- CURVE FITTING AND NUMERICAL SOLUTION OF EQUATIONS	Method of Least Squares – Fitting a straight line – Fitting a parabola – Fitting an exponential curve – Fitting a curve of the form y = axb – Calculation of the sum of the squares of the residuals-Eigen value problems by Power method – Jacobi method.	12
II FINITE DIFFERENCES AND INTERPOLATION	First and Higher order differences – Forward differences and backward differences and Central Differences – Differences of a polynomial – Properties of operators – Factorial polynomials – Shifting operator E – Relations between the operators. Interpolation – Newton-Gregory Forward and Backward Interpolation formulae - Divided differences – Newton's Divided difference formula – Lagrange's Interpolation formula – Inverse interpolation.	12
III NUMERICAL DIFFERENTIATIO N AND INTEGRATION	Numerical Differentiation and Integration: Newton's forward and backward differences formulae to compute first and higher order derivatives – The Trapezoidal rule – Simpson's one third rule and three eighth rule.	12
IV NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS	Solution by Taylor's series – Euler's method – Improved and modified Euler method – Runge-Kutta methods of fourth order (No proof) – Milne's Method - Adam's Bashforth method.	12
V NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS	Classification of Partial differential equations of the second order – Difference quotients – Laplace's equation and its solution by Liebmann's process – Solution of Poisson's equation – Solutions of Parabolic and Hyperbolic equations.	12

LEARNING OUTCOME:

1. Understanding for the analytical ability in solving mathematical problems as applied to the respective branches of Engineering.

Learning Resources	
Text Book	1. B.S. Grewal, "*Numerical Methods in engineering and science"*, Khanna Publishers, 42nd edition,2012. 2. Venkataraman M.K, "*Numerical Methods in Science and Engineering",* National Publishing Co., 2005. 3. S.S. Sastry, "*Introductory Methods of Numerical Analysis"*, 4th edition, 2005
Reference Book and other materials	1. Balagurusamy E, "*Computer Oriented Statistical and Numerical Methods"* – Tata McGraw Hill., 2000. 2. Jain M.K, Iyengar SRK and Jain RL, "*Numerical Methods for Scientific and Engineering Computation*," Wiley Eastern Ltd., 4th edition,2003 3. P.Kandasamyetal., "*Numerical Methods",* S.Chand& Co., New Delhi, 2003.

		L	T	P	C
Subject Code- BT0301	**MOLECULAR BIOLOGY & GENETICS**	**4**	**0**	**0**	**4**
Course category- C	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1.To help the students in understanding the maintenance and alteration of the cellular activities.

2. Understanding of the interaction of cells especially interactions between different various macromolecules DNA, RNA & Protein, how these interactions are regulated.

UNIT		Course contents	Contact Hours
I-	**STRUCTURE OF NUCLEIC ACID**	Structure of DNA - Different forms of DNA and RNA - Identification of DNA as genetic material by Griffith –Avery, McLeod and McCarty - Frankel and Singer - Hershey and Chase - Messelson and Stahl experiment.	12
II	**DNA REPLICATION AND MUTATION**	Semi-Conservative replication - replication of DNA in Eukaryotes - molecular basis of Mutation - classification of mutation.	12
III	**GENE EXPRESSION AND REGULATION**	Genetic code – transcription - prokaryotes and Eukaryotes - Post transcriptional modification - Translation in prokaryotes and Eukaryotes - Post translational modification - Gene Regulation - Lac operon model.	12
IV	**MENDELIAN GENETICS**	Mendel's laws - monohybrid - dihybrid inheritance - multiple alleles - structure and organization of chromosome in prokaryote and Eukaryotes.	12
V	**CROSSING OVER AND LINKAGE**	Linkage - types of linkage -crossing over and their types- Recombination mapping by two point and three point text cross mapping in bacteria.	12

LEARNING OUTCOME:

1. The course helps the students to understand the activities of the cell in the genetic and in the molecular level.

Learning Resources	
Text Book	1.Brown T.A., "Genetics- A molecular approach", Chapman & Hall, Third edition, 1999 2.Gardener, Simmons and Snustad, "Principles of Genetics", John Wiley & sons, 1991.
Reference Book and other materials	1. Benjamin Lewin," Gene VII", Oxford University Press, 2000-. 2. Jain H.K.," Genetics – Principles, Concepts, and

	Implications", Oxford, 1999. 3. Powar C.B, "Genetics – VOL 1 & 2", Himalaya Publishing House, 2003. 4. John Ringo, "Fundamental Genetics", Cambridge, 2004.P.Kandasamyetal., "*Numerical Methods"*, S.Chand& Co., New Delhi, 2003.

		L	T	P	C
Subject Code- BM0205	**BIOMEDICAL INSTRUMENTATION**	**3**	**0**	**0**	**3**
Course category- E	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES:

1. To get the basic idea of measurements and the errors associated with measurement.
2. To know about the various types of transducers.
3. To understand the function of signal generators and analyzers.
4. To gain knowledge on functioning of the various measuring instruments, display devices and application on the biomedical devices.

UNIT		Course contents	Contact Hours
I-	**MEDICAL INSTRUMENTATION**	Amplifiers, high input impedance, active filters, timers ADC and DAC circuitselectrodes andtransducers, application in medicine.	6
II	BIOMEDICAL TRANSDUCERS & BIOELECTRODES	Bioelectrodes for ECG (EKG), EEG. EMG, study of ECG in detail as sample case biomedical transducers-pressure, temperature, humidity and moisture, transducers for respiratorymeasurements, blood pressure measurements (Mercury and Aneroid Types) Skin resistance measurements.	12
III	ANALYTICAL INSTRUMENTS	PHmeters, Color meter, Bomb calorimeter, measurements of specific gravity, viscosity, Auto analysers, cell counters, UV- visible Spectrophotometers and infrared spectrophotometer, Flame photometers, Densitometers, Electrophoresis.	9
IV	**BIOSENSORS**	Electrochemical Biosensors (Enzyme-Based Biosensors, Immunosensors, Microbial Sensors), Chemical Biosensors,Chemical Fibro sensors, Ion-Selective Field-Effect Transistor (ISFET), Lab-on-a–chip.	9

V	**MEMS and NEMS**	MEMS - Microsystems (Introduction, Working Principles, micro sensors and actuators, Engineering design, fabrication and packaging), Scaling Laws in Miniaturization, Overview of Micromanufacturing. NEMS - Introduction, architecture - carbon nanotube electronics - modeling analysis and simulation - simulation of Actuators, FET, Pressure transducer. Quantum mechanics, Molecular Wires and Molecular Circuits.	9

LEARNING OUTCOME:

1. Gaining the knowledge about the measuring instruments and the methodsof measurement.

Learning Resources	
Text Book	1 "*Handbook of Biomedical Engineering*",R.S. Khandpur 2 Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
Reference Book and other materials	1. Leslie Cromwell, Fred J. Weibell, Erich.APfeiffer``*Biomedical Instrumentation andMeasurements*" second Edition published by PEARSON Education. 2. Marc Madou, Fundamentals of Microfabrication, CRC press 1997. 3. Stephen D. Senturia, Micro system Design, Kluwer Academic Publishers, 2001.

SEMESTER-VI

		L	T	P	C
Subject Code BM0304	**GENOMICS AND PROTEOMICS**	**3**	**0**	**0**	**3**
Course category- C	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. It gives emphasize on Structure and organization of genomes.
2. It provides computational approaches to analyze the genomes, Microarray, Functional and comparative genomics.
3. Gives an idea about the basics of Transcriptomics.

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UNIT		**Course contents**	**Contact Hours**
I-	**GENOMES AND THEIR ORGANIZATION**	Prokaryotic and eukaryotic genomes- structure-organization-Genomics: Genome Sequencing-Fragment Assembly- Genome Assembly- Human Genome Project- Aims- goals and achievements. General principles of Gene Therapy	9
II	**GENE EXPRESSION PROFILING**	Aligning Whole Genome Alignment (WGA) - prediction of coding regions – gene structure - conserved motifs, comparative genomics, methods of gene discovery - Prediction of gene function - methods - annotation, Coding and non-coding genes and RNA, Gene expression - regulatory mechanism, Expression profiling - Northern, RT-PCR, DD-RT-PCR, EST library - cDNA library, cDNA AFLP – SAGE Mechanical methods of delivery- Example: Duchenne myotrophy- Liposomal methods of delivery- Cystic fibrosis	10
III	**GENE REGULATORY NETWORK AND MICROARRAY**	Gene regulatory network and the models- DNA micro array and the analysis of data using clustering methods.	8
IV	**INTRODUCTION AND SCOPE OF PROTEOMICS**	Protein separation techniques: ion-exchange, size exclusion and affinity chromatography techniques, Polyacrylamide gel electrophoresis; Isoelectric focusing (IEF); Two dimensional PAGE for proteome analysis; Image analysis of 2D gels	8
V …..		Introduction to mass spectrometry; Strategies for protein identification; Protein sequencing; Protein modifications and proteomics; Applications of proteome analysis to drug; Protein-protein interaction (Two hybrid interaction screening) , Protein engineering; Protein chips and functional proteomics; Clinical and biomedical application of proteomics; Proteome database; Proteomics	9

	industry.	

LEARNING OUTCOME:

1. The students will be aware of the structure and functions of the genomes together with the computational approaches to analyze the genomes.

Learning Resources	
Text Book	1. T.A. Brown, *"Genome*", John Wiley & sons, 2006. 2. David W. Mount, "*Bioinformatics: Sequence and Genome Analysis*", Cold Spring Harbor Laboratory Press, I edition, 2001. 3. StekelDov, *"Microarray Bioinformatics*", Cambridge University Press, 2003.
Reference Book and other materials	1. Issac S Kohane, *"Microarrays for an integrative genomics"*, The MIT Press, 2002. 2. Benjamin Lewin, *"Gene VII*", Oxford University Press, 2000.

		L	T	P	C
Subject Code- 20BM0302	**THERAPEUTIC INSTRUMENTATION**	**3**	**0**	**0**	**3**
Course category- O	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES:

1. Explain the working principle of coronary care equipments
2. Illustrate the functioning of different types of physiotherapy and electrotherapy equipments
3. Overview the different components and working principle of sensory diagnosis and therapeutic equipments
4. Describe the functioning of various bone mineral density (BMD) measuring techniques and respiratory care equipments
5. Describe the use of different surgical equipments
6. Study the working principle of diagnostic and therapeutic equipments
7. Measure and interpret BMD using pDEXA
8. Design and analyze the working of basic electrical simulator
9. Understand the different parts of diagnostic and therapeutic equipments and its working principle

UNIT	**Course contents**	**Contact Hours**
I- INSTRUMENTS FOR CARDIOLOGY	Cardiac Pacemakers - Need for Cardiac Pacemaker - External Pacemakers - implantable Pacemakers - Recent Developments in Pacemaker system analyzer. Cardiac Defibrillators -Need for a Defibrillator - DC Defibrillator - Implantable Defibrillators - Pacer-cardio vector - defibrillator analysis.	9
II INSTRUMENTS FOR SURGERY	Instruments for surgery - principle of surgical diathermy - surgical diathermy machine - safety aspects in Electro-Surgical diathermy Units. Physiotherapy and electrotherapy equipment - High frequency heat therapy - short wave Diathermy - Microwave diathermy - Ultrasonic therapy unit - Pain relief through Electrical Stimulation - Bladder Stimulators - Cerebellar Stimulators.	9
III HAEMODIALYSIS	Haemodialysis Machines - Function of the kidneys - Artificial Kidney - Dialyzers - Membrances of haemodialyzers - Haemodialysis machines - Portable Kidney machines. Lithotripters - The stone disease problem - First lithotripter machine - modern lithotripter systems - Extracorporeal Shockwave Therapy.	9

IV	PULMONARY AND RADIOTHERAPY INSTRUMENTS	Anesthesia Machine - Need for Anesthesia - Anesthesia machine - Electronics in Anesthesia machine. Radiotherapy Equipment - Development of Betatron, chemotherapy,Heart lung Machine.	9
V	VENTILATORS	Ventilators: Mechanics of Respiration - Artificial Respiration - Ventilators - Types of ventilators - Classification of Ventilators - Pressure - volume - flow Diagrams - Modern ventilators - High frequency ventilators. Humidifiers - Nebulizers and Aspirators.	9

Learning Outcomes:

The purpose of learning this course on therapeutic equipment for biomedical engineering students is toacquire knowledge about the working principle of the various therapeutic biomedical equipment used in hospitals.

