



ERODE SENGUNTHAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University)

PERUNDURAI, ERODE - 638 057



UG Curriculum and Syllabus (1 to 8 Semesters)

B.E. BIOMEDICAL ENGINEERING

Choice Based Credit System (CBCS)

(For the students admitted during the
Academic year 2020-21 and onwards)

REGULATION 2019

Vision and Mission of the Institute:

Vision of the Institute:

Vision of Erode Sengunthar Engineering College is to become a World Class Technical Institution and Scientific Research Centre for the Benefit of the Society

Mission of the Institute:

Erode Sengunthar Engineering College will strive continuously to

IM1: Create Positive difference to Society through Education

IM2: Impart Value Based Technical Education to the Students from across various Socio Economic backgrounds

IM3: Build World Class Research and Development capabilities on par with the finest in the World and widen students horizons beyond Class Room Education

IM4: Bring out Competent, Ethically Strong and Quality Professionals for the Benefit of the Society

Quality Policy:

Erode Sengunthar Engineering College is committed to impart World Class Technical Know - How to the Students from diverse Socio Economic backgrounds and to transform their lives by nurturing Multi - Skills and facilitating them to develop holistically

Vision and Mission of the Department:

Vision of the Department:

To provide world class education with Centre of Excellence in the field of Biomedical Engineering through innovative research contributions, Industrial oriented teaching and training for betterment in healthcare for the prosperity of the country, ensuring quality health service delivery, education and research.

Mission of the Department:

DM 1: To achieve academic distinction in applying engineering principles, science and medicine methods to confront health science challenges,

DM 2: To catalyze interactions between biologists, physical scientists and engineers to benefit medicine and human health,

DM 3: To impart students with skills for research, design and development of biomedical devices and allied integrated systems for betterment of human society,

DM 4: To enable students to be sensitive to the ethical issues pertinent to the biomedical engineering profession.

Program Educational Objectives (PEOs) are

- I. To embrace responsible roles of highest cadre in their chosen profession through engineering knowledge, skills and teamwork.
- II. To apply and acquire quantitative, qualitative, analytic and critical thinking skills to solve engineering problems.
- III. To provide self-directed learning with management principles to identify and create professional opportunities in the field of Research and Innovation.
- IV. To prepare graduates capable of upholding and expanding their technical competence through lifelong learning.

Program Outcomes (POs)

PO1	Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7	Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and Team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs):

PSO1	Professional Approach – Specify, architect and prototype health-care solutions by applying signal and medical image processing techniques on modern hardware and software platforms.
PSO2	Interdisciplinary Skill – Investigate, Implement and demonstrate various applications of analog and digital electronic subsystems in designing and building biomedical instrumentation systems.
PSO3	Innovations through ICT – To adapt to emerging information and communication technologies (ICT) to innovate ideas and solutions for current societal and scientific issues thereby developing indigenous medical instruments that are on par with the existing technology.

CURRICULUM

ERODE SENGUNTHAR ENGINEERING COLLEGE, ERODE
DEPARTMENT OF BIOMEDICAL ENGINEERING

REGULATIONS – 2019
CHOICE BASED CREDIT SYSTEM
I TO VIII SEMESTERS CURRICULUM

Induction Program (Mandatory)	3 weeks duration
Induction program for students to be offered right at the start of the first year	- Physical activity - Creative Arts - Universal Human Values - Literary - Proficiency Modules - Lectures by Eminent People - Visits to local Areas - Familiarization to Dept. / Branch & Innovations

B.E. BIOMEDICAL ENGINEERING Minimum credits to be earned :160												
SEMESTER I												
THEORY												
Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BS101	Calculus and its Applications	I, II	1,2,3,4,12	-	3	1	0	4	40	60	100	BS
19BS102	Engineering Physics	I, II	1,2,4,5,6,8,9	1,2	2	0	2	3	40	60	100	BS
19BS103	Engineering Chemistry	I, II	1,2,3,4,5,7,12	-	3	0	0	3	40	60	100	BS
19HS101	Communicative English	IV	2,3,6,9,10, 12	-	3	0	0	3	40	60	100	HS
19BS104	Fundamentals of Bio Chemistry	I, II	1,2,3,4,12	-	3	0	0	3	40	60	100	BS
19TPS01	Soft Skills – I	III	8,9,10,12	-	1	0	1	1.5	40	60	100	EEC
PRACTICAL												
19BS105	Chemistry Laboratory	I	1,2,3,4,5,12	-	0	0	4	2	60	40	100	BS
19BS106	Bio Chemistry Laboratory	III	1,2,4	-	0	0	2	1	60	40	100	BS
19ES106	Engineering Graphics	I	1,2,3,5,10,12	-	0	0	4	2	60	40	100	ES
TOTAL					15	1	13	22.5	420	480	900	-



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SEMESTER II

THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BS201	Vector Calculus and Complex Variables	I, II	1,2,3,4, 12	-	3	1	0	4	40	60	100	BS
19BS202	Bio Physics	I, II	1,5,7	-	3	0	0	3	40	60	100	BS
	Language Elective	-	-	-	3	0	0	3	40	60	100	HS
19ES206	Semiconductor Devices and Circuits	II	1,2,3,4, 12	-	3	0	0	3	40	60	100	ES
19ES201	Problem Solving and Python Programming	I, II	1,2,3, 4,12	2	3	0	0	3	40	60	100	ES
19MC201	Environmental Science and Engineering	I, II	1,2,3,4,5, 6,7,8,12	-	3	0	0	0	40	60	100	MC
19TPS02	Soft Skills – II	II	8,9,10,12	-	1	0	1	1.5	40	60	100	EEC

PRACTICAL

19ES213	Problem Solving and Python Programming Laboratory	I, II	1,2,3,4, 5,12	2	0	0	2	1	60	40	100	ES
19ES217	Devices and Circuits Laboratory	I, III, IV	1,2,3,4, 5,11,12	-	0	0	2	1	60	40	100	ES
19ES220	Engineering Practices	I	1,3,9,12	-	0	0	2	1	60	40	100	ES
TOTAL					19	1	7	20.5	460	540	1000	-

SEMESTER III

THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BS301	Applied Linear Algebra	I, II	1,2,3,4	-	3	1	0	4	40	60	100	BS
19EE305	Circuit Theory	II	1,2,3,4,5	-	3	1	0	4	40	60	100	ES
19EC303	Signals and Systems	II, IV	1,2,3,4,5, 6,11,12	-	3	1	0	4	40	60	100	ES
19BM301	Anatomy and Human Physiology	I, IV	1,2, 6,8	1,2	3	0	0	3	40	60	100	PC
19BM302	Pathology and Microbiology	I, IV	1,2,5	1,2	3	0	0	3	40	60	100	PC

19MC301	Indian Constitution	IV	6,8,10,11,12	-	1	0	0	0	100	0	100	MC
19TPS03	Quantitative Aptitude and Logical Reasoning – I	IV	1,2,9,10,12	-	2	0	0	0	100	0	100	EEC
PRACTICAL												
19BM303	Pathology and Microbiology Laboratory	I, IV	1,2,3,5,8,9,10,12	1,2	0	0	2	1	60	40	100	PC
19BM304	Human Physiology Laboratory	I, IV	1,2,3,5,6,8,9,10,12	1,2	0	0	2	1	60	40	100	PC
19HS301	Communication Skills	I, IV	1,2,3,9,10,12	-	0	0	4	2	60	40	100	EEC
TOTAL					18	3	8	22	580	420	1000	-

SEMESTER IV

THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BS401	Probability and Statistics	I, II	1,2,3,4	-	3	1	0	4	40	60	100	BS
19BM401	Bio Sensors and Measurements	I, III	1,2,3,4,5,6	-	3	1	0	4	40	60	100	PC
19BM402	Analog and Digital Integrated Circuits	I, II	1, 2, 4	-	3	0	0	3	40	60	100	ES
19BM403	Microprocessors and Microcontrollers	I, II, III	1,2,3,4,5,6,11,12	2	3	0	0	3	40	60	100	ES
19BM404	Internet of Things in Medicine	I,II,III	1,2,3,4,5,12	1,2	3	0	0	3	40	60	100	PC
19HS402	Universal Human Values 2 : Understanding Harmony	I, III	2,3,6,8,5,11,12	-	2	1	0	3	40	60	100	HS
19TPS04	Quantitative Aptitude and Logical Reasoning - II	III, IV	1,2,9,10,12	-	2	0	0	0	100	0	100	EEC

PRACTICAL

19BM405	Analog and Digital IC Laboratory	I, III	1,2,3,4,5,6,11,12	2	0	0	4	2	60	40	100	ES
19BM406	Microprocessor and Microcontroller Laboratory	I, III	1,2,4,8	2	0	0	2	1	60	40	100	ES
TOTAL					19	3	6	23	460	440	900	-

SEMESTER V

THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BM501	Bio Control System	I, III	2, 6, 8	3	3	0	1	4	40	60	100	PC
19BM502	Biomechanics	I, II, III	1,2,4,5,6 7,9,12	-	3	0	1	4	40	60	100	PC
19BM503	Diagnostic and Therapeutic Equipment	I, IV	1,2,4	-	3	0	1	4	40	60	100	PC
19BM504	Biomedical Instrumentation	I, II	1,2,3,4, 8,11	-	3	0	0	3	40	60	100	PC
19BM505	Bio Signal Processing	I, III	1,2,3	-	3	0	0	3	40	60	100	PC
19TPS05	Quantitative Aptitude and Logical Reasoning - III	IV	9,10,11, 12	-	2	0	0	0	100	0	100	EEC

PRACTICAL

19BM506	Diagnostic and Therapeutic Equipment Laboratory	I, III	1,2,4	-	0	0	2	1	60	40	100	PC
19BM507	Bio Instrumentation Laboratory	I, III	1,2,3,8,9 10,12	-	0	0	2	1	60	40	100	PC
19BM508	Hospital Training	I, III	2,4,6,8,9 10,12	-	0	0	2	1	60	40	100	EEC
19HS501	Career Skills	I, III	2,3,6,8,5, 11,12	-	0	0	2	0	60	40	100	EEC
TOTAL					17	0	11	21	540	460	1000	-

SEMESTER VI

THEORY

Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BM601	Medical Image Processing	I, III	1,2,4,6,8 10,11,12	-	3	0	0	3	40	60	100	PC
19BM602	Health Care Analytics	I, III, IV	2,4,5	-	3	0	0	3	40	60	100	PC
19BM603	Pattern Recognition and Neural Networks	I, III, IV	2,4,5	-	3	0	0	3	40	60	100	PC
	Professional Elective - I	-	-	-	3	0	0	3	40	60	100	PE
	Professional Elective - II				3	0	0	3	40	60	100	PE


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	Open Elective - I	-	-	-	3	0	0	3	40	60	100	OE
19TPS06	Quantitative Aptitude and Logical Reasoning - IV	IV	9,10,11,12	-	2	0	0	0	100	0	100	EEC
PRACTICAL												
19BM604	Bio Signal and Image Processing Laboratory	I, III, IV	1,3,5,9	-	0	0	4	2	60	40	100	PC
19BM605	Mini Project	I, IV	2,3	-	0	0	2	1	60	40	100	EEC
TOTAL					20	0	6	21	460	440	900	-

SEMESTER VII												
THEORY												
Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
19BM701	Radiological Equipments	I, III	1,2,3,6,7	-	3	0	1	4	40	60	100	PC
19BM702	Human Assist Devices	I, IV	1,2,4,5,9,11,12	-	3	0	0	3	40	60	100	PC
19BM703	Hospital Management	I, IV	1,2,3,4,5,8	-	3	0	0	3	40	60	100	PC
19BM704	Rehabilitation Engineering	I, IV	1,2,3,4,5,8	-	3	0	0	3	40	60	100	PC
	Professional Elective – III	-	-	-	3	0	0	3	40	60	100	PE
PRACTICAL												
19BM705	Data Acquisition and Processing Laboratory	I, IV	1,2,4,5,9,11,12	-	0	0	2	1	60	40	100	PC
19BM706	Internship/ Industry Training	III, IV	1,2,3,4,5,6,8,10	-	0	0	2	1	60	40	100	EEC
TOTAL					15	0	5	18	320	380	700	-