Learning Resources	
Text Book	1. R. S. Khandpur, Handbook of biomedical Instrumentation, Tata McGraw Hill Publication company Ltd, New Delhi, 1997. 2. Joseph J. Carr, John Michael Brown, Introduction to Biomedical Equipment Technology 4th edition, Pearson Education.2001.
Reference Book and other materials	1. John G. Webster, Biomedical Instrumentation, Wiley Publications.2007.

		L	T	P	C
Subject Code BI0102	**INTRODUCTION TO BIOINFORMATICS**	**3**	**0**	**0**	**3**
Course category- C	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To enable the students to understand scope of Bioinformatics
2. Understanding of popular bioinformatics database
3. Learn Fundamentals of Databases and Sequence alignment

UNIT	**Course contents**	**Contact Hours**
I- **BASICS OF HANDLING GENOMIC DATA**	The central dogma-genome-the human genome project and the need for databases and annotation, Biological Databases-file formats; annotated sequence databases; Retrieval of biological data.	9
II **SEQUENCE BASED ALGORITHMS AND SEARCHES**	Similarity and identity among biological sequences; Amino acid substitution matrices: PAM and BLOSUM Sequence similarity searches; FASTA and BLAST; local and global alignment algorithms, multiple sequence alignment.	9
II **PHYLOGENETIC ANALYSIS**	Cladogram and Phylogram, Distance and Character Based Methods, Computer tools for phylogenetic analysis, Construction and Visualization of Phylogenetic analysis, Applications of Phylogenetic Analysis.	9
IV **STRUCTURAL BIOINFORMATICS**	Relationship of protein three -dimensional structure to protein function; protein families and pattern databases; Classification of proteins of known three-dimensional structure: CATH & SCOP-Concept of molecular modelling -homology modelling and threading.	9
V **BIOINFORMATICS IN DRUG DESIGN**	Process of drug discovery -drug design and virtual screening -structure and ligand-based ligand design -docking -scoring -small molecular libraries -lead optimization –pharmacophore.	9

Learning Outcomes:

It provides an elementary knowledge in Bioinformatics and Biological Information on the web.

Learning Resources	
Text Book	1. S.C. Rastogi & others, "*Bioinformatics- Concepts, Skills, and Applications*", CBS Publishing, 2003. 2. Andreas D Baxevanis& B F Francis, "*Bioinformatics- A practical guide to analysis of Genes &Proteins*", John Wiley, 2000. 3. T K Attwood, D J parry-Smith," *Introduction to Bioinformatics*", Pearson Education, 1st Edition, 11th Reprint 2005.
Reference Book and other materials	1. C S V Murthy," *Bioinformatics*", Himalaya Publishing House, 1st Edition 2003. 2. David.Mount "*Bioinformatics sequence and genome analysis",* Cold spring harbor lab. press, 2004. 3. S. Ignacimuthu, S. J., "*Basic Bioinformatics',* Narosa Publishing house.

		L	T	P	C
Subject Code- 20BM0306	**MICROPROCESSORS AND MICROCONTROLLERS**	**3**	**0**	**0**	**3**
Course category- E	**Pre-requisite-Nil**				
	Co-requisite-				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. Understand the fundamental concepts of 8086 microprocessors
2. Explain the basic concepts of 8051 microcontroller
3. Obtain knowledge on interfacing devices.
4. Familiarize about ARM microcontroller
5. Acquire knowledge on applications of microprocessor and microcontroller in biomedical domain.

UNIT	Course contents	Contact Hours
I INTRODUCTION TO INTEL 8085.	Evolution of Microprocessor - Architecture of 8085 - Instruction format - Addressing modes - Basic timing diagram of opcode fetch, memory read, memory write, I/O read and I/O write - Interrupts of 8085 - Software interrupts, Hardware interrupts, Priorities of interrupts8085 based system design	9
II INTEL 8085 INTERFACIN	Interfacing devices- 8255 Programmable Peripherals Interface- Architecture & various modes of operation - 8251 USART Architecture and programming features - 8237, DMA Controller Architecture & Programming features. Interfacing with ADC and DAC, LCD, keyboard Interface.	9
III INTRODUCTION TO 8086	Architecture of 8086 - Registers set of 8086 - Special function of general purpose register - Addressing modes of 8086 - Instruction set - pin diagram of 8086 - Timing diagram- memory read, memory write, I/O read and I/O write - Minimum and Maximum mode of operation Interrupts of 8086.	9
IV MICROCONTROL LER	Introduction to 8 - bit Microcontrollers - 8051 Microcontroller Architecture - Registers set of 8051 - modes of Timer operation - Serial Port operation - Interrupt Structure of 8051 - Memory and Input / Output Interfacing of 8051.	9

V **APPLICATIONS**	Application of microprocessors: Stepper Motor Control, Temperature control, TTL to RS232 Conversion - RS232 to TTL Conversion - Interfacing EPROMs & SRAMs with 8085. Interfacing Biosignal to Microprocessor- block diagram.	9

Learning Outcome:

1. The purpose of studying this course on microprocessor systems in medicine for biomedical engineering students is to enable the students to have basic knowledge about microprocessor and microcontroller thereby aid in design of circuits for various biomedical applications.

Learning Resources	
Text Book	1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 4 th Edition, Penram International Publishing, New Delhi, 2000 2. Kennith J. Ayala, 8051 Microcontroller, Thomson, 2005. 3. Dougles V. Hall, Microprocessor and Interfacing, Tata MC Graw Hill Publication, 2nd Edition, 1992.
Reference Book and other materials	1. Charless M. Gilmore, "Microprocessor Principle and application, McGraw Hill publication, 1995. 2. A.NagoorKani, Microprocessor & Microcontroller, Tata Mc Graw Hill, 3rd Edition, 2012 3. B. Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications, 2001.

SEMESTER-VII

		L	T	P	C
Subject Code- 20BM0401	**DIGITAL IMAGE PROCESSING**	**3**	**0**	**0**	**3**
Course category- E	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES:

1. Understand the image fundamentals and mathematical transforms necessary for image processing
2. Describe the various image enhancement and image restoration techniques
3. Apply various image segmentation methods and analysis in medical images.
4. Illustrate the basic concepts of wavelets and image compression techniques
5. Explain the different types of reconstruction techniques applied to various medical Images.

UNIT	**Course contents**	**Contact Hours**
I IMAGE FUNDAMENTALS	Structure of Human Eye - Image formation in eye. Fundamental steps on Image processing - components of image processing system. Basic relationship between pixels Image sensing and acquisition. Image formation model, Image sampling and quantization, aliasing, Zooming and shrinking of digital images. File Formats.	9
II IMAGE ENHANCEMENT	Enhancement by point processing - Simple intensity transformation - Histogram processing - Image subtraction - Image averaging. Spatial filtering - Smoothing filters, sharpening filters. Enhancements in frequency domain - Low pass filtering - High pass filtering. 1D DFT, 2D DFT and their properties. with ADC and DAC, LCD, keyboard Interface.	9
III IMAGE RESTORATION	Model of Image degradation / restoration process. Restoration using spatial filtering - Mean filter- Medium filter - Max and Min filter - Midpoint filter. Wiener filter. Noise reduction using Frequency domain filtering - band Reject Filter, Band pass filter - Notch filter. Inverse filtering, least mean square filter.	9
IV IMAGE SEGMENTATION AND COLOR IMAGE	Detection of discontinuities, Edge and Line Detection, region-based segmentation. Color image processing - Color models, Pseudo color image processing, full color image processing. Morphological Image Processing: Preliminaries, dilation, erosion process.	9

V IMAGE COMPRESSION	Data Redundancy, Image compression model - Source Encoder and Decoder, Channel encoder and decoder Information channel - Fundamental coding theorems - Noiseless coding - Noisy coding theorem.	9

Learning Outcome:

1. The purpose of learning this course on medical image processing for biomedical engineering students is to acquire the fundamental concepts of image acquisition.
2. Understanding in applying the image processing techniques for various medical images.

Learning Resources	
Text Book	1. Raphael C. Gonzalez and Richard E. Woods, Digital Image Processing, 2nd Edition, 2001. 2. Anil K.Jain, Fundamentals of Digital Image Processing, 4th Edition, 1989.
Reference Book and other materials	1. William K.Pratt, Digital Image Processing, 4th Edition, 2007. 2. B. Chandra and Durtta Mujamdar, Digital Image Processing and Analysis, 2006.

		L	T	P	C
Subject Code- 20BI0401	**PERL PROGRAMMING & BIOPERL**	**3**	**0**	**0**	**3**
Course category- C	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

		L	T	P	C
Subject Code- 20BI0401	**PERL PROGRAMMING & BIOPERL**	**3**	**0**	**0**	**3**
Course category- C	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES:

1. To understand the basic Linux commands
2. To understand the basic Perl – control structures, subroutines and modules.
3. To apply Perl in biological problems

UNIT	Course contents	Contact Hours
I **INTRODUCTION TO LINUX**	Linux OS-Working Environment- editors-Navigation commands, File handling - creating and manipulating sequence files-text processing, System administration commands, Archival commands, process management networking and advanced commands and quantization, aliasing, Zooming and shrinking of digital images. File Formats.	8
II **INTRODUCTION TO PERL**	Data types, variables, operators, formatting of input/output, Array operations, Hashes, @ARGV, control structures and file handling, Debugging.	8
III **PERL SUBROUTINES A AND REGULAR EXPRESSIONS**	Builtin functions, subroutines, scoping of variables, Regular expressions met a characters and special operators, translation and substitution operators, pattern matching.	10
IV **PERL MODULES**	OOP concepts in Perl, Packages, libraries and modules- basic modules - getopt::long, LWP,CWD, file::basename.	10
V **BIOPERL**	Bioperl installation and applications, Bioperl modules- Databases, sequence retrieval & alignment, phylogentic tree construction, restriction enzyme analysis, mutation studies.	9

Learning Outcome:

1. The purpose of this course is to provide an understanding of application of Perl programming in

general as well as in biological problem solving in addition to the basic Linux working environment.

Learning Resources	
Text Book	1. James Tisdall, "*Mastering Perl for Bioinformatics*", O'Reilly, 2010.
Reference Book and other materials	1. Harshawardhan P Bal, "*Perl Programming for Bioinformatics*", Tata McGraw Hill, 2003. 2. James Lee, "*Beginning Perl*", Apress, 2004. 3. D. Curtis Jamison, "*Perl Programming for Bioinformatics & Biologists*", John Wiley & Sons, INC., 2004. 4. Michael Moorhouse, Paul Barry, "*Bioinformatics Biocomputing and Perl*", Wiley, 2004.

		L	T	P	C
Subject Code- BM0403	**NANOTECHNOLOGY IN MEDICINE**	**3**	**0**	**0**	**3**
Course category- C	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1.To recognize the structural and functional principles of bionanotechnology
2. To employ bionanomaterials for analysis and sensing techniques
3. To understand the application of nanomaterials in disease diagnosis
4. To apprehend and explain the biomedical applications of nanotechnology

UNIT	**Course contents**	**Contact Hours**
I **Introduction to Nanoscience**	Nano and Nature: Nanoscopic colours (Butterfly wings), Bioluminescence (fireflies), Tribology (Gecko's Sticky Feet, Nasturtium Leaf-Lotus effect etc) in nature. The development of nanoscale science: size scale, Nanotechnology Timeline: Pre-18th Century:,19th Century, 20th Century, 21st Century. Generations of nanotechnology. Classification of nanomaterials:0D,1D,2D and 3D and types of nanomaterials (QDs, QW, CNT's, Bucky Balls, Nanocomposites etc)	9
II **Introduction to Nanobiology and Nanomedicine**	Nanobiology – Introduction. Biological Nanostructures and natural biological assemblies at nanoscale: Bacterial S layers, phospholipid membranes, viruses, Nucleic acids, Oligosaccharides, polysaccharides, biological polymers, Proteins. Biological nanomotors, protein assemblies: Kinesin and dynein, cilia. Bacterial flagella: structure and function; nanomotor. Ion channels: nanopores of high specificity. Bioinspired nanomaterials: DNA and peptide based. Interaction between biomolecules and nanoparticle surfaces .	9
III **Synthesis of Nanomaterials and nanoformulations**	Types of nanomaterials: Inorganic metal nanoparticles, carbon dots, nanotubes, nanowires, fullerens, colloids, clusters, powders, rods, thin films etc. Top down and bottom up approach for synthesis of nanomaterials. Synthesis of nanomaterials using physical, chemical and Biological methods. Characterization techniques for nanomaterials. Nanobioassemblies: Different types of inorganic materials used for the synthesis of hybrid nano-bio Assemblies. Formulation of nanocrystals,	9

	nanoemulsions, polymeric micelles. Introduction to liposome and solid lipid nanoparticles (SLN). Fate of nanoformulations in body.	
IV Nano diagnostics	Nanotechnology in molecular imaging. Materials for use in diagnostic and therapeutic applications. Diagnosis using nanomaterials, Nanoparticles for bioanalytical applications, Nanoparticles for MRI, X Ray, ultrasonography, gamma ray imaging. Nanoparticles and quantum dots as molecular labels. Diagnostic Nanochips, lab on chips (microfluidic technology) and microelectromechanical systems (MEMS). Biosensor and nanobiosensor basic concepts, characterization, perception, Different types of nanobiosensors;	9
V **Nanomedicine: Applications of nano in biology**	Concept of disease, Cause and molecular/cellular progression of key diseases including infectious, inherited diseases, immunological diseases and cancer. Approach to developing nanomedicines. Various kinds of nanosystems in use. Nanodrug administration nano-devices for drug delivery and theranostics. Introduction to the potentials, applications and challenges of nanomedicine. Nanomedicine and tissue engineering, nanobiomachines and nanorobots.	9

Learning Outcomes

1. The goal of this course is to provide an insight into the fundamentals of nanotechnology in biological and biomedical research.
2. It will also guide the students to understand how nanomaterials can be used for a diversity of analytical and medicinal rationales

Learning Resources	
Text Book	1. Charles P. Poole Jr. and Franks. J. Qwens (2003) Introduction to Nanotechnology. John Wiley and Sons. 2. Ehud Gazit (2007) Plenty of Room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial college Press 3. Bharat Bhushan (2007) Springer Handbook of Nanotechnology. Springer Verlag. 4. Challa S., S. R. Kumar, J. H. Carola (2006) Nanofabrication towards biomedical application: Techniques, tools, Application and impact. John Wiley and sons. 5. Robert A. Freitas Jr (2003) Nanomedicine, Vol. I: Basic Capabilities.
Reference Book and other materials	1. Neelina H. Malsch (2005) Biomedical Nanotechnology. Taylor and Francis. CRC press. 2. Patrick Boisseau, Marcel Lahmani (2009) Nanoscience: Nanobiotechnology and Nanobiology. Springer Publishers. 3. Ralph S. Greco, Fritz B. Prinz, R. Lane Smith (Editors) (2004) Nanoscale Technology in Biological Systems. CRC Press 9.

	Harry F. Tibbals (2010) Medical Nanotechnology and Nanomedicine. CRC Press.

		L	T	P	C
Subject Code- 20BM0405	**REHABILITATION ENGINEERING**	**3**	**0**	**0**	**3**
Course category- E	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1 The course is designed to provide a brief and basic knowledge to understand musculoskeletal, neuromuscular, sensory disorders, prosthetics and orthotics and their applications.

2. The main aim is to provide the basic concept so that the students can implement their knowledge for higher studies in developing innovative and effective rehabilitation and assistive technologies.

UNIT	Course contents	Contact Hours
I INTRODUCTION TO REHABILITATION	Introduction Concepts and principles of rehabilitation engineering, Ergonomics - Positioning anatomical site, simplicity and intuitive operation, adaptability and flexibility, mental and chronological age appropriateness. Knowledge of disability act 1995 for physically disabled, visually impaired, hearing impaired and others. Rehabilitation Team.	9
II ORTHOTICS & ORTHOPROSTHETICS	Orthopedic prosthetics and orthotics in Rehabilitation Fundamentals, Applications: Computer Aides Engineering in customized component design. Intelligent prosthetic knee and hand. A self-aligning orthotic knee joint. FES System: Restoration of hand function; restoration of standing and walking. Hybrid Assistive systems (HAS) Active prostheses. Active Above knee Prosthesis. Myoelectric hand and arm prostheses. Orthotics - FO, AFO, TLSO, LSO	9
III Wheeled Mobility	History and Categories of Wheelchairs. Wheelchair Structure and Component Design. Ergonomics of wheel chair propulsion. Power Wheelchair Electrical System. Personal transportation. Tricycles	9
IV SENSORY AUGMENTATION AND SUBSTITUTION	Visual System: Visual augmentation. Tactual vision substitution. Auditory vision substitution: Auditory System: Auditory augmentation. Cochlear implantation. Visual auditory substitution. Tactual auditory substitution.	9

	Tactual system: Tactual augmentation. Tactual substitution. Alternative and Augmentative communication, User Interface: Outputs: Acceleration Techniques.	
V ADVANCED APPLICATIONS IN REHABILITATION ENGINEERING	Interfaces in Compensation for visual perception. Improvement of orientation and mobility. Computer - assisted lip reading. Brain - computer interface. Electronic Travel Applications (ETA) : Path Sounder, Laser Cane, Ultrasonic Torch, Sonic Guide, Light Probes, Nottingham Obstacle Sensor, Electro-cortical Prosthesis,. Polarized Ultrasonic Travel Aid.	9

Learning Outcomes:

1. The purpose of learning this course on rehabilitation ENGINEERING for biomedical engineering students is to acquire knowledge on the working concepts of various rehabilitation equipments for human movements.

Learning Resources	
Text Book	1. Bronzino, Biomedical Engineering, Hand Book IEEE Press Volume 1. 2. Robinson C. J, Rehabilitation Engineering, CRC Press. 1995. 3. Ballabio E. et al, Rehabilitation Technology, IOS Press. 1993.
Reference Book and other materials	1. Handbook of Physical Medicine & Rehabilitation, W.B.Saunders Publication, 2003. 2. Hanfredclynes, Biomedical Engineering System, McGraw Hill, 1999.

DEPARTMENATAL ELECTIVE-I

		L	T	P	C
Subject Code-	**MEDICAL PHYSICS**	**3**	**0**	**0**	**3**
Course category- D	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. Understand the principle of physics used in metabolism and statics of the body

2. Explain the physics behind the working of cardiovascular system

3. Identify the function and working of the respiratory system

4. Acquire the knowledge in origin of speech and hearing systems

5. Describe the physics applied in the optical system of the eye and vision acquire knowledge about the application of principles of physics in biomedical Engineering.

UNIT	**Course contents**	**Contact Hours**
I Statics and Metabolism of The Body	Statics : motion in one plane and levers, Statics of the body: lower arm, hip problem, and synovial joints, Statics of the body: three force rule and multi segment modeling Metabolism: conservation, energy and heat flow, the energy content of the body flow Energy storage molecule, metabolic rates and loss of body heat Basal metabolic rates, metabolic rates during common activities Heat losses from the body and measurement of pressure in the body.	9
II Cardiovascular System	Introduction to cardiovascular system: circulation, cardiac cycle and valves. Physics of the circulatory system: properties of blood, blood pressure and flow in vessel. Capillaries, osmotic pressure, blood flow rates and speeds. Work done with heart and metabolic needs of the heart. Strokes and aneurysms. Physics principle used the circulatory system and heart.	9
III Lung and Breathing	Physics of the alveoli, physics of breathing and volume of lungs. Breathing under usual and unusual condition: flow air during breathing. Mechanical model of breathing. Inspiration and expiration cycle. Breathing with diseased lungs. Breathing at higher elevation.	9

IV Sound, Speech and Hearing	The physics of sound waves: the speed and properties of sound waves. Intensity of sound waves and resonant cavities. Speech production: types of sound, system in speech production. Parameter of the human voice, the enteritis of speaking. Hearing: auditory sensitivity, connection to hearing perception. Vibration in the body: cardiac and other source of sounds.	9
V Light, Eye and Vision	Focusing and imaging with lenses: image formation, scientific basis for imaging. Combination of lenses or refractive surfaces. Imaging and detected by the eye: transmission of the light in the eye, as a compound lens, accommodation. Field of view and binocular vision, adjustment of light level, limitation to visual activity and imperfect vision. Correction of vision by eyeglass, contact lenses and other application. Types of vision impairment, connection to visual perception.	9

Learning Outcome:

The purpose of learning this course on medical physics for biomedical engineering students is to acquire knowledge about the application of principles of physics in biomedical Engineering.

Learning Resources	
Text Book	1. Herman I.P, "Physics of the Human Body", Springer Publications, 2nd edition, 2011. 2. J. R. Cameron & J. G. Skofronick, "Medical Physics", John Wiley and Sons, 2nd edition, 2008.
Reference Book and other materials	1. Paul Davidovits, "Physics in Biology and Medicine", Academic Press, 4th edition, 2012. 2. Widmaier, Raff &Strang, "Vander's Human Physiology- The mechanism of body Function", McGrawHill,12th edition,2010.