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SEMESTER VIII												
THEORY												
Code No	Course	Objective & Outcomes			L	T	P	C	Maximum Marks			Category
		PEOs	POs	PSOs					CA	ES	Total	
	Professional Elective – IV	-	-	-	3	0	0	3	40	60	100	PE
	Professional Elective – V	-	-	-	3	0	0	3	40	60	100	PE
PRACTICAL												
19BM801	Project Work	II, IV	1,2,3,4,5,6,7,8,9,10,11,12	-	0	0	12	6	60	40	100	EEC
TOTAL					6	0	12	12	140	160	300	-

LANGUAGE ELECTIVES								
Code No	Course	Objective & Outcomes			L	T	P	C
		PEOs	POs	PSOs				
LANGUAGE ELECTIVE – I								
19HX201	English for Engineers	III	9,10,12	3	3	0	0	3
19HX202	Hindi	III	9,10,12	3	3	0	0	3
19HX203	Japanese	III	9,10,12	3	3	0	0	3
19HX204	French	III	9,10,12	3	3	0	0	3



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PROFESSIONAL ELECTIVES								
Code No	Course	Objective & Outcomes			L	T	P	C
		PEOs	POs	PSOs				
PROFESSIONAL ELECTIVE – I								
19BMX01	Total Quality Management	I, IV	1,2,3,11	-	3	0	0	3
19BMX02	Disaster Management	I, IV	1,2,3,7	1	3	0	0	3
19BMX03	Hospital Waste Management	I, III	1,6,7,10,11	1	3	0	0	3
19BMX04	Multimedia Compression and Networks	I, III, IV	2,4,6,8,9,10,12	-	3	0	0	3
19BMX05	Human Body Area Networks	I, II, IV	1,2,3,4,5,6,7,8,9,11	2	3	0	0	3
PROFESSIONAL ELECTIVE – II								
19BMX06	Mobile Apps Development	I, III	1,2,4,5,6,7,8,10,12	-	3	0	0	3
19BMX07	Telehealth Technology	I, IV	1,6,7,10,11	3	3	0	0	3
19BMX08	Bio Statistics	I, II, III	1,2,3,4,5,7,8,11,12	2	3	0	0	3
19BMX09	Embedded Systems in Medicine	I, II, III	1,2,3	-	3	0	0	3
19BMX10	Virtual Instrumentation	I, IV	1,2,3,7	1	3	0	0	3
PROFESSIONAL ELECTIVE – III								
19BMX11	Robotics in Medicine	I, III	1,2,3	-	3	0	0	3
19BMX12	Nanotechnology in Medicine	I, III	1,2,3,4,5,7,10,11,12	2	3	0	0	3
19BMX13	Biometric Systems	I, III, IV	1,2,3,4,5,7,8,11,12	1	3	0	0	3
19BMX14	Biomaterials and Applications	I, III, IV	1,2,3,4,5,6,7,8,9,11	-	3	0	0	3
19BMX15	Computer Application in Medicine	I, IV	1,2,5,6,7,8,10,11,12	-	3	0	0	3
PROFESSIONAL ELECTIVE – IV								
19BMX16	Healthcare Product Development	I, IV	1,2,3	-	3	0	0	3
19BMX17	Physiological Modeling	I, IV	6,7,8,9,10,11,12	-	3	0	0	3
19BMX18	Medical Ethics and Standards	I, III, IV	1,6,7,10,11	2	3	0	0	3
19BMX19	Bio MEMS	I, III, IV	1,2,3,4,5,7,8,11,12	-	3	0	0	3
19BMX20	Research Methodology	I, III, IV	1,2,3,7	-	3	0	0	3


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PROFESSIONAL ELECTIVE – V								
19BMX21	Clinical Engineering	I, IV	1,2,3	-	3	0	0	3
19BMX22	Principles of Tissue Engineering	I, IV	6,7,8,9,10 11,12	-	3	0	0	3
19BMX23	Medical Textiles Fundamentals	I, III, IV	1,6,7,10, 11	2	3	0	0	3
19BMX24	Wearable Systems	I, III, IV	1,2,3,4,5,7 8,11,12	-	3	0	0	3
19BMX25	Medical Optics	I, III, IV	1,2,3,7	-	3	0	0	3

MANDATORY COURSES								
Code No	Course	Objectives & Outcomes			L	T	P	C
		PEOs	POs	PSOs				
19MC201	Environmental Science and Engineering	I, II	1,2,5,6, 7, 8,12	-	3	0	0	0
19MC301	Indian Constitution	IV	10,12	-	2	0	0	0


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OPEN ELECTIVES OFFERED BY BIOMEDICAL ENGINEERING								
Code No	Course	Objective & Outcomes			L	T	P	C
		PEOs	POs	PSOs				
OPEN ELECTIVE								
19BMY01	Basics of Biomedical Instrumentation	I, IV	1,6,8,9,10	-	3	0	0	3
19BMY02	Biosensors and Transducers	I, III	1,6,7,10 11	2	3	0	0	3
19BMY03	Biotelemetry & Telemedicine	III, IV	1,2,3,7	-	3	0	0	3
19BMY04	Biomedical Engineering in Fitness	I, IV	6,7,8,9,10 11,12	-	3	0	0	3
19BMY05	Principles of Genetic Analysis	I,IV	1,2,3	1	3	0	0	3
19BMY06	Medical Electronics	III, IV	1,2,3,7	-	3	0	0	3
19BMY07	Medical Informatics	I,IV	1,2,3	-	3	0	0	3
19BMY08	Design of Medical Electronic Devices	I,IV	1,2,3,7	-	3	0	0	3
19BMY09	Hospital Engineering and Management	I,IV	1,2,3	1	3	0	0	3
19BMY10	MEMS and NEMS	I,IV	1,2,3,7	-	3	0	0	3



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S.No.	Category	Credits Per Semester								Total Credit	Credits in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	16	7	4	4	0	0	0	0	31	19.4	10%	20%
2	ES	2	9	8	9	0	0	0	0	28	17.5	10%	20%
3	HS	3	3	0	3	0	0	0	0	9	5.6	5%	10%
4	PC	0	0	8	7	20	11	14	0	60	37.5	30%	40%
5	PE	0	0	0	0	0	6	3	6	15	9.4	5%	10%
6	OE	0	0	0	0	0	3	0	0	3	1.9	5%	10%
7	EEC	1.5	1.5	2	0	1	1	1	6	14	8.8	5%	10%
Total		22.5	20.5	22	23	21	21	18	12	160	100	70%	120%

BS -Basic Science

ES -Engineering Science

HS - Humanities and Social Science

PE -Professional Elective

OE -Open Elective

PC - Professional Core

MC - Mandatory course

CA - Continuous Assessment

ES - End Semester Examination

EEC - Employability Enhancement Course



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SYLLABUS

Department	BIOMEDICAL ENGINEERING					R 2019	Semester I	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS101	CALCULUS AND ITS APPLICATIONS	3	1	0	4	60	100	
Course Objective(s): The purpose of learning this course is to • Interpret the introductory concepts of Limit and continuity • Interpret the introductory concepts of calculus, this will enable them to model and analyze physical phenomena involving continuous change of variables • Find eigen values and eigen vectors which is one of the powerful tools to handle practical problems arising in the field of engineering. • Summarize and apply the methodologies involved in solving problems related to functions of several variables. • Develop enough confidence to identify surface and area there by solving using integration								
Course Outcomes: At the end of this course, learners will be able to: • Apply differentiation to solve maxima and minima problems use both the limit definition and rules of differentiation to differentiate functions • Identify and model the real time problems using first order linear differential equations. Recognize and solve the higher order ordinary differential equations. • Analyze the characteristics of a linear system with Eigen values and Eigen vectors. • Characterize the functions of several variables and get the solutions of the same. • Integrate the functions for evaluating the surface area and volume.								
Unit I	LIMITS AND CONTINUITY						12	
Representation of a function-Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of one variable								
Unit II	ORDINARY DIFFERENTIAL EQUATIONS						12	
Linear differential equations of second and higher order with constant coefficients. Linear differential equations of higher order with variable coefficients: Cauchy's linear differential equation – Method of variation of parameters for second order differential equations -Vibrating string - Electrical circuits								
Unit III	MULTIVARIABLE CALCULUS						12	
Functions of Two Variables - Total Differential - Derivative of implicit functions - Jacobian's - constrained maxima and minima.								
Unit IV	MULTIPLE INTEGRALS						12	
Double integration with constant and variable limits - Region of integration - Change the order of integration - Area as double integral in Cartesian coordinates. Triple integral in Cartesian coordinates.								
Unit V	EIGEN VALUES AND EIGEN VECTORS						12	
Eigen Values and Eigen Vectors of a real matrix - Properties of Eigen Values - Cayley - Hamilton Theorem Orthogonal matrix - Diagonalisation - Quadratic form: Reduction of a quadratic form to a canonical form.								
REFERENCE(S):								
1.	Thomas Calculus, 14th Edition by Pearson							
2.	Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2015.							
3.	Peter V. O Neil , Advanced Engineering Mathematics, Eight Edition , Cengage Learning India Private Limited, 2018							
4.	C. Ray Wylie and C Louis Barrett Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.							
5.	Glyn James, Advanced Engineering Mathematics, Third Edition, Wiley India, 2014.							

Department	BIOMEDICAL ENGINEERING					R 2019	Semester I	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS102	ENGINEERING PHYSICS	2	0	2	3	60	100	
Course Objective(s): The purpose of learning this course is to To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology								
Course Outcomes: At the end of this course, learners will be able to: - Gain knowledge on the basics of properties of matter and its applications - Acquire knowledge on the concepts of Ultrasonic's and their applications - Have adequate knowledge on the concepts of fiber & Laser and their applications - Get knowledge on advanced Physics concepts of quantum theory and its applications in tunneling microscopes - understand knowledge on the concepts of thermal properties of materials and their applications in expansion of joints and heat exchangers								
Unit I PROPERTIES OF MATTER								6
Elasticity - Stress-strain diagram and its uses - torsional stress and deformations - twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment - cantilever: theory and experiment - uniform and non-uniform bending: theory and experiment - I-shaped girders.								
Unit II ULTRASONICS								6
Introduction-Classification of Sound- Ultrasonic's Production - Magnetostriction generator - Piezo electric generator-cavitations-ultrasonic cleaning-Non Destructive Testing- Pulse echo system through transmission and reflection modes- A, B and C - scan displays- Engineering Applications-Cutting, welding and drilling.								
Unit III LASER AND FIBRE OPTICS								6
Lasers: population of energy levels, Einstein's A and B coefficients derivation - Semiconductor lasers: homojunction and heterojunction - Industrial applications of laser. Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) - fibre optic sensors: pressure and displacement.								
Unit IV QUANTUM PHYSICS								6
Black body radiation - Planck's theory (derivation) - Compton effect: theory and experimental verification - wave particle duality - electron diffraction - concept of wave function and its physical significance - Schrödinger's wave equation - time independent and time dependent equations - particle in a one-dimensional rigid box.								
Unit V THERMAL PHYSICS								6
Transfer of heat energy - thermal expansion of solids and liquids - expansion joints - bimetallic strips - thermal conduction, convection and radiation - heat conduction in solids - thermal conductivity - Lee's disc method: theory and experiment - conduction through compound media (series and parallel) - applications: heat exchangers, ovens and solar water heaters.								
TEXT BOOK(S): - Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2015 - Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012 - Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012								
REFERENCE(S): - Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2015 - Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2010 - Tipler, P.A. & Mosca, G. - "Physics for Scientists and Engineers with Modern Physics". W.H. Freeman, 2007								


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List of Experiments PHYSICS (ANY FIVE) – 30 Hours

1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. Determination of Young's modulus by uniform bending method
4. Determination of wavelength and particle size using Laser
5. Determination of acceptance angle and numerical aperture in an optical fiber
6. Determination of thermal conductivity of a bad conductor – Lee's Disc method
7. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
8. Determination of wavelength of mercury spectrum – spectrometer grating
9. Determination of band gap of a semiconductor
10. Determination of thickness of a thin wire – Air wedge method


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester I	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS103	ENGINEERING CHEMISTRY	3	0	0	3	45	100	

Course Objective(s):The purpose of learning this course is to

- Understand the basic concepts of water characterization and treatment methods,
- Know the fundamental concepts of electrochemistry and corrosion,
- Understand the principles and generation of energy in batteries and nuclear reactors,
- Gain knowledge on polymers,
- Know the types of fuels and the manufacture of solid, liquid and gaseous fuels.