		L	T	P	C
Subject Code-	**ELECTROPHYSIOLOGY OF HUMAN SYSTEM**	**3**	**0**	**0**	**3**
Course category- D	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES:

1. To understand the basics of the cell physiology
2. To study about the electro cardiology
3. To perform the electrical activity of the muscles physiology
4. To understand the function and nerve conduction
5. To study about the peripheral nervous system

UNIT	Course contents	Contact Hours
I **INTRODUCTION TO CELL PHYSIOLOGY**	Level of organizing the body-chemical level, cellular level, organ level, organism level- Concept of membrane potential-Membrane potential. Electrical field in cells and Organism-Electrical structure of the living organism-extracellular field and currents- passive –action potential-electrical tissue and cell suspension-single cell in external electrical field-manipulation of cell by electric field.	10
II **ELECTRICAL CARDIAC PHYSIOLOGY**	Electrical activity of the heart-cardio auto rhythmic the action potential of contractile cell-ECG record different part of the ECG record, ECG diagnosis the abnormal events-Mechanical events of the cardiac cycle-Cardiac output its control.	9
III **ELECTRICAL MUSCLE PHYSIOLOGY**	Molecular basis of the skeletal muscle contraction-Skeletal muscle fibred, myosin forms thick filaments-Muscle mechanics- Group of muscle fiber, types of contraction, EMG motor unit: EMG conduction motor unit, Muscle motor unit recruitment, Muscles fiber frequency of stimulation- Types of muscles based on the ATP hydrolysis and synthesis	9
IV **INVASIVE ELECTROPHYSIOLOGY**	Baseline Assessment, Calculations (BPM to Cycle Length), Interval Measurements - Methods of Recording and Evaluation -Electrogram recognition - Assessment of conduction system - Determination of refractory period --Stimulation Protocols - ECG Morphology during Intracardiac Pacing- Evaluation of Arrhythmia- Supraventricular tachycardia -Ventricular	9

	tachycardia - Response to stimulation - Response to drug studies.	
V **CLINICAL ELECTROPHYSIOLOGY**	Initial Assessment-Diagnostic workup, Clinical Evaluation of Arrhythmia -Response to drugs- Response to vagal maneuvers - Emergency management, Indications, Contraindications for EP Study.	8

Learning Outcome:

The purpose of the course is to understand the concepts and methods of electrical bio physics in the diagnosis and treatment of human diseases.

Learning Resources	
Text Book	1. Laura lee Sherwood, "*Human Physiology from cell to system*", eighth edition, 2012 2. Laura lee Sherwood, "*Fundamental of Physiology of Excitable Cells*", 2010.
Reference Book and other materials	1. Lionel Opie, "Heart Physiology" 2009 2. Aidley, "The Physiology of Excitable Cells", 3rd/4 the edition, 2008 Cambridge Press. 3. Francis D Murgatroyd, Andrew D. Krahn, Handbook of cardia Electrophysiology: A practical guide to invasive EP studies and catheter Ablation, Remedica Publishing 1st Edition 2002. 4. Issa miller Zipes, Clinical Arrhythmology and electrophysiology Saunders; 2nd edition 2012.

		L	T	P	C
Subject Code-	**OPTICAL INSTRUMENTATION**	**3**	**2**	**0**	**4**
Course category- D	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES:

…….

UNIT	**Course contents**	**Contact Hours**
I **INTRODUCTION TO CELL PHYSIOLOGY**	Interference of light – Analytical treatment of interference – Coherent sources – Derivation of expression for fringe width in double slit experiment – White light fringes – Fringe shift with thin transparent plate – Interference on thin films – colour of thin films – Newton's rings – Air wedge – Planeness of surfaces.	10
II **ELECTRICAL CARDIAC PHYSIOLOGY**	Diffraction of light – Fresnel and Fraunohoffer diffraction – Zone plates – Plane diffraction grating – Measurement of Wave length – Dispersive power of grating – Resolving power – Raleigh's criterion – Resolving power of telescope and grating.	9
III **ELECTRICAL MUSCLE PHYSIOLOGY**	Polarization of light – Polarization by reflection – refraction – Brenster's law – Double refraction – Negative and Positive crystals – Nicol prism – Quarter and half wave plates – Production and detection of circularly and elliptically polarized lights – Rotatory polarization – Half shade polarimeter – Applications of polarized light.	9
IV **INVASIVE ELECTROPHYSIOLOGY**	Nuclear fusion – Energy of fission – Chain reaction – Concept of critical size – Thermal power reactor – Breeder reactor – Atom bomb Fusion – Thermonuclear reaction – Fusion bomb – Particle accelerators – Cyclotron – Betatron. Module V Wave particle duality – The postulates of quantum mechanics – De Broghlie's concept of matter waves – properties of matter waves – Denisson&Germer's experiment – G.P. Thomsons experiment – Uncertainty principle – Crystal structure – Spare Lattice – Unit cell – Crystal systems – Cubic – Body centered and fare centered cubes – Lattice Planes. Miller indices – sparing between lattice	9

	planes. Miller indices – sparing between lattice planes – Powder method for crystal study – production of x-rays. Continuum and characteristics X-ray – Bragg's law.	
V **CLINICAL ELECTROPHYSIOLOGY**	Initial Assessment-Diagnostic workup, Clinical Evaluation of Arrhythmia -Response to drugs-Response to vagal maneuvers - Emergency management, Indications, Contraindications for EP Study.	8

Learning Outcome:

To familiarize the students with optical instruments

Learning Resources	
Reference Book and other materials	1. J.B. Rajam – Modern Physics 2. Irving Kaplan – Atomic and Nuclear Physics 3. Sathyaprakash – Optics and Atomic Physics

DEPARTMENTAL ELECTIVE-II

		L	T	P	C
Subject Code-	**BIO FLUID DYNAMICS & MECHANICS**	**4**	**0**	**0**	**4**
Course category- D	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES:

1. Understand fluid and solid mechanics that are pertinent to blood flow in the heart and blood vessels.
2. Apply fluid mechanical analyses relevant to biomedical engineering problems.
3. Conduct fluid mechanical analyses of human circulation, primarily applied to blood flow at the arterial level.
4. Illustrate the fundamental concepts of kinematics and kinetics of human motion
5. Explain the functions of bone and its skeletal articulations
6. Describe the structure, movements, and various loads applied on the shoulder, elbow hand, hip, knee, ankle and spine.

UNIT	Course contents	Contact Hours
I	Fluids and non-fluids, continuum coordinate systems, force and moments, stress at a point, rate of strain, properties of fluids, classification of fluids.Different types of fluid flows, laminar and turbulent flow, transition from laminar to turbulent flow, laminar flow-annulus, laminar flow between parallel plates, measurement of viscosity.Development of boundary layer, estimates of boundary layer thickness, boundary layer equation.	
II	Nature of turbulence, smooth and rough surface, boundary layer separation.Friction loss in flow in a tube. Velocity distribution of aortic system, waveform of pressure and velocity in aorta, wave reflections and impedance in arterial segments, blood flow in veins and blood flow in capillaries.Control theory and system analysis, mechanical analysis of circulatory systems, basic concept of myocardial mechanics, index of contractibility, fluid dynamics of aortic and mitral valves.	
III	Use of statics, kinetics – rigid and non rigid bodies – Forces and motion – Newtons laws – Moment of force – Static equillibrum – Centre of gravity – Stability of equilibrium - Steps in analyzing a biomechanical problem – Graphical methods – contact forces – resolution of forces.	

IV	Skeletal joints, skeletal muscles, basic considerations, basic assumption and limitations, forces and stresses in human joints, mechanics of the elbow, shoulder, spinal column, hip, knee and ankle. Human locomotion, gait analysis and goniometry, Ergonomics, Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Total Hip Prosthesis: requirements, different types of components, Stress analysis & instrumentation, Knee Prosthesis.	
V	Mechanical properties of blood vessels – arteries, arterioles, capillaries, veins, physics of cardio vascular diseases, prosthetic heart valves and replacement.Alveoli mechanics, interaction of blood and lung, P-V curve of lung, breathing mechanism, airway resistance, physics of lung diseases.	

Learning Outcomes;

Understand physiologically relevant fluid, solid mechanics and the basic mechanical concepts involved in human movement.

Learning Resources	
Text Book	1. K.L.Kumar, "Engineering fluid mechanics", Eurasia Publishing House (P) Ltd., New Delhi, 1998. 2. Frank Bell, Principles of Mechanics and Biomechanics, Stanley Thorne (Publishers) Ltd., 1998 3. Donald R. Peterson and Joseph D. Bronzino, Biomechanics Principles and applications, CRC press, Taylor & Francis Group, LLC, 2008 4. Duane Knudson, Fundamentals of Biomechanics, Second Edition,Springer publication , 2007.
Reference Book and other materials	1. .H.Bergel, "Cardiovascular fluid dynamics"- Vol. I, Academic Widmaier, Raff &Strang, "Vander's Human Physiology- The mechanism of body Function", McGrawHill,12th edition,2010.

		L	T	P	C
Subject Code-	**DATA SCIENCE**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVE

To Acquire Knowledge of probability theory, statistics, and programming

UNIT	Course contents	Contact Hours
I **Descriptive Statistics**	Introduction to the course Descriptive Statistics, Probability Distributions Inferential Statistics Inferential Statistics through hypothesis tests Permutation & Randomization Test.	
II	Regression & ANOVA Regression ANOVA(Analysis of Variance) 4. Machine Learning: Introduction and Concepts Differentiating algorithmic and model based frameworks Regression : Ordinary Least Squares, Ridge Regression, Lasso Regression, K Nearest Neighbours Regression & Classification	
III	Supervised Learning with Regression and Classification techniques – Bias-Variance Dichotomy, Model Validation Approaches Logistic Regression Linear Discriminant, Analysis Quadratic Discriminant Analysis Regression and Classification Trees Support Vector Machines	
IV	Supervised Learning with Regression and Classification techniques - Ensemble Methods: Random Forest Neural Networks Deep learning	
V	Unsupervised Learning and Challenges for Big Data Analytics Clustering Associative Rule Mining Challenges for big data analytics. Prescriptive analytics Creating data for analytics through designed experiments Creating data for analytics through Active learning Creating data for analytics through Reinforcement learning Model Validation Approaches Logistic Regression Linear Discriminant Analysis Quadratic Discriminant Analysis Regression and Classification Trees Support Vector Machines	

Learning Outcome

Students will be familiar with linear calculus.

Learning Resources	
Text Book	
Reference Book and other materials	

		L	T	P	C
Subject Code-	**BIOMEDICAL LASER INSTRUMENTATION**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSES OBJECTIVES:

1. Know the laser radiation characteristics and interaction of lasers with tissues
2. Explain the types, construction and operation of different laser systems
3. Biomedical application of different types of laser systems.
4. Know the applications of laser in ophthalmology, dermatology, urology, gynecology and neurology, orthopaedic surgery.
5. Precautionary method in laser safety to be taken

UNIT	Course contents	Contact Hours
I	Laser Tissue Interaction Principle and fundamentals of laser. Laser radiation and its characteristics. Mutual interaction process, primary and secondary factors. Biological tissue composition. Light penetration and reflectance. Laser medicine domains. Laser light scattering in tissues. Speckle formation, interference and polarization methods of tissue diagnostics. Alterations of bio tissue properties during hyperthermal and ablation reactions, photodynamic therapy.	
II	Types of Laser Used In Medicine. Types of laser, construction and working principle of solid state laser. Atomic laser. Molecular laser. Liquid dye laser. Diode laser. Solid state dye laser.	
III	Laser Applications. Principles of laser applications in medicine and biology. Laser in biology: Optical properties of tissue, Pathology of laser reaction in skin, thermal effects, laser irradiation, Non thermal reactions of laser energy in tissue, effect of adjuvant. Applications of laser radiation in ophthalmology. Laser treatment for eye tissues and diseases. Lasers in dermatology- handling of pain. Dermatological disorders. Lasers in cardiovascular diagnostics. Lasers in cardiovascular therapy.	
IV	Laser Applications. Lasers in urology- laser stone disintegration Lasers treatment for benign prostatic hyperplasia, bladder neck incision, bladder tumor and upper urinary tract. Lasers in gynecology- laser application for the lower genital tract. Lasers in laparoscopy. Lasers in laryngeal surgery. Lasers in otology. Lasers in neurology.	

V	Laser In Orthopaedic Surgery, Dentistry and Laser Safety. Mechanism of bone and cartilage reparation. Lasers in orthopaedic surgery. Laser techniques used in spinal surgery. Lasers in dentistry-lasers in endodontic procedures. Caries detection and treatment by laser radiation. Laser bleaching. Types of laser hazards, laser safety, laser use risk management. Application Safety with biomedical Lasers. Fiber optics in diagnosis: Transmission of signals, light, and construction details of optical fiber, application of fiber optics in medical field.	

Learning outcomes:

Learning Resources	
Text Book	1. Helena Jelinkova, "Lasers for medical applications: Diagnostics, Therapy and Surgery", Woodhead Publishing, 1st edition, 2013. REFERENCE BOOKS/OTHER READING MATERIAL. 2. MarkolfH.Neimz, "Laser tissue interactions-Fundamentals and applications", Springer, 3rd edition, 2014. 3. OrazioSvelto and David C. Hanna, "Principles of lasers", Springer, 5th edition, 2010. 4. William T. Silfvast, "Laser fundamentals", Cambridge University Press, 2nd edition, 2009.
Reference Book and other materials	1. Leon Goldman, " The Biomedical laser Technology and Clinical Applications " Springer-Verlar 2. Leon Goldman, "Lasers in Medicine", Springer-Verlac 3. Pratesi E.D.R, and Sacchi, "Lasers in photomedicine and photo biology", Springer-Verlay 3. BashtM.L.Wel, "Laser applications in medicine and biology", Vol I,II,III, Plenum Press (1971 & 1974). 4. Nandini K. Jog, "Electronics in medicine and biomedical instrumentation", PHI.

DEPARTMENTAL ELECTIVE-III

		L	T	P	C
Subject Code-	**HOSPITAL SAFETY AND MANAGEMENT**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To study dynamics of disease transmission
2. To learn Changing pattern of diseases
3. To learn Concept of health & disease and well being.

UNIT	Course contents	Contact Hours
I	Clinical engineering program, educational responsibilities, role to be performed by them in hospital, staff structure in hospital – HIS. Need for evolving health policy, health organization in state, health financing system, health education, health insurance, health legislation.	9
II	Difference between hospital and industrial organization, levels of training, steps of training, developing training program, evaluation of training, wages and salary, employee appraisal method.	9
III	Necessity for standardization, FDA, AERB, Joint Commission of Accreditation of hospitals, ICRP and other standard organization, methods to monitor the standards.	9
IV	Nature and value of strategic management in hospitals - Awareness on the application of IT in Various functions of Hospital. Application of statistical tools in the areas of Health services. Introduction to support services - Disaster management, Ambulance services, Laundry services, Civil Assets etc.	9
V	Elements of Safety - Safety Publications and Standards Organizations - Orientation to Laboratory Safety - Types of risks in the hospitals - factors of environment - Safety showers and Eye Washes – Radiation hazards – radiation detection – safety measures – standards. Ergonomics - Flammables and Explosives – Formaldehydes - PEL Standards and Calculations - Material Safety - Organization of Safety in the hospitals.	9

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Learning Outcome:

Study regarding the natural history of disease and role of hospitals to offer various levels of care.

Learning Resources	
Text Book	1. P.E.Stanley, Handbook of hospital safety, CRC Press (UNIT V) .

	2. Arun Kumar, Hospital Management, Anmol Publications Pvt. Ltd., Jan 2000 , 1st.ed (UNITS I, II, III & IV) .
Reference Book and other materials	1. William Charney, Handbook of Modern Hospital Safety, CRC press. 2. Webster J.C. and Albert M.Cook, "Clinical Engineering Principle and Practice", Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979. 3. Goyal R.C., "Handbook of hospital personal management", Prentice Hall of India, 1996.

		L	T	P	C
Subject Code-	**NEURAL NETWORKS**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To learn the basics of ANN in comparison with Human brain
2. To learn the various architectures of building an ANN and its applications
3. To learn the advanced methods of representing information in ANN like self- organizing networks and competitive learning.

UNIT	Course contents	Contact Hours
I **INTRODUCTION**	**Ar**tificial Neural Networks- Architectures, Definition and Fundamental Concepts, A Brief Overview - Engineering Approaches to Neural Computing- The Mappings View point, The Structure Viewpoint, Learning Approaches- Mathematical Foundations for ANN Study- Vector and Matrix Fundamentals- Geometry for State-Space Visualization- Optimization.	9
II **PERCEPTRONS**	Elementary ANN Building Blocks- Biological Neural Units, Artificial Unit Structures, Unit Net Activation to Output Characteristics- Artificial Unit Model Extensions- Single Unit Mappings and Perceptron - Introduction, Linear Separability, Techniques to Directly Obtain Linear Unit Parameters- Perceptrons and Adaline / Madaline Units and Networks- Multilayer Perceptrons- Gradient Descent Training using Sigmoidal Activation Functions.	9
III **PATTERN ASSOCIATORS & FEEDFORWARD NETWORKS**	Introduction to Neural Mappings and Pattern Associator Applications- Neural Network based pattern associators- The Influence of Psychology on PA Design and Evaluation Linear Associative Mappings- Training and Examples- Hebbian or Correction based learning, Feed Forward Networks and Training- Multilayer Feedforward Network Structure- The Delta Rule- Architecture- Hidden Layer-MappingCapability.	9
IV **EXTENSIONS AND ADVANCED TOPICS**	Feedforward Pattern Associator Design - Weight Space - Error Surfaces and Search - Generalization - Output Error Norms - Higher Order Derivative Based Training - Stochastic Optimization for Weight Determination - Network Architecture Determination Problem - Genetic Algorithms for Network Training - Network Cascade Correlation - Minimization - Inversion.	9

V **COMPETITIVE AND SELF-ORGANISING NETWORKS**	Introduction- Formal Characterization and General Clustering Procedures- Competitive Learning Architectures and Algorithms- Self-Organizing Feature Maps- Adaptive Resonance Architectures- RBF Networks and Time Delay Networks- ANN Hardware and Implementation.	9

Learning Outcome:

This course provides a way to study the Artificial Neural Networks and its applications.

Learning Resources	
Text Book	1. Simon Haykin, "Neural Networks - A Comprehensive Foundation", Pearson Education Asia. 2002.
Reference Book and other materials	1. Yegnanarayana B. "Artificial Neural Networks", Prentice - Hall of India, 2004. 2. Robert J. Schalkoff, "Artificial Neural Networks", McGraw Hill International Ed, 1997. 3. James. A. Freeman and David. M. Skapura, "Neural Networks Algorithms, Applications and Programming Techniques", Pearson Education, 2002.

		L	T	P	C
Subject Code-	**GENE THERAPY**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. Characterize the latest topics in gene therapy
2. Defined the reasons to use gene therapy in different diseases.
3. Compare between gene therapies systems to provide the best treatment
4. Criticize studies in gene therapy

UNIT		Course contents	Contact Hours
I	**INTRODUCTION**	Somatic and germ line gene therapy, Gene replacement and gene addition.	9
II	**In vivo gene therapy**	In vivo, ex vivo and in vitro gene therapy, Transgenic animal models,Vehicles for gene transfer-viral vectors: retrovirus,Adenovirus, Adeno-associated virus.	9
III	**Viral vectors**	Lentivirus, Recombinant SV40 virus, Nonviral vectors, DNA vaccines, Liposomes and lipoplexes, Naked DNA, transposon.	9
IV	**Cancer gene therapy**	Cancer gene therapy, RNA-DNA chimera, Gene therapies for Criglar-Najjar syndrome I.	9
V	Gene Therapy and diseases	Cystic fibrosis, Duchnne muscular dystrophy, Bleeding disorders, Tyrosinemia.	9

Learning Outcome:

The course focuses on understanding the meaning of gene theray and its progression over time

Learning Resources	
Text Book	1. Friedman T. 1999. The Development of Human Gene Therapy. Cold Spring Harbor, NY: Cold Spring Harbor Lab Press.
Reference Book and other materials	1. Knipe DM, Howley PM, eds. 2001. Fields Virology. Philadelphia,PA: Lippincott Williams & Wilkins. 2. Hackett NR, Crystal RG. 2000.Adenovirus vectors for gene

	therapy. In Gene Therapy, ed. NS Templeton, DD Lasic, pp.17-39. New York: Marcel Dekker.

DEPARTMENTAL ELECTIVE-IV

		L	T	P	C
Subject Code-	**CHEMOINFORMATICS & DRUG DESIGNING**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. Study the basic concepts of molecular modeling
2. Understand the drug discovery and development process
3. Study the representation of structures and descriptors.
4. Predict the biological activities through QSAR analysis
5. Emphasize the significance of chemical libraries

UNIT	Course contents	Contact Hours
I **MOLECULAR MODELING IN DRUG DESIGN**	Molecular modeling in drug discovery- Molecular docking- *De-novo* ligand designing- and structure-based methods.	8
II **DRUG DISCOVERY AND DEVELOPMENT**	Drug discovery: targets and receptors- target identification and validation- drug interactions- small molecule drugs- Pharmacodynamics- Pharmacokineticstoxicology- animal tests- formulations and delivery systems.	10
III **REPRESENTATION OF STRUCTURES AND MOLECULAR DESCRIPTORS**	Representation and Manipulation of 2D Molecular Structures- Representation and Manipulation of 3D Molecular Structures. - Descriptors Calculated from the 2D Structure- Descriptors Based on 3D Representations.	9
IV **SIMILARITY AND QSAR METHODS**	Similarity Methods- Similarity Based on 2D Fingerprints- Similarity Coefficients- 2D Descriptor Methods- 3D Similarity- Selecting Diverse Sets Of Compounds- Introduction- deriving a QSAR Equation- Simple and Multiple Linear Regression- Designing a QSAR "Experiment"- Principal Components Regression- Partial Least Squares- Molecular Field Analysis.	9
V HIGH THROUGHPUT AND VIRTUAL SCREENING	Analysis of High-Throughput Screening Data- Data Visualization- Data Mining Methods- Virtual Screening- Drug-Likeness and Compound Filters- Structure- Based Virtual Screening- chemical libraries.	9

Learning Outcomes:

This subject portraits the fundamentals of chemo informatics and applications of computer aided drug designing.

Learning Resources

Text Book	1. Andrew R Leach, Valerie J Gillet, "*An Introduction to Chemoinformatics*", Kluwer academic publishers, 2003. 2. Rick NG, "*Drugs: from Discovery to Approval*", John Wiley &sons, 2004. 3. Andrew R Leach, "*Molecular Modelling- Principles and applications*", Prentice Hall, II edition, 1996. 4. Cold Spring Harbor, NY: Cold Spring Harbor Lab Press.
Reference Book and other materials	1. Johann Gasteiger, Thomas Engel, "*Chemoinformatics- A Textbook*", Wiley- VCH, 2003. 2. Jürgen Bajorath, "*Chemoinformatics: Concepts, Methods, and Tools for Drug Discovery*", Humana press, 2004. 3. Garland R Marshall, *"Chemoinformatics in Drug Discovery*" ,John Wiley & Sons, 2006.