Course Outcomes: At the end of this course, learners will be able to:

- Make the students conversant with water treatment techniques,
- Know the reaction involved in corrosion and corrosion protection methods,
- Impart knowledge on renewable energy sources like nuclear and to impart knowledge on energystorage devices,
- Aware the synthesis & industrial application of polymers,
- Impart knowledge on different types of fuels (solid liquid, gas, primary, secondary and synthetic) and combustion process.

Unit I	WATER CHEMISTRY	9
Hardness of water – types – Estimation of hardness of water by EDTA – problems – Domestic water treatment-boiler troubles (scales, sludge, Priming, Foaming, Caustic embrittlement) – Internal conditioning (Carbonate, phosphate, sodium aluminate and calgon conditioning). External treatment – Demineralization process – Desalination – Reverse Osmosis.		
Unit II	ELECTROCHEMISTRY AND CORROSION	9
Electrochemical cell – redox reaction, electrode potential – Nernst equation (derivation and problems). Standard hydrogen electrode – Calomel Electrode – Corrosion – factors – types – chemical, electrochemical corrosion (galvanic, differential aeration) – factors influencing corrosion – corrosion control – sacrificial anode and impressed current cathodic method.		
Unit III	ENERGY SOURCES	9
Introduction – nuclear energy – nuclear fission – nuclear fusion – nuclear chain reactions – light water reactor – breeder reactor – solar energy conversion – solar cells – wind energy. Batteries and fuel cells: Types of batteries – alkaline battery – lead storage battery – lithium ion battery – fuel cell H ₂ – O ₂ fuel cell.		
Unit IV	POLYMER CHEMISTRY	9
Monomers – polymers – polymerization – functionality – degree of polymerization – classification of polymers based on source and applications. Types of polymerization: addition, condensation and copolymerization. Preparation, properties and applications of thermosetting (epoxy resin and bakelite) and thermoplastics (poly vinyl chloride, poly tetrafluoroethylene and PMMA). Rubber: SBR. Compounding of plastics (blow moulding, injection, extrusion).		
Unit V	FUELS AND COMBUSTION	9
Fuel: Introduction – classification of fuels – solid fuels-coal – proximate and ultimate analysis – manufacture of metallurgical coke (Otto Hoffmann method) – Liquid fuels: petroleum – synthetic petrol Fischer – Tropsh and Bergius processes – knocking – octane number – Cetane number – Gaseous fuels: liquefied petroleum gases (LPG) – water gas – bio diesel. Combustion – flue gas analysis (ORSAT Method).		

TEXT BOOK(S):

- Jain P.C. and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2019
- Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2019

REFERENCE(S):

1. Dara S.S, Umare S.S, "Engineering Chemistry", S. Chand & Company Ltd., New Delhi 2016,
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2017,
3. Gowariker V.R, Viswanatha.N.V, Jayadev Sreedhar- "Polymer Science", Publishing company New Age International Publishers, New Delhi, 2015,
4. Ozin G. A. and Arsenault A. C., "Nanotechnology: A Chemical Approach to Nanomaterials", RSC Publishing, 2017,
5. Ashima Srivastava and Janhavi N N., "Concepts of Engineering Chemistry", ACME Learning Private Limited., New Delhi. 2015.


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester I	HS
Course Code	Course Name	Hours /Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS101	COMMUNICATIVE ENGLISH	3	0	0	3	45	100	
Course Objective(s): The purpose of learning this course is to - Acquire Basic English grammar. - Develop listening skills to listen lectures and basic videos. - Enhance the reading skill to comprehend technical writings. - Improve writing skills to express thoughts freely. - Develop speaking skills to speak fluently in real contexts.								
Course Outcomes: Upon completing this course student will be familiar with know: - Improve language usage in LSRW skills. - Develop listening skills to comprehend general / technical talks. - Acquire the ability to understand different written texts. - Enhance the writing skills to express the ideas of the learners. - Communicate fluently in real time context.								
Unit I	LANGUAGE FOCUS						9	
Parts of speech - Word formation - Sentence types (declarative, imperative, exclamatory & interrogative) - Tense forms - Subject - Verb agreement								
Unit II	LISTENING						9	
Listening for specific information: Short conversations / monologues - Gap filling - Telephone conversations - Telephone etiquette - Note-taking - Listening for gist / interviews - Listening to songs and completing the lyrics - Clear individual sounds - Word stress								
Unit III	READING						9	
Completing the sentences - Prediction - Skimming for gist - Scanning for specific information - Understanding text and sentence structure - Close reading								
Unit IV	WRITING						9	
Paragraph writing (descriptive, narrative, expository & persuasive) - Letter (formal and informal) - Dialogue writing - E-mail - Instructions								
Unit V	SPEAKING						9	
Self-introduction - Giving personal and factual information - Talking about present circumstances, past experiences and future plans - Mini-presentation - Expressing opinions and justifying opinions - Agreement / disagreement - Likes and dislikes								
TEXT BOOK(S): 1. Communicative English by KN Shoba, Lourdes JoavaniRayenPublised by Cambridge University 2017.								
REFERENCE(S): 1. Murphy, Raymond. English Grammar in Use - A Self-Study Reference and Practice Book For 2. Intermediate learners Of English .Ived. United Kingdom: Cambridge University Press. 2012. 3. Seely, John. Oxford Guide to Effective Writing and Speaking. Indian ed. New Delhi: Oxford University Press. 2005. 4. Anderson, Kenneth et al. Study Speaking: A Course in Spoken English for Academic Purposes. United Kingdom: Cambridge University Press 1992. 5. Wren and Martin, High school English Grammar and Composition, Publisher: S.Chand. 2019.								


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester I	BS
Course Code	Course Name	Hours /Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS104	FUNDAMENTALS OF BIOCHEMISTRY	3	0	0	3	45	100	

Course Objective(s): The purpose of learning this course is to

- Extend their knowledge on biological processes taking place in living organisms.
- Understand the mechanism of metabolic pathway of carbohydrates.
- Know the constitution, composition and analysis of oils and fats.
- Know the properties, synthesis and structure of Nucleic acids and proteins.
- Understand the concept of enzymes.

Course Outcomes: Upon completing this course student will be familiar with know:

- Understand the role of biological process in living organisms.
- Understand the biological reaction mechanisms of carbohydrates.
- Know the various pathways involved in lipid mechanism.
- Know the significance of synthesis of nucleic acid in human body.
- To impart knowledge on catalytic activity of enzymes.

Unit I INTRODUCTION TO BIOCHEMISTRY

9

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson – Hasselbalch equation, physiological buffers in living systems, Energy in living organism. Biological membrane- Electrolytes – Clinical application of Electrolytes and radioisotopes.

Unit II CARBOHYDRATES

9

Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates- Isomerism- racemisation and mutarotation. Digestion and absorption of carbohydrates. Metabolic pathways - Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle - Biochemical aspect of Diabetes mellitus and Glycogen storage Disease.

Unit III LIPIDS

9

Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat. Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism, ketogenesis, Biosynthesis of Cholesterol. Disorders of lipid Metabolism.

Unit IV NUCLEIC ACIDS & PROTEINS

9

Structure of purines and pyrimidines, nucleoside, nucleotide, DNA as a genetic material, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Classification, structure and properties of proteins, structural organization of proteins, classification and properties of amino acids. Separation of protein, Inborn Metabolic error of amino acid metabolism

Unit V ENZYME AND ITS CLINICAL APPLICATION

9

Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Kinetics of enzymes – Michaelis - Mentenequation. Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Inhibitors of enzyme action: Competitive, non- competitive, irreversible. Enzyme: Mode of action, allosteric and covalent regulation. Clinical enzymology.

TEXT BOOK(S):

1. RAFI MD –Text book of biochemistry for Medical Student|| Second Edition, University Press, 2014.
2. David.W.Martin, Peter.A.Mayes, Victor. W.Rodwell, –Harper's Review of Biochemistry||, LANGE Medical Publications, 1981.


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REFERENCE(S):

1. Keith Wilson & John Walker, "Practical Biochemistry - Principles & Techniques", Oxford University Press, 2009.
2. Pamela.C.Champe&Richard.A.Harvey, "Lippincott Biochemistry Lippincott's Illustrated Reviews", Raven publishers, 1994.
3. Victor Rodwell , David A ,benderHarpers Illustrated Bio Chemistry,31 Edition,2018
4. Albert L. Lehninger,David L. Nelson, Michael M. Cox, Principles of Bio Chemistry,W.H. Freeman,2014.
5. Frederick A. Bettelheim (Author), William H. Brown (Author), Mary K. Campbell ,Introduction to general organic & Biochemistry,11 thEdition,Brooks Cole,2017.



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Department	BIOMEDICAL ENGINEERING				R 2019	Semester I	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
19TPS01	SOFT SKILLS – I	L	T	P	C	30	100
		1	0	1	1.5		

Course Objective(s): The purpose of learning this course is to

- Develop basic grammar knowledge in English.
- Enhance Speaking Skills in English.
- Improve Verbal and Non-verbal Communication Skills.
- Develop Confidence and Emotional Intelligence
- Develop Inter Personal Skills.

Course Outcomes: At the end of this course, learners will be able to:

- Have competent knowledge of grammar
- Speak fluent English by enriching Vocabulary Knowledge.
- Have good Presentation Skills through verbal and non verbal communication.
- Handle any Situation with confidence by being emotionally stable
- Work in a team by having team coherence and dealing with people.

Unit I	EFFECTIVE ENGLISH – WRITTEN ENGLISH	6
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Basic rules of Grammar - Parts of Speech - Tenses - Verbs. Sentence Construction. Dialogues and Conversations - Writing. Exercises to practice and improve these skills.

Unit II	EFFECTIVE ENGLISH – SPOKEN ENGLISH	6
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Vocabulary - Idioms & Phrases - Synonyms - Antonyms. Dialogues and Conversations -Writing. Exercises to practice and improve these skills.

Unit III	ART OF COMMUNICATION & THE HIDDEN DATA INVOLVED	6
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Verbal Communication - Effective Communication - Active listening -Paraphrasing - Feedback.

Non Verbal Communication - Body Language of self and others. Importance of feelings in communication - Dealing with feelings in communication.

Unit IV	WORLD OF TEAMS – PART – 01	6
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Self Enhancement -Importance of developing assertive skills - Developing self confidence - Developing emotional intelligence

Unit V	WORLD OF TEAMS – PART – 02	6
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Importance of Team work - Team vs. Group - Attributes of a successful team - Barriers involved Working with Groups - Dealing with People- Group Decision Making.

REFERENCE(S):

1. The Seven Habits of Highly Effective People - Stephen R. Covey,
2. All the books in the "Chicken Soup for the Soul" series.
3. Man's search for meaning - Viktor Frankl
4. The greatest miracle in the world - OgMandino
5. Goal - EliyahuGoldratt.
6. Working with Emotional Intelligence - David Goleman.
7. Excel in English - Sundra Samuel, Samuel Publications
8. Developing Communication Skills by Krishna Mohan and MeeraBanerji; MacMillan India Ltd., Delhi
9. Essentials of Effective Communication, Ludlow and Panthon; Prentice Hall of India
10. Effective Presentation Skills (A Fifty-Minute Series Book) by Steve Mandel
11. Strategic interviewing" by Richaard Camp, Mary E. Vielhaber and Jack L. Simonetti - Published by Wiley India Pvt. Ltd.
12. Effective Group Discussion: Theory and Practice" by Gloria J. Galanes, Katherine Adams, John K. Brillhart.

Department	BIOMEDICAL ENGINEERING					R 2019	Semester I	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS105	CHEMISTRY LABORATORY	0	0	4	2	60	100	

Course Objective(s): The purpose of learning this course is to

- Determination of total, temporary & permanent hardness of water by EDTA method.
- Determination of chloride content of water sample by argentometric method.
- Estimation of iron content of the given solution using potentiometer.
- Determination of strength of given hydrochloric acid using pH meter.
- Conductometric titration of strong acid vs strong base.

Course Outcomes: At the end of this course, learners will be able to

- Make the student to acquire practical skills in the determination of water quality parameters through volumetric analysis.
- Acquire the knowledge about chloride content in water sample.
- Make the student to acquire practical skills about strength of iron using potentiometric titrations.
- Understand the how to estimate hydrochloric acid in water sample using pH meter.
- Gain the knowledge about conductance of ions

List of Experiments

1. Determination of Total, Temporary & Permanent hardness of water by EDTA method,
2. Determination of chloride content of water sample by Argentometric method,
3. Determination of Dissolved oxygen content in water sample using Winklers Method,
4. Determination of Alkalinity in Water Sample,
5. Determination of strength of given hydrochloric acid using pH meter,
6. Determination of strength of acids in a mixture of acids using conductivity meter,
7. Conductometric titration of Weak acid vs Weak base,
8. Estimation of iron content of the given solution using potentiometer,
9. Conductometric titration of strong acid vs strong base,
10. Determination of Molecular weight of polyvinyl alcohol using Ostwald viscometer,
11. Estimation of iron content of the water sample using spectrophotometer,
12. Estimation of Copper in Brass.

LIST OF EQUIPMENT

S.No	Description of Equipment	Quantity required	Quantity available
1.	Potentiometer	10 Nos.	10 Nos.
2.	pH meter	10 Nos.	10 Nos.
3.	Conductivity meter	10 Nos.	10 Nos.
4.	Spectrophotometer	2 Nos.	2 Nos.
5.	Oswald viscometer	30 Nos.	30 Nos.


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Department	BIOCHEMISTRY LABORATORY					R 2019	Semester II	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS106	BIO CHEMISTRY LABORATORY	0	0	2	1	30	100	

Course Objective(s): The purpose of learning this course is to

- Determination of strength of given solution using pH meter.
- Determination of absorption maxima (λ_{max}) of a given solution.
- Preparation of serum and plasma from blood.
- Estimation of Haemoglobin.
- Estimation of blood glucose.

Course Outcomes: At the end of this course, learners will be able to:

- Understand how to estimate pH of the given sample.
- Make the student to acquire practical skills about the absorption maxima (λ_{max}) of a given solution.
- Acquire the knowledge about preparation of serum and plasma.
- Understand how to estimate the haemoglobin content of blood sample.
- Gain the knowledge about estimation of blood glucose.

LIST OF EXPERIMENTS

1. Preparation of solutions: 1) Percentage solutions, 2) Molar solutions, 3) Normal solutions,
2. Determination of strength of given solution using pH meter,
3. Spectroscopy: Determination of absorption maxima (λ_{max}) of a given solution,
4. General tests for carbohydrates, proteins and lipids,
5. Preparation of serum and plasma from blood,
6. Estimation of Haemoglobin from blood,
7. Estimation of blood glucose from blood,
8. Estimation of urea from blood,
9. Estimation of creatinine from blood,
10. Estimation of cholesterol from blood.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	Colorimeter	02
2.	Spectrophotometer	01
3.	pH meter	01
4.	Weighing balance	01
5.	Refrigerator	01
6.	SDS gel electrophoresis	01
7.	TLC, ready TLC plates	01
8.	Wintrobe's tube	02
9.	Centrifuge Normal	01
10.	Micro Slides	2 Packets
11.	Lancet	5 Boxes
12.	Microscope	01
13.	Neubaur's Chamber	02
14.	Heparinized Syringe	1 Box
15.	Haemoglobinometer	01
16.	Elisa reader	01
17.	Capillary tubes	01 Box

Department	BIOMEDICAL ENGINEERING					R 2019	Semester I	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
19ES106	ENGINEERING GRAPHICS	L	T	P	C			
		0	0	4	2	60	100	
Course Objective (s): The purpose of learning this course is to • Learn conventions and use of drawing tools in making engineering drawings. • Draw orthographic projection of points and lines. • Draw the projection of planes and simple solids. • Draw the section of solids and obtain the development of surfaces of given solids. • Draw the isometric projection of the given solids.								
Course Outcomes: At the end of this course, learners will be able to: • Recognize the conventions and apply dimensioning concepts while drafting simple objects. • Draw the orthographic projection of points and lines. • Draw the projection of planes and simple solids. • Draw the section of solid drawings and development of surfaces of given solids. • Draw the isometric projection of the given objects.								
CONCEPTS AND CONVENTIONS (Not for Examination)								1
Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning.								
Unit I	PLANE CURVES							12
Basic Geometrical constructions, Curves used in engineering practices: Conics - Construction of ellipse, parabola and hyperbola by eccentricity method - Construction of cycloid - construction of involutes of triangle, square and circle - Drawing of tangents and normal to the above curves.								
Unit II	PROJECTION OF POINTS AND LINES							11
Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method.								
Unit III	PROJECTION OF PLANES & SOLIDS							12
Projection of planes (polygonal and circular surfaces) inclined to both the principal planes. Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.								
Unit IV	PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES							12
Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones.								
Unit V	ISOMETRIC PROJECTIONS							12
Principles of isometric projection - isometric scale -Isometric projections of simple solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions.								
TEXT BOOK(S): 1. Natrajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2012. 2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.								
REFERENCE(S): 1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010. 2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008. 3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007. 4. N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS201	VECTOR CALCULUS AND COMPLEX ANALYSIS	3	1	0	4	60	100	
Course Objective(s): The purpose of learning this course is to - Summarize problems related to fundamental principles of Vector Calculus - Apply the methodologies involved in solving problems related to fundamental principles Vector Differentiation and Vector Integration. - Implement the Complex Analysis, an elegant method in the study of heat flow, fluid dynamics and electrostatics. - Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment. - Defining a complex function and solving through complex integration								
Course Outcomes: At the end of this course, learners will be able to: - Characterize the calculus of vectors. - Apply the theoretical aspects of vector integral calculus in their core areas. - Recognize the differentiation properties of complex functions. - Identify the complex functions and their mapping in certain complex planes. - Use the concepts of integration to complex functions in certain regions.								
Unit I	DIFFERENTIATION OF VECTORS						12	
Vector point function - Directional derivative - Gradient - Divergence - Curl - Solenoidal - Irrotational vector fields - Scalar potential								
Unit II	INTEGRATION OF VECTORS						12	
Work done - Line Integral - Surface integral - Green's theorem in a plane - Stoke's Theorem - Gauss divergence theorem - Applications involving cubes and parallelepiped.								
Unit III	ANALYTIC FUNCTIONS						12	
Analytic Functions - Necessary and Sufficient conditions of Analytic Function - Properties of Analytic function - Determination of Analytic Function using Milne Thompson method - Applications to the problems of Potential Flow.								
Unit IV	MAPPING OF COMPLEX FUNCTIONS						12	
Conformal mapping - Application of transformation: translation, rotation, magnification and inversion of multi valued functions - Linear fractional Transformation (Bilinear transformation).								
Unit V	COMPLEX INTEGRATION						12	
Cauchy's Fundamental Theorem - Cauchy's Integral Formula - Taylor's and Laurent's series - Classification of Singularities - Cauchy's Residue Theorem								
REFERENCE(S):								
1.	Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2015							
2.	C. Ray Wylie and C. Louis Barrett, Advanced Engineering Mathematics, Tata McGraw - Hill Publishing Company Ltd, 2003							
3.	J. A. Brown and R. V. Churchill, Complex Variables and Applications , Sixth Edition, McGraw Hill, New Delhi, 1996							
4.	Peter V. O. Neil, Advanced Engineering Mathematics, Eighth Edition, Cengage Learning India Private Limited, 2018							
5.	Glyn James, Advanced Engineering Mathematics, Third Edition, Wiley India, 2007							

Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS202	BIO PHYSICS	3	0	0	3	45	100	
Course Objective(s): The purpose of learning this course is to • Study principles and effects of ionizing and non-ionizing radiation in human body • Discuss the physics of the senses • Explore the effects of radiation in matter and how isotopes are produced • Understand various detectors for detecting the presence of ionizing radiation.								
Course Outcomes: At the end of this course, learners will be able to: • Explain about non-ionizing radiation, interaction with tissue and its effects. • Define and compare intensities of sensory stimuli • Summarizes how ionizing radiation interacts with the human body, how to quantify it and its levels seen in the environment and healthcare • Explain the fundamentals of radioactivity and radioactive isotopes • Illustrates the methods of detecting and recording the ionizing radiation and its interaction with matter.								
Unit I	NON – IONIZING RADIATION AND ITS MEDICAL APPLICATIONS						9	
Introduction and objectives - Tissue as a leaky dielectric - Relaxation processes, Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light, Measurement of light and its unit- limits of vision and color vision an overview, Ultraviolet								
Unit II	RADIATION DOSE AND ITS EFFECTS						9	
Dose and Exposure measurements - Units (SI), Inverse square law, Maximum permissible exposure, relationship between the dosimetric quantities, Radiation biology - Effects of radiation, concept of LD 50, stochastic and Nonstochastic effects, Radiation Syndrome.								
Unit III	PRINCIPLES OF RADIOACTIVE NUCLIDES						9	
Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology ,Decay series, Production of radionuclide's – Cyclotron produced Radionuclide- Reactor produced Radio- nuclide-fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclide's, radionuclide Generator-Technetium generator.								
Unit IV	RADIOACTIVE DECAY AND INTERACTION OF RADIATION WITH MATTER						9	
Spontaneous Fission- Isomeric Transition-Alpha Decay-Beta Decay-Positron Decay-Electron Capture-Interaction of charged particles with matter -Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter- Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation, Interaction of neutron with matter and their clinical significance.								
Unit V	SCINTILLATION, SEMICONDUCTOR and GAS FILLED DETECTORS						9	
Scintillation Detectors - Solid Scintillation Counters - Gamma-Ray Spectrometry-Liquid Scintillation Counters-Characteristics of Counting Systems-Gamma Well Counters-Thyroid Probe-Principles of Gas-Filled Detectors - Ionization Chambers-Geiger-Müller Counters								
TEXT BOOK(S): 1. Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine", 4th Edition, Springer, 2013. 2. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, "Medical Physics and Biomedical Engineering", 2nd Edition, IOP Publishers.2001.								
REFERENCE(S): 1. S.Webb "The Physics of Medical Imaging", Taylor and Francis, 1988 2. J.P.Woodcock, "Ultrasonic, Medical Physics Handbook series 1", Adam Hilger, Bristol, 2002 3. Hylton B.Meire and Pat Farrant "Basic Ultrasound" John Wiley & Sons, 1995								