		L	T	P	C
Subject Code-BM0303	**ARTIFICIAL INTELLIGENCE AND MEDICAL INFORMATICS**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES:

1. To understand the basic concepts of Artificial intelligence structures and strategies
2. To understand the concepts of knowledge representation in AI
3. To study the different pattern recognition techniques and feature extraction based on clustering
4. To give an insight knowledge about the different types of classification techniques
5. To study about the application of AI in medical field

UNIT	Course contents	Contact Hours
I **ARTIFICIAL INTELLIGENCE**	Artificial Intelligence (AI): Introduction, definition & history, Components, Problem definition- Structures and Strategies for state space search- Depth first and breadth first search- DFS with iterative deepening- Heuristic Search- Best First Search- A* Algorithm- AND, OR Graphs, Problems.	9
II **KNOWLEDGE REPRESENTATION IN AI**	Propositional- and Predicate- calculus, Theorem proving by resolution, AI representational schemes- Semantic nets, Conceptual graphs: Using frames and scripts- Production system, Rule based expert system.	9
III **PATTERN RECOGNITION**	Classes, patterns & features- Pattern similarity and PR Tasks- Pattern discrimination Feature space metrics & Covariance matrix- Feature assessment- Unsupervised learning, Statistical, syntactic and descriptive approaches 184 BM –Engg &Tech-SRM - 2013	9
IV **CLASSIFICATION**	Linear discriminants, Bayesian classification, Bayes rule for minimum risk, minimum error rate classification, discriminant functions, and decision surfaces, Model free technique – ROC Curve, Classifier evaluation, Back propagation learning, Competitive learning, K-means clustering.	9
V APPLICATIONS IN MEDICINE	Diagnosis of disease using AI, Biometrics: Face recognition and Gene matching. Automated drug delivery systems- Computer aided diagnosis- Mining of electronic health record- Computer vision	9

Learning Outcomes:

To enable the students to acquire knowledge about the artificial intelligence techniques and to recognize the patterns and its application in medicine.

Learning Resources

Text Book	1. George.F.Luger, "Artificial Intelligence- Structures and Strategies for Complex Problem Solving", 4/e, 2002, Pearson Education. 2. Duda and Hart P.E, "Pattern classification and scene analysis", John wiley and sons, NY, 1973.
Reference Book and other materials	1. Earl Gose, Richard Johnsonbaugh, and Steve Jost; "Pattern Recognition and Image Analysis", PHI Pvte. Ltd., NewDelhi-1, 1999. 2. Fu K.S., "Syntactic Pattern recognition and applications", Prentice Hall, Eaglewood cliffs, N.J., 1982. 3. Rochard O. Duda and Hart P.E, and David G Stork, "Pattern classification", 2nd Edn., John Wiley & Sons Inc., 2001. 4. Carlo Combi, Yuval Shahar; "Artificial Intelligence in Medicine" – 12 th Conference – Springer.

		L	T	P	C
Subject Code-	**SYSTEM BIOLOGY**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To exhibit cellular behaviors such as secretion, proliferation and action potentials.
2. To learn the properties of such subcellular and cellular systems.
3. To study the mechanisms by which emergent behaviors of systems arise.
4. To study gene regulation at a single cell level

UNIT	**Course contents**	**Contact Hours**
I Fundamentals Overview of Gene Control	Working of Genetic Switches – Introductory Systems Biology The biochemical paradigm, genetic paradigm and the systems paradigm.	9
II Kinetics Equilibrium Binding and Co-operativity	Michaelis Menten Kinetics –identical and independent binding sites – Identical and interacting binding sites, non-interacting binding sites.	9
III Genetic switch in Lambda Phage	Noise-based Switches and Amplifiers for Gene Expression. Synthetic genetic switches –E. coli chemotaxis – biological oscillators- genetic oscillators -The Origin and Consequences of Noise in Biochemical Systems.	9
IV Developmental Systems Biology Building an Organism Starting From a Single Cell	Quorum Sensing – Programmed Population Control by Cell-Cell Communication and Regulated KillingDrosophila Development. Establishment of Developmental Precision and Proportions in the Early Drosophila embryo.	9
V Gene expression networks Gene regulation at a single cell level	Transcription Networks -basic concepts -coherent Feed Forward Loop (FFL) and delay gate -The incoherent FFL - Temporal order, Signaling networks and neuron circuits -Aspects of multi-stability in gene networks.	9

Learning Outcome:

To understand how macromolecules interact with each other to form modules that act as discrete functional systems.

Learning Sources:

Learning Resources	
Text Book	1. George.F.Luger, "Artificial Intelligence- Structures and Strategies for Complex Problem Solving", 4/e, 2002, Pearson Education. 2. Duda and Hart P.E, "Pattern classification and scene analysis", John wiley and sons, NY, 1973.
Reference Book and other materials	Mathematical and Computational Biology, 2nd edition, 2006.

OPEN ELECTIVE- I

		L	T	P	C
Subject Code-	**DIGITAL SYSTEM**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. Apply Boolean algebra and other techniques to express and simplify logic expressions
2. Analyze and design combinational and sequential digital systems.
3. Use different techniques, among them a hardware description language and a functional programming language, to design digital systems.

UNIT	**Course contents**	**Contact Hours**
I NUMBER SYSTEM AND BOOLEAN ALGEBRA	Introduction to number systems- Types and Conversions, Binary Arithmetic, Signed Binary Numbers, Binary Codes - BCD, ASCII, Excess-3 codes, Gray codes, Code conversion, Boolean Algebra - De-Morgans Theorem, Reduction of Switching Equations Using Boolean Algebra.	
II Kinetics Equilibrium Binding and Co-operativity	Introduction to logic gates- Design of two level gate network-Two level NAND-NAND and NOR-NOR networks, Universal property of NAND and NOR gates, Standard forms of Boolean equation-Minimization of SOP and POSKarnaugh maps - Advantages and Limitations- Quine-Mclusky Methods.	
III COMBINATIONAL CIRCUITS	Binary Adder- Subtractor, Parallel Binary Adder, Parallel Binary Subtractor, Parallel Adder/ Subtractor, Decoders, Encoders, Priority Encoders, Multiplexers and De Multiplexer, Magnitude Comparators- one bit and two bit.	
IV SEQUENTIAL CIRCUITS	Flip flops - SR, JK, T, D, Master slave FF, Characteristic and Excitation table, Shift Registers, Counters- two bit and three bit Asynchronous and Synchronous Counters- UP/DOWN Counter, State Diagram representation of filp flops, State Minimization Techniques, State Assignment.	
V LOGIC FAMILIES AND MEMORIES	Classification and Characteristics of Logic Families - Operation of RTL, DTL, HTL, ECL, MOS and CMOS Comparision of Logic Families Memories-Random Access Memory - Static RAM, Dynamic RAM, Read Only Memory, Programmable memory-EPROM, EEPROM, , Charge Coupled Devices.	

Learning Resources	
Text Book	1. Morris Mano, Digital Design , Prentice Hall of India, 2001. 2. Ronald J. Tocci, Digital System Principles and Applications , PHI,

	6th Edition, 1997. 3. CharlesH.Roth, Fundamentals Logic Degisn ,Jaico Publishing,IV Edition,2002.
Reference Book and other materials	1. Floyd, Digital Fundamentals , Universal Book stall, New Delhi, 1986. 2. R. P. Jain, Modern Digital Electronics , Tata McGraw Hill, 3rd edition, 1997. 3. Malvino.A.P. and Donald.P.Leach, Digital Principal and Applications, 4th Edition, Tata McGraw Hill, 2007.

		L	T	P	C
Subject Code-	**INTERNET PROGRAMMING**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To introduce the basics of internet and HTML
2. To make the students understand the scripting languages
3. To introduce the markup languages XML and XHTML
4. To give the students an understanding of server side programming
5. To make the students understand the fundamentals and applications of ASP.NET

UNIT	Course contents	Contact Hours
I INTERNET BASICS, HTML	Basic internet concepts - web server, client – Apache server – Internet Information Services (IIS)- Markup Language- Introduction to HTML and Cascading Style Sheets (CSS)- Internet applications- Email – chat – search engines – news groups.	9
II SCRIPTING LANGUAGES	Java Scripting - VB scripting- Object model and event model- Document Object Model (DOM) – Common Gateway Interface (CGI) & data base connectivity- Introduction to PHP and Perl scripting.	9
III XML AND XHTML	Introduction to XML – Document Type Definitions - XML schemas – XML Database creation. Introduction to XHTML and XHTML elements.	9
IV SERVER SIDE PROGRAMMING	Multi tier application- Introduction to Java servlets- HTTP GET & POST request- JDBC principles- cookies session tracking;	9
V ASP.NET	Introduction to ASP.NET- using objects- data types- data access objects connection object- command object. CASE STUDY- Developing a web based tool for sequence analysis.	9

Learning Outcome:

The purpose of this course is to learn the fundamentals of various programming methods employed in the internet.

Learning Resources	
Text Book	1. Steven M. Schafer, "*HTML, XHTML, and CSS Bible*", Fifth Edition, Wiley Publishing, Inc. 2010. 2. Deital and Deital, Goldberg, "*Internet & World Wide Web, How To Program*", third edition, Pearson Education, 2004. 3. CharlesH.Roth, Fundamentals Logic Degisn ,Jaico Publishing,IV Edition,2002.

Reference Book and other materials	1. Paul Wilton and Jeremy McPeak, "*Beginning JavaScript*", Wrox, 4th edition, 2009. 2. Cerami Ethan, "*XML for Bioinformatics*", Springer, 2005. 3. Adrian Kingsley-Hughes, Kathie Kingsley-Hughes, Daniel Read, "*VBScript Programmer's Reference*", 3rd Edition, Wrox, 2007. 4. Vivek Chopra, Jon Eaves, Rupert Jones, Sing Li, John T. Bell, "*Beginning JavaServer Pages*", Wrox, 2005. 5. Macdonald Mathew, "*Asp.Net - The Complete Reference*", McGraw-Hill/ Osborne, 2002.

		L	T	P	C
Subject Code-	**CANCER BIOLOGY**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

To understand the common cellular and molecular mechanisms that are deregulating cancerous cells? & how does their regulation contribute to the development of cancer.

UNIT	Course contents	Contact Hours
I FUNDAMENTALS OF CANCER BIOLOGY	Regulation of Cell cycle- Mutations that cause changes in signal molecules effects on receptor- signal switches tumour suppressor genes- Modulation of cell cycle-in cancer- Different forms of cancers- Diet and cancer.	9
II PRINCIPLES OF CARCINOGENESIS	Chemical Carcinogenesis- Metabolism of Carcinogenesis- Natural History of Carcinogenesis- Targets of Chemical Carcinogenesis- Principles of Physical Carcinogenesis- X-Ray radiation - Mechanism of radiation Carcinogenesis.	9
III PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER	Oncogenes- Identification of Oncogenes- Retroviruses and Oncogenes- detection of Oncogenes- Growth factor and Growth factor receptors that are Oncogenes- Oncogenes/ Proto Oncogenes activity- Growth factors related to transformations.	9
IV PRINCIPLES OF CANCER METASTASIS	Clinical significances of invasion- heterogeneity of metastatic phenotype-Metastatic cascade- Basement membrane disruption- Three step theory of invasion- Proteinases and tumour cell invasion.	9
V NEW MOLECULUS FOR CANCER THERAPY	Different forms of therapy- Chemotherapy- Radiation Therapy- Detection of Cancers- Prediction of aggressiveness of Cancer- Advances in Cancer detection. Bioinformatics and Cancer.	9

Learning Outcome:

To understand gene mutation play in the development of cancer

Learning Resources	
Text Book	Weinberg, Robert A. The Biology of Cancer, Second Edition. NewYork: GarlandScience, 2013.
Reference Book and other materials	1. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics, Lauren Pecorino 2. Principles of Cancer Biology, Klein smith.