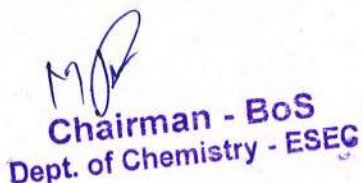
Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES206	SEMICONDUCTOR DEVICES AND CIRCUITS	3	0	0	3	45	100	
Course Objective(s): The purpose of learning this course is to - Understand the structure of basic electronic devices, - Be exposed to active and passive circuit elements, - Familiarize the operation and applications of transistor like BJT and FET, - Explore the characteristics of amplifier gain and frequency response, - Learn the required functionality of positive and negative feedback systems.								
Course Outcomes: At the end of this course, learners will be able to: - Explain the structure and working operation of basic electronic devices, - Able to identify and differentiate both active and passive elements, - Analyze the characteristics of different electronic devices such as diodes and transistors, - Choose and adapt the required components to construct an amplifier circuit, - Employ the acquired knowledge in design and analysis of oscillators.								
Unit I	PN JUNCTION DEVICES						9	
PN junction diode – Structure, operation and V-I characteristics, diffusion and transition capacitance – Rectifiers – Half Wave and Full Wave Rectifier, Display devices – LED, Laser diodes, Zener diode characteristics – Zener Reverse characteristics – Zener as regulator								
Unit II	TRANSISTORS AND THYRISTORS						9	
BJT, JFET, MOSFET – structure, operation, characteristics and Biasing UJT, Thyristors and IGBT – Structure and characteristics.								
Unit III	AMPLIFIERS						9	
BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response – MOSFET small signal model – Analysis of CS and Source follower – Gain and frequency response – High frequency analysis.								
Unit IV	MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER						9	
BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers – Types								
Unit V	FEEDBACK AMPLIFIERS AND OSCILLATORS						9	
Advantages of negative feedback – Voltage / Current, series, Shunt feedback – Positive feedback – Condition for oscillations, Phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.								
TEXT BOOK(S):								
1. David A. Bell, "Electronic devices and circuits", Oxford University higher education, 5 th edition 2008,								
2. Thomas L.Floyd, —Electronic devices Conventional current version, Pearson prentice hall, 10th Edition, 2017.								
REFERENCE(S):								
1. Balbir Kumar, Shail.B.Jain, —Electronic devices and circuits PHI learning private limited, 2nd edition 2014.								
2. Donald A Neamen, —Electronic Circuit Analysis and Design Tata McGraw Hill, 3rd Edition, 2003.								
3. Robert L.Boylestad, —Electronic Devices and Circuit Theory, 2002.								
4. Robert B. Northrop, —Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation, CRC Press, 2004.								
5. Sedra and smith, —Microelectronic circuits, 7th Ed., Oxford University Press								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES201	PROBLEM SOLVING AND PYTHON PROGRAMMING	3	0	0	3	45	100	
Course Objective(s): The purpose of learning this course is to - Understand problem solving techniques, - Understand why Python is a useful scripting language for developers and to read and write simple Python programs, - Develop Python programs with conditionals and loops, - Use Python data structures — lists, tuples, dictionaries, - Do input/output with files in Python.								
Course Outcomes: At the end of this course, learners will be able to - Apply problems solving techniques to real world problems, - Recognize and construct common programming idioms: variables, loop, branch, and input/output, - Be able to design, code, and test Python programs using List, Tuples and Strings, - Able to write code using dictionaries and functions, - Able to read and write data from/to files in Python Programs.								
Unit I	PROBLEM SOLVING TECHNIQUES						9	
Introduction to components of a computer system: Disks, Primary and Secondary memory, Processor, Operating System, Compilers, Creating, Compiling and executing a program etc., Number systems, Introduction to Algorithms: Steps to solve logical and numerical problems. Representation of Algorithm, Flowchart / Pseudo code with examples, Program design and structured programming.								
Unit II	INTRODUCTION TO PYTHON						9	
History – Installation and working with Python – Understanding Python variables – Python basic Operators – Declaring and using Numeric data types: int, float, complex – Using string data type and string operations – Methods.								
Unit III	FLOW CONTROL, LIST AND TUPLES						9	
Conditional blocks using if, else and elif – Simple for loops in python – For loop using ranges – Use of while loops in python – Loop manipulation using pass, continue, break and else – Programming using Python conditional and loops block creating list – Accessing List – Operations on List – Working with Lists – Function and Methods – Creating tuple – Tuple Operations – Functions and Methods.								
Unit IV	DICTIONARIES, FUNCTIONS AND MODULES						9	
Creating Dictionaries – Accessing values in Dictionaries – Working with Dictionaries – Properties – Functions – Defining a Functions – Calling a Function – Types of Functions – Function Arguments – Anonymous Functions – Global and Local variables – Modules – Importing Module – Math Module – Random Module – Packages – Composition.								
Unit V	FILES AND EXCEPTION HANDLING						9	
Files – Opening and Closing File – File opening modes – Reading and Writing Files – Functions. Exception Handling – Exception – Exception clause – Try, finally clause user. Defined Exceptions.								
TEXT BOOK(S):								
1. David Riley and Kenny Hunt, "Computational Thinking for the Modern Problem Solver", Chapman & Hall/CRC, 2014.								
2. M. Sprankle, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, NewDelhi, 2011.								
REFERENCE(S):								
1. Brian Heinold," Introduction to Programming Using Python", Mount St. Mary's University, 2013.								
2. Michael Dawson, "Python Programming for the Absolute Beginner", 3rd Edition, 2010.								
3. Allen Downey, Green Tea Press Needham, "Think Python, How to Think Like a Computer Scientist", Massachusetts.								
4. Cunningham, sams teach yourself python in 24 hours, Second edition Pearson, 2014								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	MC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MC201	ENVIRONMENTAL SCIENCE AND ENGINEERING	3	0	0	0	45	100	
Course Objective(s): The purpose of learning this course is • Study the nature and facts about environment. • Finding and implementing scientific, technological and economic solutions to environmental problems. • Know the types of natural resources and the individual role in conserving the resources. • Apply the knowledge to various social issues by understanding the environmental legislation laws. • Study the integrated themes and biodiversity, natural resources, pollution control and waste management.								
Course Outcomes: At the end of this course, learners will be able to: • Extend their knowledge in maintaining ecological balance and make use of their knowledge in the preservation of biodiversity. • Outline the role of human being in maintaining a clean environment and useful environment for the future generations. • Explain the constituents of environment, precious resources in the environment and conservation of natural resources. • Find the role of government and Non-Government organization and explain the various rain water harvesting techniques. • Develop their awareness about population growth, Family planning programme and HIV/AIDS and extend their knowledge in role of informative technologies in IT and human health								
Unit I	ECOSYSTEMS AND BIODIVERSITY							10
Environment: Scope - importance - need for public awareness - Concepts of an ecosystem - Structure and function of an ecosystem - Producers, consumers and decomposers - Food chains - food webs - types of ecosystem - structure and functions of forest ecosystem and river ecosystem - Biodiversity - value of biodiversity - consumptive use-productive use - social - ethical - aesthetic values - Hotspots of biodiversity -Threats to biodiversity - Habitat loss - poaching of wildlife and man wildlife conflicts.Conservation of biodiversity - In-situ and Ex-situ conservation.								
Unit II	ENVIRONMENTAL POLLUTION							8
Pollution: Causes - effects and control measures of Air pollution - Water pollution - Soil pollution and Noise pollution - Solid waste management - Causes - effects -control measures of urban and industrial wastes - Role of an individual in prevention of pollution - Disaster managements - Floods - cyclone- landslides.								
Unit III	NATURAL RESOURCES							9
Forest resources - Use-over exploitation-deforestation - Water resources - use-over utilization of surface and ground water - conflicts over water - Mineral resources - use-exploitation-environmental effects of extracting and using mineral resources - Food resources - world food problems changes caused by agriculture - Effects of modern agriculture - fertilizer- pesticide problems - Energy resources - Renewable energy sources - solar energy - wind energy. Land resources - land degradation - soil erosion - Role of an individual in conservation of natural resources.								
Unit IV	SOCIAL ISSUES AND THE ENVIRONMENT							9
Sustainable & Unsustainable development-Water conservation - rain water harvesting (roof top method)- climate change-global warming - acid rain - ozone layer depletion - Environment protection act - Air (Prevention and control of pollution) Act - Water (prevention and control of pollution) Act - Green Chemistry - 12 Principles of Green chemistry - Application of Green chemistry.								
Unit V	HUMAN POPULATION AND THE ENVIRONMENT							9
Population growth - variation among nations - Population explosion & its consequences - Family,child, women welfare programmes - Human rights - HIV/AIDS - Human health and environment - Role of information technology in environment and human health.								



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TEXT BOOK(S):

1. AnubhaKaushik and C.P. Kaushik, Environmental Science and Engineering, New Age International Publishers, New Delhi (2015)
2. Dr. A.Ravikrishan, Environmental Science and Engineering., Sri Krishna Hitech Publishing co. Pvt. Ltd., Chennai, 12th Edition (2016)

REFERENCE(S):

1. Masters, Gilbert M, "Introduction to Environmental Engineering and Science", Second Edition, Pearson Education, New Delhi (2012),
2. Santosh Kumar Garg, Rajeshwarigarg, smfRanjniGarg "Ecological and Environmental Studies" Khanna Publishers, NaiSarak, Delhi (2014),
3. R.K. Trivedi, "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standard", Vol. I and II, Enviro Media,
4. Dharmendra S. Sengar, "Environmental law", Prentice Hall of India PVT LTD, New Delhi, 2007. 4. Rajagopalan, R, "Environmental Studies-From Crisis to Cure", Oxford University Press 2005,
5. Cunningham, W.P. Cooper, T.H. Gorhani, "Environmental Encyclopedia", Jaico Publ., House, Mumbai, 2015.


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES213	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is

- Apply problem solving techniques,
- Write, test, and debug simple Python programs,
- Implement Python programs with conditional and loops,
- Use functions for structuring Python programs,
- Represent compound data using Python lists, tuples and dictionaries,
- Read and Write data from / to files in Python.

Course Outcomes: At the end of this course, learners will be able to

- Write algorithm, pseudo code and draw flowchart,
- Write, test, and debug simple Python programs,
- Implement Python programs with conditionals and loops,
- Develop Python programs step-wise by defining functions and calling them,
- Use Python lists, tuples, dictionaries for representing compound data,
- Read and write data from/to files in Python.

List of Experiments

1. Write algorithms and pseudo code to solve real time problems,
2. Draw flow chart,
3. Working in Python Interpreter,
4. Simple python programming using looping and conditional statements,
5. Programs to handle strings,
6. Programs using list, tuples and dictionaries,
7. Programs using functions,
8. Programs using modules and packages,
9. Program to handle files and exception handling,
10. Program to draw various charts.

PLATFORM NEEDED

Python 3 Interpreter for Windows / Linux

TEXT BOOK(S):

1. David Riley and Kenny Hunt, "Computational Thinking for the Modern Problem Solver", Chapman & Hall/CRC, 2014,
2. M. Sprankle, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, New Delhi, 2011.

REFERENCE(S):

1. Brian Heinold, "Introduction to Programming Using Python", Mount St. Mary's University, 2013,
2. Michael Dawson, "Python Programming for the Absolute Beginner", 3rd Edition, 2010,
3. Allen Downey, Green Tea Press Needham, "Think Python, How to Think Like a Computer Scientist", Massachusetts.
4. Cunningham, Sams teach yourself python in 24 hours, Second edition Pearson, 2014


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
19TPS02	SOFT SKILLS – II	L	T	P	C	30	100	
		1	0	1	1.5			

Course Objective (s): The purpose of learning this course is to

- Train the Students on Group Discussion Do's and Don'ts. C
- Coach the students on Interview Skills.
- Develop Presentation Skills.
- Develop Business Etiquette.
- Teach importance of Ethics and Values.

Course Outcomes: At the end of this course, learners will be able to:

- Participate Group Discussion with Confidence by knowing the tips and Tricks,
- Attend the interview with positive attitude by having Mock Interviews
- Present them very well by enhancing their Presentation Skills.
- Behave very well in official gathering and Meeting by knowing Etiquette.
- Have good ethics and values in their Personal and Professional Life.

Unit I	GROUP DISCUSSION	6
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GD skills - Understanding the objective and skills tested in a GD - General types of GDs - Roles in a GD - Do's & Don'ts - Mock GD & Feedback.

Unit II	INTERVIEW SKILLS	6
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Interview handling Skills - Self preparation checklist - Grooming tips: do's & don'ts - mock interview & feedback.

Unit III	PRESENTATION SKILLS	6
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Presentation Skills - Stages involved in an effective presentation - selection of topic, content, aids - Engaging the audience - Time management - Mock Presentations & Feedback

Unit IV	BUSINESS ETIQUETTE	6
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Grooming etiquette - Telephone & E-mail etiquette - Dining etiquette - do's & Don'ts in a formal setting - how to impress.

Unit V	ETHICS	6
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Ethics - Importance of Ethics and Values - Choices and Dilemmas faced - Discussions from news headlines

REFERENCE(S):

1. The Seven Habits of Highly Effective People - Stephen R. Covey.
2. All the books in the "Chicken Soup for the Soul" series.
3. Man's search for meaning - Viktor Frankl
4. The greatest miracle in the world - OgMandino
5. Goal - EliyahuGoldratt.
6. Working with Emotional Intelligence - David Goleman.
7. Excel in English - Sundra Samuel, Samuel Publications
8. Developing Communication Skills by Krishna Mohan and MeeraBanerji; MacMillan India Ltd., Delhi
9. Essentials of Effective Communication, Ludlow and Panthon; Prentice Hall of India.
10. Effective Presentation Skills (A Fifty-Minute Series Book) by Steve Mandel
11. "Strategic interviewing" byRichaard Camp, Mary E. Vielhaber and Jack L. Simonetti - Published by Wiley India Pvt. Ltd
12. "Effective Group Discussion: Theory and Practice" by Gloria J. Galanes, Katherine Adams , John K. Brillhart.

Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19ES217	DEVICES AND CIRCUITS LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Learn the characteristics of basic electronic devices such as Diode, BJT, FET, SCR
- Understand the working of RL, RC and RLC circuits

Course Outcomes: At the end of this course, learners will be able to:

- Analyze the characteristics of basic electronic devices
- Design RL and RC circuits

Name of Experiments

1. Study of Electronic Components
2. Measurement of AC Signal Parameter using CRO
3. Characteristics of PN Junction Diode
4. Characteristics of Zener Diode
5. Measurement of Ripple factor of FWR & HWR
6. Characteristics Common Emitter Configuration
7. Characteristics Common Base Configuration
8. FET Characteristics
9. SCR Characteristics
10. Frequency Response of BJT and FET Amplifiers
11. Soldering Practice using general purpose PCB.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	BC 107, BC 148	25
2.	2N2646	25
3.	BFW10	25
4.	1N4007	25
5.	Zener Diodes	25
6.	Resistors, Capacitors, Inductors (sufficient quantities)	25
7.	Bread Boards	15
8.	CRO (30MHz)	10
9.	Function Generators (3MHz)	10
10.	Dual Regulated Power Supplies(0-30V)	10
11.	Soldering Gun	5
12.	PCB Board	5



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Department	BIOMEDICAL ENGINEERING				R 2019	Semester II	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
19ES220	ENGINEERING PRACTICES	L	T	P	C	30	100
		0	0	2	1		

Course Objective (s): The purpose of learning this course is to

- Provide hands on training for fabrication of components using carpentry, sheet metal and welding equipment / tools.
- Gain the skills for making fitting joints and household pipe line connections using suitable tools.
- Develop the skills for preparing the green sand mould and to make simple household electrical connection
- Provide hands on training for dismantling and assembling of petrol engines, gearbox and pumps.
- Develop the skills for making wood/sheet metal models using suitable tools

Course Outcomes: At the end of this course, learners will be able to:

- Fabricate simple components using carpentry, sheet metal and welding equipment/tools
- Make fitting joints and household pipe line connections using suitable tools.
- Prepare green sand mould and make simple household electrical connections using suitable tools
- Dismantle and assemble petrol engines, gear box and pumps.
- Make simple models using wood and sheet metal.

Name of Experiments

1. Forming of simple object in sheet metal using suitable tools (Example: Dust Pan / Soap Box)
2. Fabrication of a simple component using thin and thick plates. (Example: Book rack)
3. Making a simple component using carpentry power tools. (Example: Pen stand/Tool box/ Letter box.
4. Prepare a "V" (or) Half round (or) Square joint from the given mild Steel flat.
5. Construct a household pipe line connections using pipes, Tee joint, Four way joint, elbow, union, bend, Gate way and Taps (or) Construct a pipe connections of house application centrifugal pump using pipes, bend, gate valve, flanges and foot valve.
6. Prepare a green sand mould using solid pattern/split pattern.
7. Dismantling and assembly of Centrifugal Gear Pump / Gear box.
8. Dismantling and assembly of two-stroke and four-stroke petrol engine.
 - a) Preparation of butt joints, lap joints and T- joints by Electric Arc Welding.
 - b) Gas Welding practice.
9. Mini-Project (Fabrication of small components).

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings	15 sets
2.	Carpentry Vice (fitted to work bench)	15 Nos.
3.	Standard woodworking tools	15 Sets.
4.	Models of industrial trusses, door joints, furniture joints	5 each
5.	Power Tools: (a) Rotary Hammer	2Nos.
	(b) Demolition Hammer	2Nos.
	(c) Circular Saw	2Nos.
	(d) Planer	2Nos.
	(e) Hand Drilling Machine & Jigsaw	Each 2Nos.
6.	Arc welding transformer with cables and holders	5Nos.
7.	Welding booth with exhaust facility	2 Nos.
8.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
9.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfits	2 Nos.
10.	Centre lathe	2 Nos.
11.	Hearth furnace, anvil and smithy tools	2 Sets.
12.	Moulding table, foundry tools	2 Sets.
13.	Power Tool: Angle Grinder	2 Nos.

Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS301	APPLIED LINEAR ALGEBRA	3	1	0	4	60	100	
Course Objective(s): The purpose of learning this course is to • Introduce the system of linear equations and solve numerically. • Understand the concepts of vector space • Understand linear transformations and diagonalization. • Apply the concept of inner product spaces in orthogonalization. • Apply eigen values and eigen vectors in real life								
Course Outcomes: At the end of this course, learners will be able to: • Explain the fundamental concepts of system of linear equations and their solutions • Explain advanced algebra and their role in modern Mathematics and applied contexts. • Demonstrate accurate and efficient use of advanced algebraic techniques • Demonstrate their mastery by solving non - trivial problems related to the concepts and by proving simple theorems about the statements proven by the text. • Understand the applications of eigen values and eigen vectors								
Unit I	SYSTEM OF LINEAR EQUATIONS						12	
Direct method: Gauss elimination method - Gauss-Jordan method - Iterative methods: Gauss-Seidel method - LU decomposition method - Cholesky decomposition method - Relaxation Method.								
Unit II	VECTOR SPACES						12	
Vector spaces and subspaces - Linear independence and dependence - Basis and Dimension - Null spaces, column spaces - Dimension Theorem.								
Unit III	LINEAR TRANSFORMATION						12	
Similarity transformation - Diagonalization - Orthogonal space- matrix of linear transformation-Geometry of linear transformation - kernel - range - Nullity.								
Unit IV	INNER PRODUCT SPACE						12	
Inner product - Length and orthogonality - Orthogonal sets - Orthogonal projections - Inner product spaces - The Cauchy Schwarz Inequality - The Gram Schmidt Orthogonalization process - Applications of inner product spaces.								
Unit V	APPLICATION OF EIGENVALUES AND EIGENVECTORS						12	
Generalized Eigen vectors - Power method - Jacobi method for symmetric matrix - Quadric surface.								
REFERENCE(S): 1. Strang, G., "Linear Algebra and its applications", Thomson (Brooks/Cole), New Delhi, 2005 2. Friedberg, A.H., Insel, A.J. and Spence, L., "Linear Algebra", Prentice - Hall of India, New Delhi, 2004. 3. Bernard Kolman, David R. Hill, "Introductory Linear Algebra", Pearson Education, New Delhi, First Reprint 2009. 4. Howard Anton, Elementary Linear Algebra Applications, Wiley India Pvt. Ltd., Bangalore, 9th Edition, 2008. 5. Steven Chapra , Numerical Methods for Engineers, Tata McGraw Hill seventh Edition, 2015.								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19EE305	CIRCUIT THEORY	3	1	0	4	60	100	
Course Objective (s): The purpose of learning this course is to • Introduce electric circuits and its analysis • Impart knowledge on solving circuit equations using network theorems • Introduce the phenomenon of resonance in coupled circuits. • Educate on obtaining the transient response of circuits. • Introduce Phasor diagrams and analysis of three phase circuits								
Course Outcomes: At the end of this course, learners will be able to: • Analyze electrical circuits • Apply circuit theorems • Analyze transients response of RL, RC and RLC Circuits • Understand the concepts of single and three phase circuits • Design of tank circuit for given frequency and analyze the coupled circuits in series and parallel.								
Unit I	BASIC CIRCUITS ANALYSIS							12
Resistive elements - Ohm's Law - Resistor, Inductor, Capacitor - series and parallel circuits-Kirchhoff's laws - Mesh current and node voltage-methods of analysis.								
Unit II	NETWORK REDUCTION AND THEOREMS FOR DC CIRCUITS							12
Network reduction: voltage and current division, source transformation-star delta conversion. Thevenins and Norton Theorems -Super position Theorem-Maximum power transfer theorem- Reciprocity Theorem-Millman's theorem.								
Unit III	SINGLE AND THREE PHASE CIRCUITS							12
A.C. circuits - Average and RMS value - Phasor Diagram - Power, Power Factor and Energy.- Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & unbalanced - phasor diagram of voltages and currents-power measurement three phase circuits.								
Unit IV	RESONANCE AND COUPLED CIRCUITS							12
L and C elements-Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. sinusoidal input.								
Unit V	RESONANCE AND COUPLED CIRCUITS							12
Series and parallel resonance-their frequency response-Quality factor and Bandwidth-Self and mutual inductance -Coefficient of coupling-Tuned circuits-Single tuned circuits.								
TEXT BOOK(S): 1. Joseph A. Edminister, Mahmood Nahri, "Electric circuits", Schaum's series, McGraw- Hill, New Delhi, 2010. 2. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw Hill publishers, edition, New Delhi, 2013. 3. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Second Edition, McGraw Hill, 2013. 4. Allan H. Robbins, Wilhelm C. Miller, "Circuit Analysis Theory and Practice", Cengage Learning India, 2013. Grewal B.S., "Higher Engineering Mathematics", 43rd Edition, Khanna Publishers, New Delhi, 2014								
REFERENCE(S): 1. Chakrabarti A, "Circuits Theory (Analysis and synthesis), Dhanpath Rai & Sons, New Delhi, 1999 2. Jegatheesan, R., "Analysis of Electric Circuits," McGraw Hill, 2015. 3. M E Van Valkenburg, "Network Analysis", Prentice-Hall of India Pvt Ltd, New Delhi, 2015. 4. Mahadevan, K., Chitra, C., "Electric Circuits Analysis," Prentice-Hall of India Pvt Ltd., New Delhi, 2015. 5. Richard C. Dorf and James A. Svoboda, "Introduction to Electric Circuits", 7th Edition, John Wiley & Sons, Inc. 2015. 6. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", McGraw Hill, 2015.								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19EC303	SIGNALS AND SYSTEMS	3	1	0	4	60	100	
Course Objective (s): The purpose of learning this course is to - Understand the concepts of different types of signals and systems - Apply Fourier Series, Fourier Transform and Laplace Transform to Continuous Time signals - Apply Fourier Transform and Laplace Transform to Continuous Time LTI systems - Apply DTFT and Z Transform to Discrete Time signals - Apply DTFT and Z Transform to Discrete Time LTI systems								
Course Outcomes: At the end of this course, learners will be able to: - Categorize different types of signals and Systems - Analyze Continuous Time signals using Fourier Series, Fourier Transform and Laplace Transform - Analyze Continuous Time LTI systems using Fourier Transform and Laplace Transform - Analyze Discrete Time signals using DTFT and Z Transform - Analyze Discrete LTI Systems using DTFT and Z Transform								
Unit I	CLASSIFICATION OF SIGNALS AND SYSTEMS						12	
Signals: Types of continuous and discrete time signals - Classification of CT and DT signals - Basic operations on signals. Systems: CT and DT systems- Classification and properties of systems.								
Unit II	ANALYSIS OF CONTINUOUS TIME SIGNALS						12	
Fourier series for periodic signals - Fourier Transform - properties - Laplace Transforms and properties								
Unit III	LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS						12	
Impulse response - convolution integrals - Differential Equation - Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.								
Unit IV	ANALYSIS OF DISCRETE TIME SIGNALS						12	
Low Pass Sampling Theorem - Fourier Transform of discrete time signals (DTFT) - Properties of DTFT - Z Transform & Properties								
Unit V	LINEAR TIME INVARIANT – DISCRETE TIME SYSTEMS						12	
Impulse response - Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.								
TEXTBOOK(S): - Oppenheim, Alanv., Willsky, Alan S, and Hamid Nawab S, Signals & Systems, 2nd Edition, Pearson Education, New Delhi, 2014, ISBN :9781292025902, - Haykin, Simon and Barry Van Veen, Signals and Systems, John Wiley & Sons, 2nd Edition, NewYork, 2007, ISBN: 9788126512652								
REFERENCE(S): - Roberts, M.J, Signals And Systems Analysis Using Transform Method and Matlab, 2nd Edition, Tata McGraw-Hill, New Delhi, ,2011, ISBN :9780073380681 - Schaum's Outline of Signals and Systems, 3rd Edition ,2013								