OPEN ELECTIVE-II

		L	T	P	C
Subject Code-	**DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. This course will introduce the basic concepts and techniques for processing signals on a computer.

2. By the end of the course, the student will be familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.

3. The course emphasizes intuitive understanding and practical implementations of the theoretical concepts.

UNIT	Course contents	Contact Hours
I INTRODUCTION TO DISCRETE TIME SIGNALS & SYSTEMS	Representations - Classification of DT Signals & DT Systems - Concepts of Signal processing - Advantages of digital signal processing compared with analog processing - Typical applications - Analysis of DT-LTI Systems – ZTransform and its properties - Inverse Z-Transform - Long division method - Partial fraction method - Residue or Contour integration method - Convolution method.	9
II FREQUENCY ANALYSIS OF SIGNALS	Discrete Fourier Transform and its properties - Relationship of the DFT to other transforms - General computation of DFT - convolution - Linear convolution, Circular convolution - Introduction to Fast Fourier Transform - Radix-2 FFT algorithms - Decimation in time (DIT), Decimation in Frequency (DIF) algorithms.	9
III FIR FILTER DESIGNIN	Introduction - Digital filtersLinear phase FIR filters - Designing of FIR Filters - Fourier series method of designing FIR filters - Design of FIR filters using windows - Rectangular window - Hamming Window – Hanging Window functions - Frequency sampling method of designing of FIR filters - Frequency response and Design.	9
IV IIR FILTER DESIGNING	Introduction - Frequency selective filters - Digital versus Analog filters - Advantages & disadvantages of digital filters - Butterworth and Chebyshev Filters - Frequency Transformation in analog & Digital domain - Low pass to Low pass - Low pass to High pass - Low pass to Band pass - Low pass to Band stop - Realization of digital filters - Direct form I & II.	9
V DSP APPLICATION	Multirate signal processing: Decimation - Efficient transversal structure & Polyphase structure of Decimator, Interpolation - Efficient transversal structure & Polyphase structure of Interpolator - Polyphase Decimation & Interpolation using Z-Transform - Adaptive Filters: Introduction, Applications of adaptive filtering to equalization - Medical applications - ECG, EEG analysis.	9

Learning Resources	
Text Book	1. John G. Proakis & Dimitris G. Manolakis, Digital Signal Processing - Principles, Algorithms & Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007. 2. Allan V. Oppenheim et al, Signals and Systems, 2nd Edition, Prentice Hall of India Pvt. Ltd., 1997. 3. Haykin. S and Van Been. B., Signals and Systems, 2nd Edition, John Wiley & Sons, 2003.
Reference Book and other materials	1. Emmanuel C..Ifeachor, & Barrie.W.Jervis, Digital Signal Processing, Second Edition, Pearson Education / Prentice Hall, 2002. 2. Sanjit K. Mitra, Digital Signal Processing - A Computer Based Approach, Tata Mc Graw Hill, 2007. 3. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 8th Indian Reprint, Pearson, 2004. 4. Andreas Antoniou, Digital Signal Processing, Tata Mc Graw Hill, 2006.

		L	T	P	C
Subject Code-	**INTRODUCTION TO PYTHON**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To understand the basics of Python as prelude for Biopython.
2. To learn the control statements and file parsing methods in Python
3. To learn sequence handling using python
4. To learn how to use python for handling the biological databases.
5. To get familiarized with some of the advanced options in Biopython.

UNIT	Course contents	Contact Hours
INTRODUCTION TO PYTHON	Simple values, expressions, operators. Names, functions and modules. Collections:- Sequences, mappings, streams, and expression features.	9
CONTROL STATEMENTS, FILE PARSING	Conditional statements:- loops, iterations, exception handlers. Extended examples - Extracting Information from an HTML File, Bioinformatics File Parser, Parsing GenBank Files, Translating RNA Sequences, Constructing a Table from a Text File.	9
BIOPYTHON	Introduction to Biopython, sequence objects, sequence record objects. Sequence input and output:- parsing sequences, parsing sequences from the net, sequence files as dictionaries, writing sequence files. Multiple Sequence Alignment objects.	9
DATABASE SEARCH USING BIOPYTHON	BLAST using Biopython:- running BLAST, parsing BLAST output, PSI-BLAST and RPS-BLAST. Accessing NCBI's Entrez databases. Swiss-Prot and ExPASy.	9
ADVANCED MODULES IN BIOPYTHON	PDB module, phylogenetics, sequence motif analysis and cluster analysis.	9

Learning Outcome;

The purpose of this course is to introduce biopython and its applications in bioinformatics

Learning Resources	
Text Book	1. Jeff Chang, Brad Chapman, Iddo Friedberg, Thomas Hamelryck, *Biopython Tutorial and Cookbook*", http://biopython.org/DIST/docs/tutorial/Tutorial.html, 2013. 2. Haykin. S and Van Been. B., Signals and Systems, 2nd Edition, John Wiley & Sons, 2003.

Reference Book and other materials	1. Mitchell L Model, "*Bioinformatics Programming Using Python*", O'Reilly media, Cambridge, 2010.

		L	T	P	C
Subject Code-	**INTRODUCTION TO R**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To understand the basics of R
2. To learn the control statements and file parsing methods in R
3. To learn sequence handling using R
4. To learn how to use R for handling the biological databases.

UNIT	**Course contents**	**Contact Hours**
I Introduction and history of R	RStudio, Getting help, Colon (:) operator, Functions - *ls(), objects(), rm(), q(),c(),assign(), seq().* Numerical vectors, Vector arithmetic, Arithmetic operators,Use of functions-*sum(), mean(), length(), max(), min(),sort(),sqrt(),* Logical vectors, Logical operators, Missing values-NA, NaN, Use of functions -*is.na(), is.nan(),* Character vectors,Function – *paste()* , Index vectors.	9
II Type of objects in R	Vectors, Matrices, Factors, Lists, Data frames, Functions; Mode of objects, changing mode-Coercion. Changing the length of an object, Getting and setting attributes, Class of an object,	9
	Functinons– *mode(), class(),typeof(), as.character(), as.integer(),* Ordered and unordered factors, functions*tapply()* and ragged arrays	9
	Arrays, Array indexing, Index matrices, The *array()* function, The outer product of two arrays, Generalized transpose of an array, Matrix multiplication, Forming partitioned matrices, *cbind()* and *rbind(),* The concatenation function, c(), with arrays, Frequency tables from factors	9
	Lists, Constructing and modifying lists, Concatenating lists, Data frames, Making data frames, *attach()* and *detach(),* Working with data frames, Attaching arbitrary lists, Managing the search path Reading data from files, The l*read.table()* function, The *scan()* function, Accessing builtin datasets, Loading data from other R packages, Editing data	9

Learning Outcome:

The purpose of this course is to introduce R and its applications in Bioinformatics

Learning Resources	
Text Book	1. Robert J Knell, "*Introductory R: A Beginner's Guide to Data Visualisation*

	and Analysis using R", 2013. 2. Thomas Rahlf. "*Data Visualisation with R*", Springer International Publishing, New York, 2017 3. TorstenHothorn and Brian S. Everitt, "*A Handbook of Statistical Analyses Using R*" Chapman & Hall/CRC Press, 2014. 4. Hadley Wickham and Garrett Grolemund, " *R for Data Science*", O'Reilly Publication, 2018.
Reference Book and other materials	1 Victor A. Bloomfield, "*Using R for Numerical Analysis in Science and Engineering",* Chapman & Hall/CRC, 2014 1. William N. Venables, David M. Smith, *"An Introduction to R"*, Springer, 1990.

OPEN ELECTIVE-III

		L	T	P	C
Subject Code-	**NUCLEAR MEDICINE**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To learn the basics of nuclear medicine
2. To study the construction and principle of operation of various nuclear medicine instruments.
3. To have some knowledge about the characteristics and mechanisms of radiopharmaceuticals
4. To study the diagnostics and therapeutic applications of nuclear medicine.
5. To have idea about the radiation safety procedures and regulations.

UNIT	Course contents	Contact Hours
I BASICS OF NUCLEAR MEDICINE	Radioactivity and interaction of radiation; Alpha, Beta and gamma emission, Laws of radioactive decay, Mechanisms of radioactive delay, Radiation intensity and exposure, Decay schemes and energy levels, Compton scattering, Pair productions, Particle interactions	8
II RADIOPHARMACEUTICALS	Radionuclide production, 99Mo/99mTc generator, Mechanism of localization, Types of radiopharmaceuticals, characteristics of radio pharmaceuticals, Radiopharmaceuticals for diagnosis and treatments in human, Dispensing of radio pharmaceuticals, RIA radiopharmaceuticals and kits production.	9
III NUCLEAR MEDICINE INSTRUMENTATION	Construction and principle operation of Gamma camera, Rectilinear scanner, Basic principles of pulse height analyser, Radiation detectors-Ionization chamber, Geiger Muller counter, Semiconductor detectors, Scintillation detectors, Electronic Instrumentation for radiation detection system	9
IV DIAGNOSTIC AND THERAPEUTIC APPLICATIONS OF RADIONUCLIDE	PET-CT, Single photon emission computed tomography (SPECT), Radio iodine therapy for Thyrotoxicosis , Differentiated thyroid cancers, Palliative treatment for 149 BM-Engg&Tech-SRM-2013 bone metastasis - 32P and 89 Strontium Dosage, Intravascular particulate radio nuclide Therapy, Receptor targeted therapy, 131I- MIBG Therapy, Targeted internal radiation in HCC: 90 Y, Radio-synovectomy using Yttrium	10
V RADIATION SAFETY	Radiation protection indifferent nuclear isotope therapy procedures, Management of radiation accidents, Radiation effect on pregnancy and fertility, Diagnosis, evaluation and treatment of radiation overexposure, Instruments used in radiation survey & monitoring, Handling of radioactive patients, Role of national and international bodies in radiation safety, ICRP recommendations, BARC regulations regarding limits of radiation exposure	9
Learning Resources		

Text Book	1. Simon Cherry, James Sorenson, Michael Phelps. "Physics in Nuclear Medicine", Elsevier Saunders , 4th Edition ,2012. 2. Jennifer Prekeges, "Nuclear Medicine Instrumentation", Jones and Barlett publishers, 1st edition, 2011.
Reference Book and other materials	1. Max.H.Lombardi, "Radiation safety in Nuclear Medicine", CRC Press, Florida, USA, 2nd edition 199

Learning Outcome:
To understand the fundamentals of Nuclear Medicine and learn about the instruments involved in production techniques and therapeutic uses of Nuclear Medicine.

		L	T	P	C
Subject Code-	**RADIOTHERAPY BASICS AND APPLICATION**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To make them understand the basics of radiotherapy physics
2. To impart the knowledge about the different pretreatment imaging and treatment verification
3. To gain in-depth knowledge about the radiotherapy effects
4. To make the students understand the function of various types of Radiotherapy equipments.