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM301	ANATOMY AND HUMAN PHYSIOLOGY	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Identify all the organelles of an animal cell and their function. - Understand structure and functions of the various types of systems of human body. - Demonstrate their knowledge of importance of anatomical features and physiology of human systems								
Course Outcomes: At the end of this course, learners will be able to: - Students would be able to explain basic structure and functions of cell - Students would be learnt about anatomy and physiology of various systems of human body - Students would be able to explain interconnect of various systems								
Unit I	CELL AND TISSUE STRUCTURE							9
Structure of Cell - structure and functions of sub organelles - Cell Membrane -Transport of Across Cell Membrane - Action Potential - Cell to Cell Signaling - Cell Division. Types of Specialized tissues - Functions								
Unit II	SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS							9
Skeletal::Types of Bone and function - Physiology of Bone formation - Division of Skeleton -Types of joints and function - Types of cartilage and function. Muscular: Parts of Muscle -Movements. Respiratory: Parts of Respiratory Systems - Types of respiration - Mechanisms of Breathing - Regulation of Respiration								
Unit III	CARDIOVASCULAR AND LYMPHATIC SYSTEMS							9
Cardiovascular: Components of Blood and functions.- Blood Groups and importance - Structure of Heart - Conducting System of Heart - Properties of Cardiac Muscle - Cardiac Cycle - Heart Beat - Types of Blood vessel - Regulation of Heart rate and Blood pressure. Lymphatic: Parts and Functions of Lymphatic systems - Types of Lymphatic organs and vessels								
Unit IV	NERVOUS AND ENDOCRINE SYSTEMS AND SENSE ORGANS							9
Nervous: Cells of Nervous systems - Types of Neuron and Synapses - Mechanisms of Nerve impulse - Brain: Parts of Brain - Spinal Cord - Tract and Pathways of Spines - Reflex Mechanism - Classification of Nerves - Autonomic Nervous systems and its functions. Endocrine- Pituitary and thyroid gland, Sense Organs: Eye and Ear								
Unit V	DIGESTIVE AND URINARY SYSTEMS							9
Digestive: Organs of Digestive system - Digestion and Absorption. Urinary: Structure of Kidney and Nephron - Mechanisms of Urine formation - Regulation of Blood pressure by Urinary System- Urinary reflex								
TEXT BOOK(S): - Prabhjot Kaur. Text Book of Anatomy and Physiology. Lotus Publishers. 2014 - Elaine.N. Marieb , "Essential of Human Anatomy and Physiology", Eight Edition, Pearson Education, New Delhi, 2007								
REFERENCE(S): - Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. Pearson Publishers, 2014 - Gillian Pocock, Christopher D. Richards, The human Body - An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2013 - William F.Ganong, "Review of Medical Physiology", 22nd Edition, McGraw Hill, New Delhi, 2010 - Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", W.B. Saunders Company, 2015 - Guyton & Hall, "Medical Physiology", 13th Edition, Elsevier Saunders, 2015								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM302	PATHOLOGY AND MICROBIOLOGY	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Attain knowledge on the structural and functional aspects of microorganisms that interferes with the health of living organisms,
- Learn the fluid and hemodynamic disturbances in the body,
- Gain awareness and knowledge of infectious and life style diseases,
- Impart knowledge on microscopy and staining techniques,
- Gain the knowledge on the immune system and related disorders.

Course Outcomes: At the end of this course, learners will be able to:

- Illustrate the different types of Cell degeneration, how and when it gets repaired,
- Demonstrate the different pathologic conditions related to the body fluids,
- Comprehend about the normal flora, structure and identification of bacteria.
- Explain the functioning and use of various microscopes and staining techniques
- Interpret the response of human body when a microbe enters the human system and the techniques to confirm the presence of microbe.

Unit I	CELL DEGENERATION, REPAIR AND NEOPLASIA	9
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Cell injury – Reversible cell injury and Irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification – Dystrophic and Metastatic. Cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumors, carcinogenesis, spread of tumors Autopsy and biopsy.

Unit II	FLUID AND HEMODYNAMIC DERANGEMENTS	9
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Edema, Hyperemia/Ischemia, normal homeostasis, thrombosis, disseminated intra vascular coagulation, embolism, infarction, shock, Chronic venous congestion. Hematological disorders – Bleeding disorders, Leukemia's, Lymphomas Haemorrhage.

Unit III	MICROBIOLOGY	9
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Structure of Bacteria and Virus. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria and virus, growth curve, identification of bacteria, culture media and its types, culture techniques and observation of culture. Disease caused by bacteria, fungi, protozoal, virus and helminthes.

Unit IV	MICROSCOPES	9
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Light Microscope – Bright field, dark field, phase contrast, fluorescence, Electron Microscope (TEM& SEM). Preparation of samples for electron microscope. Staining methods – simple, gram staining and AFB staining.

Unit V	IMMUNOPATHOLOGY	9
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Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonization, phagocytosis and inflammation, Secondary immunodeficiency including HIV infection. Auto – Immune disorders: Basic concepts and classification, SLE. Antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies.

TEXT BOOK(S):

1. Ananthanarayanan & Panicker, "Textbook of Microbiology", University press (India) Private Limited, 10th edition, 2017.
2. Willey JM, Sherwood LM, and Woolverton CJ, Prescott's Microbiology. McGraw Hill Education, New York, 10th Edition, 2017
3. Harsh Mohan, "Textbook of Pathology" 8th Edition, Jaypee Brothers Medical Publishers (P) Ltd., 2018.

REFERENCE(S):

1. Prescott, Harley and Klein, "Microbiology", 10th edition, McGraw Hill, 2017
2. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2007.
3. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2005.
4. Churchill Livingstone "Underwood JCE: General and Systematic Pathology", 3rd edition, 2000.



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	MC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19MC301	INDIAN CONSTITUTION	1	0	0	0	30	100	

Course Objective (s): The purpose of learning this course is to

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective,
- Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism,
- Address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes: At the end of this course, learners will be able to:

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

Unit I INTRODUCTION

5

History of Indian Constitution – Drafting Committee, (Composition & Working) – Philosophy of the Indian Constitution – Preamble – Salient Features

Unit II CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

5

Fundamental Rights – Right to Equality – Right to Freedom – Right against Exploitation – Right to Freedom of Religion – Cultural and Educational Rights – Right to Constitutional Remedies – Directive Principles of State Policy – Fundamental Duties.

Unit III ORGANS OF GOVERNANCE

5

Parliament – Composition – Qualifications and Disqualifications – Powers and Functions Executive – President – Governor – Council of Ministers – Judiciary, Appointment and Transfer of Judges, Qualifications – Powers and Functions.

Unit IV STATE GOVERNMENT AND ITS ADMINISTRATION

5

Governor: Role and Position, CM and Council of ministers, State Secretariat: Organization, Structure and Functions

Unit V LOCAL ADMINISTRATION

5

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

Unit VI ELECTION COMMISSION

5

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women


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TEXT BOOK(S):

1. "The Constitution of India", 1950 (Bare Act), Government Publication,
2. Dr. S. N. Busi, "Dr. B. R. Ambedkar Framing of Indian Constitution", 1st Edition, 2016.Ava Publishers,
3. M. P. Jain, "Indian Constitution Law", 7th Edn, Lexis Nexis, 2014.

REFERENCE(S):

1. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS03	QUANTITATIVE APTITUDE AND LOGICAL REASONING – I	2	0	0	0	30	100	
Course Objective (s): The purpose of learning this course is to • Crack aptitude assessment by using speed math concepts. • Solve problems using fast track method by learning simplification and numbers. • Learn the basic of ratio and proportion and mixture concepts. • Calculate different ways of solving problems on average and ages. • Learn the logical skills by analyzing the objects.								
Course Outcomes: At the end of this course, learners will be able to: • Solve the question with speed and accuracy. • Crack the quantitative aptitude questions by using simplification and numbers system. • Solve most of the aptitude topics by knowing ratio and proportion topics with allegation. • Solve the problems on average and ages by using logical way of approach. • Develop their logical thinking.								
UNIT 1	SPEED MATHS AND NUMBER SYSTEMS							6
SPEED MATHS: Square and square roots - Square for numbers from 31 to 50. Finding squares of numbers between 81 to 100. Cubes and cubes roots. NUMBER SYSTEMS: Numbers and types of Numbers - Properties of Numbers -Face value and place value - Divisibility rules - Concept on unit digit and remainder theorem.								
UNIT 2	SIMPLIFICATIONS & PROBLEMS ON NUMBERS							6
SIMPLIFICATIONS: BODMAS rule - Application of algebraic formulae -Simplification of decimal fraction & mixed fraction - Continued fraction and its simplification - Recurring decimals. PROBLEMS ON NUMBERS: Set of numbers - Assume the unknown numbers and form equations								
UNIT 3	RATIO & PROPORTION, ALLIGATIONS & MIXTURE							6
RATIO AND PROPORTION: Ratio between two or more persons - Miscellaneous problems. ALLIGATIONS AND MIXTURES: Definition - Allegation rule - Mean value (or cost price) of the mixture - Six golden rules to solve problems on mixture - Removal among the quantities more than two.								
UNIT 4	AVERAGES & PROBLEM ON AGES							6
AVERAGES: Average from total -Total from the average - Miscellaneous problems. PROBLEMS ON AGES: Ages - Persons in Past - Present - Future. Miscellaneous problem.								
UNIT 5	ANALOGY & MIRROR & WATER IMAGES							6
ANALOGY: Study and topic relationship - Worker and tool relationship - Tool and action relationship - Work and working place - Worker and product - Product and raw materials - Instrument and measurement - Quantity and unit - Animals and young ones - Male and female. MIRROR IMAGES AND WATER IMAGES: Letter inverted - Object inverted.								
REFERENCE(S): 1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012 2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012. 3. R.V.Praveen," Quantitative Aptitude and Reasoning" Third Edition, PHI Learning, 2016. 4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017. 5. Arun Sharma "How to Prepare for Quantitative Aptitude"Eight Edition, McGraw Hill Education, 2018. 6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication, 2020.								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM303	PATHOLOGY AND MICROBIOLOGY LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Use Compound microscope,
- Practice on chemical examinations, Cryoprocessing, Histopathological examinations

Course Outcomes: At the end of this course, learners will be able to:

- Student can perform practical experiments on tissue processing, cryoprocessing, staining Processes
- Have knowledge about basic concepts of infection and immunity of the human body,
- Acquire the fundamental knowledge of structure of Bacteria, virus and its cause.