UNIT	Course contents	Contact Hours
I RADIOTHERAPY PHYSICS & PRE-TREATMENT IMAGING	Atoms, nuclei and radioactivity- Radiation interactions with matter- Radiation measurement and detection- Imaging with X-ray, MRI and ultrasound-Imaging with radio nuclides- Therapy with unsealed radio nuclides-Radiotherapy beam production.	9
II RADIATION TREATMENT PLANNING	Immobilization, localization and verification techniques- Principles and practice of radiation treatment planning- Brachytherapy- Networking, data and image handling and computing in radiotherapy- Quality management in radiotherapy.	9
III RADIOTHERAPY EFFECTS	Epidemiology of cancer-screening- Biological and pathological introduction- Molecular, cellular and tissue effects of radiotherapy- Principles and management of patients with cancer- Chemotherapy and hormones- Skin and lip cancer-head and neck cancer.	9
IV RADIOTHERAPY ASSISTING DEVICES	Features of conventional simulator and modern simulator - Immobilization equipment for head, neck, pelvic and extremities. 151 BM-Engg&Tech-SRM-2013.	9
V ADVANCED APPLICATIONS	Cobalt units, Gamma knife, Linear accelerators, Helical tomotheraphy, Ancillary equipment – Superficial and ortho voltage equipment.	9

Learning Outcome: To provide the ability to work in different radiotherapy Equipments and its applications in Biomedical Engineering

Learning Resources	
Text Book	1. Symonds, Deehan, Meredith & Mills Walter and Miller, "Textbook of Radiotherapy: Radiation Physics, Therapy and Oncology", Churchill Livingstone, Seventh Edition, 2012. 2. Pam Cherry, Angela Duxbury, "Practical Radiotherapy-Physics and Equipment", John Wiley & Sons, Second Edition, 2009.
Reference Book and other materials	1.Todd Powliki, Peter Dunscombe B, Arno J, Mundt, Pierre Scalliet, "Quality and safety in radiotherapy", CRC Press, First Edition, 2010. 2. Subramania Jayaraman, Lawrence Lanzl H, "Clinical Radiotherapy Physics", CRC Press, Second Edition, 1996. 3. William N. Venables, David M. Smith, *"An Introduction to R"*, Springer, 1990.

		L	T	P	C
Subject Code- BT0403	**ETHICAL ISSUES & IPR**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES 1. To caution the nature of hazards related to biotechnology and the importance of biosafety in research.

2. To debate on ethical issues related to biotechnology research.

3. To give an overview of the methods used in scientific research and to emphasize on the importance of statistical concepts.

4. To provides guidelines on accessing scientific literature, and preparing scientific papers and presentation.

5. To impart knowledge on the importance of intellectual property and its protection under the constitution.

UNIT	Course contents	Contact Hours
I BIOSAFETY AND GMOs IN INDIA	Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC) - Institutional Biosafety Committee (IBSC) - Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC) - State Biosafety Coordination Committee (SBCC) - District Level Committee (DLC). Recombinant DNA Guidelines (1990) -Revised Guidelines for Research in Transgenic Plants (1998) - Prevention Food Adulteration Act (1986) - The Food Safety and Standards Bill (2005)	9
II BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS	Rules for the manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells (Ministry of Environment and Forests Notification (1989) - Plant Quarantine Order (2003), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007) National Environment Policy (2006) - Convention of Biological Diversity (1992) - 140 Biotech-2013 SRM (E&T) Cartagena Protocol on Biosafety - Objectives and salient features of Cartagena Protocol - Advanced Information Agreement (AIA) procedure - procedures for GMOs intended for direct use-risk assessment- risk management-handling, transport, packaging and identification of GMOs - Biosafety Clearing House- unintentional transboundary movement of GMOs	9
III BIOETHIC	The legal and socioeconomic impacts of biotechnology-Public education of the process of biotechnology involved in generating new forms of life for informed decision making ethical concerns of biotechnology research and innovation.	9
IV RESEARCH METHODOLOGY	Introduction to the design, analysis, and presentation of scientific projects - methods used in scientific research - hypothesis testing - the measurement of functional relationships - and observational research-important features of experimental design,- control of errors- instrument calibration - data analysis	9

V INTELLECTUAL PROPERTY RIGHTS	Intellectual property rights - patents and methods of application of patents - legal implications- objectives of the patent system - basic principles and general requirements of patent law-biotechnological inventions and patent law - patentable subjects and protection in biotechnology- TRIPs – GATT - Biodiversity and Plant variety protection and farmer rights - Seed Policy (2002).	9

Learning Outcome:

The course is designed to outline the methodology for research in biotechnology and provides an understanding of the ethical issues underlying biotechnology research and innovation in addition to protection of the acquired intellectual property. The student will gain an understanding research methodology, the ethical issues underlying biotechnology research and the importance of protection of intellectual property.

Learning Resources	
Text Book	1. Sasson.A , "Biotechnologies and Development", UNESCO Publications. 2. Singh.K, "Intellectual Property rights in Biotechnology", , BCIL, New Delhi. 3. "Regulatory Framework for GMOs in India" Ministry of Environment and Forest, Government of India,New Delhi, (2006).
Reference Book and other materials	1. "Cartagena Protocol on Biosafety" Ministry of Environment and Forest, Government of India, New Delhi, (2006). 2. Michael P. Marder "Research methods for Science" Cambridge University Press. 1.

OPEN ELECTIVE-IV

		L	T	P	C
Subject Code-	**TELEMEDICINE**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite-Nil**				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

At the end of the course, student will be able to

1. Explain the development and transmission techniques used in telemedicine a
2. Describe the types of communication and network systems
3. Explain the technologies used in data exchange and privacy of telemedicine
4. Illustrate the current system of tele-health and mobile health
5. Describe the currents and futures perspective of telemedicine

UNIT	Course contents	Contact Hours
Background of Telemedicin	Introduction ,definitions of telemedicine, telehealth and telecare, Origins and development of telemedicine: from beginning to modern times, modern telemedicine and telecare, Drivers of telemedicine and telecare: technology drivers, non technological drivers, the funding dilemma, Telemedicine in developed and underdeveloped countries ,benefits and limitations of telemedicine , Types of information and transmission in telemedicine: audio, video, still images, text and data.	9
Communication and Network Systems in Telemedicine	Types of communication and network: public switched telephone network, plain old telephone service, integrated services digital network, internet, asynchronous transfer mode. Wireless communications basics and its types ,Wireless sensor standards and homecare concerns, medical sensors for mobile communication devices, Development of disposable adhesive wearable human monitoring system, Implantable systems: implantable system architecture, Signal Processing in implantable neural recording microsystems, electronic health signal processing.	9
Technologies for Safeguarding Medical Data and Privacy, Data Exchanges	Network configuration, circuit and packet switching, Data security and standards: Encryption, cryptography, mechanisms of encryption, phases of encryption , Cryptography, safeguarding patient medical history, Anonymous data collection and processing, biometric security and identification	9
Telehealth and Mobile Health, Medical robotics	surgical robots, rehabilitation robots Modern devices for tele-surgery: Main component and functionalities of a robotics tele-surgery System, design guidelines and methodology Microsurgery Systems: Robot-assisted microsurgery system,miniaturization, microsurgical tools, visualization methods and systems Image-guided microsurgery: Image guidance component and workflow,	9

	image guidance by surgical domain	
V Implementation of Telemedicine and Future Trends in Technology	Tools and devices, Teleradiology and Tele-audiology, Telepathologysystem development and implementation Acute care telemedicine and monitoring for elderly care Virtual doctor systems for medical practices, wireless electrical impedance tomography, Synthetic biometrics in biomedical systems, bio-kinematics for mobility	9

Learning Outcomes:

The purpose of learning this course on introduction to telemedicine for biomedical engineering students is to acquire knowledge on the basic concepts of telemedicine and the technology used in healthcare system

Learning Resources	
Text Book	1. Olga Ferrer-Roca, M. SosaLudicissa, Handbook of Telemedicine, IOS press 2002.
Reference Book and other materials	1. A.C. Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002.

		L	T	P	C
Subject Code-	**TROUBLESHOOTING OF MEDICAL EQUIPMENTS**	**3**	**2**	**0**	**4**
Course category-	**Pre-requisite-** Basic knowledge of calculus, linear algebra & differential equations				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

Course OBJECTIVES

1. To know about power supply operation and troubleshooting
2. To design electrical equipments with safety standards
3. To know the principle of medical equipments.
4. Course Outcomes:
5. Identify the reasons for equipment failure.
6. Appreciate the need for grounding aspects , maintenance and troubleshooting.
7. Design advanced equipments to solve critical problems.

UNIT	Course contents	Contact Hours
	AC, DC power supply, Grounding, shielding, Guarding, insulation testing, insulation resistance measurement.	9
	Testing of electronic components, Troubleshooting of PCB boards	9
	Calibration of analog and digital sensor probe, Display interface, Safe electrical practice, Cables and standard, Fuse, Transformer testing, CT and PT, Panel wiring.	9
	Troubleshooting of X-ray machines, Troubleshooting of ECG recorders, ultrasound machine, patient monitor, ventilator, dialyser, heart lung machine, surgical lights, incubator, baby warmer, infusion pumps, annual maintenance, contract requirements, vendor services, quality and safety standards.	9
	Tools and devices, Teleradiology and Tele-audiology, Telepathologysystem development and implementation Acute care telemedicine and monitoring for elderly care Virtual doctor systems for medical practices, wireless electrical impedance tomography, Synthetic biometrics in biomedical systems, bio-kinematics for mobility	9

Learning Resources	
Text Book	1. Medical Equipment Maintenance Manuel, Ministry of Health and Family

	Welfare, New Delhi, 2010. 2. Shakti Chatterjee,Aubert Miller, "Biomedical Equipment Repair", Cengage Learning Technology& Engineering, 2010. 3. David Herres, "Troubleshooting and Repairing Commercial Electrical Equipment", McGrawHill ,Professional edition, 2013. 2.
Reference Book and other materials	1. L.Nokes.B.Turton, D.Jennings, T. Flint,"Introduction to Medical Electronics Applications", A Butterworth Heinemann Title. 1995 2. Joseph F. Dyro, "Clinical engineering handbook, Elsevier Academic Press, 2004.

		L	T	P	C
Subject Code-	**ROBOTICS & AUTOMATION IN MEDICINE**	**3**	**0**	**0**	**3**
Course category-	**Pre-requisite**-Basic knowledge of calculus, linear algebra & differential equations				
	Co-requisite				
	Designed by Department of Biomedical Engineering				

COURSE OBJECTIVES

1. To introduce the functional elements of Robotics
2. To impart knowledge on the direct and inverse kinematics
3. To introduce the manipulator differential motion and control
4. To educate on various path planning techniques
5. To introduce the dynamics and control of manipulators

UNIT	Course contents	Contact Hours
I BASIC CONCEPTS	Brief history-Types of Robot–Technology-Robot classifications and specifications-Design and control issues- Various manipulators – Sensors - work cell - Programming languages.	9
II DIRECT AND INVERSE KINEMATICS	Mathematical representation of Robots - Position and orientation – Homogeneous transformation Various joints- Representation using the DenavitHattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- SCARA robots- Solvability – Solution methods-Closed form solution.	9
III MANIPULATOR DIFFERENTIAL MOTION AND STATICS	Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance.	9
IV PATH PLANNING	Definition-Joint space technique-Use of p-degree polynomial-Cubic polynomial-Cartesian space technique - Parametric descriptions - Straight line and circular paths - Position and orientation planning.	9
V DYNAMICS AND CONTROL	Lagrangian mechanics-2DOF Manipulator-Lagrange Euler formulation-Dynamic model – Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator.	9

Learning outcome:

To impart application based understanding of automation technologies in medicines

Learning Resources	
Text Book	1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005. 2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control,

	Third edition, Pearson Education, 2009. 3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
Reference Book and other materials	1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010. 2. K. K.AppuKuttan, Robotics, I K International, 2007. 3. Edwin Wise, Applied Robotics, Cengage Learning, 2003. 4. R.D.Klafter,T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994. 5. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998. 6. S.Ghoshal, "*Embedded Systems & Robotics*" – Projects using the 8051 Microcontroller, Cengage Learning, 2009.