Name of Experiments

1. Urine physical and chemical examination
2. Study of parts of compound microscope
3. Histopathological slides of benign and malignant tumours.
4. Manual paraffin tissue processing and section cutting (demonstration)
5. Cryo processing of tissue and cryosectioning (demonstration)
6. Basic staining - Hematoxylin and eosin staining
7. Special stains - cresyl fast Blue (CFV)- Trichrome - oil red O - PAS
8. Capsule , Simple, AFB and Gram stain
9. Antigen-Antibody reaction Immuno electrophoresis
10. Slides of malarial parasites, micro filaria and leishmaniadonovani
11. Haematology slides of anemia and leukemia
12. Study of bone marrow charts

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	UV-Vis Spectrophotometer	01
2.	Colorimeter	02
3.	Electronic Weighing balance	01
4.	Optical Microscope	01
5.	Centrifuge	01
6.	Cryosectioning	01
7.	Hot Air Oven	01
8.	Incubator	01
9.	Autoclave	01
10.	Fridge	01
11.	PH Meter	01
12.	Homogeniser	01
13.	Magnetic Stirrer	01
14.	Sonicator	01
15.	Vortex Mixer	02
16.	Laminar Air Flow	01
17.	Wax Dispenser	01
18.	Slide Dispenser	01

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM304	HUMAN PHYSIOLOGY LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Estimation and quantification of blood cells
- Learnt methods for identification of blood groups
- Estimation of hematological parameters
- Learnt the analysis of visual and hearing test

Course Outcomes: At the end of this course, learners will be able to:

- Identification and enumeration of blood cells
- Enumeration of hematological parameters
- Analysis of special sensory organs test

Name of Experiments

1. Collection of Blood Samples
2. Identification of Blood groups (Forward and Reverse)
3. Bleeding and Clotting time
4. Estimation of Hemoglobin
5. Total RBC Count
6. Total WBC Count
7. Differential count of Blood cells
8. Estimation of ESR
9. PCV, MCH, MCV, MCHC
10. Hearing test - Tuning fork
11. Visual Activity - Snellen's Chart and Jaeger's Chart

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	Microscope	2
2.	Centrifuge Normal	1
3.	Wintrobe's tube	2
4.	PCV tube	2
5.	Neubaur's Chamber	2
6.	Heparinized Syringe	1
7.	Haemoglobinometer	1
8.	Blood grouping kit	1
9.	Capillary tubes	1
10.	Ophthalmoscope	1
11.	Tuning fork (256Hz to 512Hz)	5
12.	Microslides (Packets)	2
13.	Lancet (boxes)	5

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester III	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS301	COMMUNICATION SKILLS	0	0	4	2	60	100	
Course Objective (s): The purpose of learning this course is to - Involve the students in effective listening activities. - Improve the oral communication skills in proper manner. - Focus the effective reading of general and technical text. - Enhance and comprehend the written text. - Integrate LSRW skills.								
Course Outcomes: At the end of this course, learners will be able to: - Understand the technical talks. - Communicate to his peer group properly. - Comprehend the general and technical text. - Write the reports and job application in clear manner. - Integrate LSRW skills.								
Unit I	LISTENING						12	
Listening as a key skill- its importance - Listen to a process information- give information, as part of a simple explanation - Being an active listener: giving verbal and non-verbal feedback - taking lecture notes - preparing to listen to a lecture								
Unit II	SPEAKING						12	
Give personal information - ask for personal information - express ability - enquire about ability - ask for clarification - Improving pronunciation - pronunciation basics - conversation starters: small talk - stressing syllables and speaking clearly - summarizing academic readings and lectures								
Unit III	READING						12	
Strategies for effective reading- Read and recognize different text types-Predicting content using photos and title - Read for details-Use of graphic organizers to review and aid comprehension - Understanding pronoun reference and use of connectors in a passage- speed reading techniques								
Unit IV	WRITING						12	
Plan before writing- Develop a paragraph: topic sentence, supporting sentences, concluding sentence - Write a descriptive paragraph - Write a paragraph with reasons and examples- Write an opinion paragraph - Email writing - Types of essays- descriptive-narrative- issue-based-argumentative-analytical.								
Unit V	INTEGRATION OF LSRW						12	
Task based Instruction :Listing Task- Sorting and ordering-comparing-Problem solving-sharing Personal Experience-Content based instruction : Texts, Articles, Adds , Videos)								
TEXT BOOK(S): - Gramer F. Margot and Colin S. Ward Reading and Writing (Level 3) Oxford University Press: Oxford, 2011 - Brooks,Margret. Skills for Success. Listening and Speaking. Level 4 Oxford University Press, Oxford: 2011 - Richards,C. Jack. & David Bholke. Speak Now Level 3. Oxford University Press, Oxford: 2010								
REFERENCE(S): - Davis, Jason and Rhonda Llss.Effective Academic Writing (Level 3) Oxford University Press: Oxford, 2006 E. Suresh Kumar and et al. Enriching Speaking and Writing Skills. Second Edition. Orient Black swan - Anderson, Kenneth et al. Study Speaking: A Course in Spoken English for Academic Purposes. United Kingdom: Cambridge University Press 1992.								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester IV	BS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BS401	PROBABILITY AND STATISTICS	3	1	0	4	60	100	
Course Objective(s): The purpose of learning this course is to • Understand the basic concepts of probability and the distributions with characteristics • Understand the basic concepts of random variables • Understand the basic concepts of hypothetical testing of samples from a population • Summarize and apply the methodologies for the data analysis using statistical notions. • Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment.								
Course Outcomes: At the end of this course, learners will be able to: • Demonstrate and apply the basic probability axioms and concepts in their core areas. • Apply the concepts of probability distributions in an appropriate place of science and Engineering.. • Apply basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems. • Design an experiment for an appropriate situation using ANOVA technique. • Correlate and predict the valid outcome of a real time problem								
Unit I	PROBABILITY AND RANDOM VARIABLES						12	
Probability - Axioms of probability - Conditional probability - Total probability - Bayes's theorem - Random variable - Probability mass function - Probability density function - Properties - Moment generating functions.								
Unit II	PROBABILITY DISTRIBUTIONS						12	
Moment generating functions of probability distributions - Concept and applications of standard probability distributions: Binomial - Poisson - Uniform - Exponential - Normal - Weibull distributions.								
Unit III	TESTING OF HYPOTHESIS						12	
Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means - Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.								
Unit IV	DESIGN OF EXPERIMENTS						12	
One way and Two way classifications - Completely randomized design - Randomized block design - Latin square design								
Unit V	CORRELATION AND REGRESSION						12	
Correlation - Multiple correlation - Regression - Multiple regression - Linear fit - Quadratic fit								
REFERENCE(S): 1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014. 2. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004. 3. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004. 4. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.								

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester IV	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM401	BIO SENSORS AND MEASUREMENTS	3	0	1	4	60	100	
Course Objective (s): The purpose of learning this course is to • Discuss the basic concepts of Transducer, Electrodes and its classification. • Determine the recording of biological components. • Describe the knowledge in electrochemical and optical biosensors. • Discuss the various biological components using biosensors. • Demonstrate the various types of Transducer.								
Course Outcomes: At the end of this course, learners will be able to: • Classify and describe resistive, inductive and capacitive transducers which are used for measuring various parameters like displacement, temperature, humidity etc • Define units and standards, their conversions, characteristics and error analysis of measurement systems. • Identify the various transducers used for various applications.								
Unit I	MEASUREMENT SYSTEM AND BASIC TRANSDUCER						12	
General measurement system - Transducer and its classification - Resistive Transducer - Capacitive Transducer – Inductive Transducer.								
Unit II	TRANSDUCER						12	
Temperature Transducer - Piezoelectric Transducer - Piezo Resistive Transducer - Photoelectric Transducer - Introduction to Smart sensors and MEMS								
Unit III	BIO POTENTIAL ELECTRODES						12	
Half Cell potential - Types of Electrodes - Micro Electrodes, Depth and Needle Electrodes, Surface Electrodes, Chemical Electrodes and Catheter type Electrodes - Electrode Paste - Electrode Material								
Unit IV	BIO SENSORS						12	
Biological elements - Immobilization of biological components - Chemical Biosensor - Electro Chemical Biosensor – Chemical fibro sensors.								
Unit V	APPLICATIONS OF BIO SENSOR						12	
Blood Glucose Sensor - Bananatrode - Non Invasive Blood gas monitoring - UREASE Biosensor - Fermentation process control - Environmental monitoring - Medical applications.								
TEXT BOOK(S): 1. ShakthiChatterjee, "Biomedical Instrumentation", Tata McGraw Hill, New York, 2013 2. E.A. Doebelin, „Measurement Systems - Applications and Design", Tata McGraw Hill, New York, 2012 3. John P. Bentley, "Principles of Measurement Systems", 4th Edition,Pearson Education, 2005 4. John G Webster,“Medical Instrumentation: Application and design", John Wiley Publications,2001.								
REFERENCE(S): 1. S. Ranganathan, „Transducer Engineering", Allied Publishers Pvt. Ltd., 2003. 2. D.V.S. Murthy, „Transducers and Instrumentation", Prentice Hall of India, 2011. 3. D.Patranabis, „Sensors and Transducers", Prentice Hall of India, 2004 4. Geddes and Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, John Wiley Publications. 2008.								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM402	ANALOG AND DIGITAL INTEGRATED CIRCUITS	3	0	0	3	45	100	
Course Objective(s): The purpose of learning this course is to - Study the circuit configuration of linear integrated circuits - Introduce practical applications of linear integrated circuits - Introduce the concept of analog multiplier and Phase Locked Loop with applications - Study the application of ADC and DAC in real time systems - Understand the Real time applications and introduce special function ICs and its construction								
Course Outcomes: At the end of this course, learners will be able to: - Ability to comprehend and appreciate the significance and role of the operational amplifier in the present contemporary world - Ability to design new analog linear circuit using operational amplifier - Ability to analyzer and develop communication systems using linear ICs - Ability to deploy the data converters in real time scenario - Ability to select appropriate ICs and circuits for analog system design								
Unit I	CIRCUIT CONFIGURATION FOR LINEAR ICS						9	
Current sources, Analysis of difference amplifiers with active loads, supply and temperature independent biasing, Band gap references, Monolithic IC operational amplifiers, specifications, frequency compensation, slew rate and methods of improving slew rate. Interpretation of TL082 datasheet.								
Unit II	APPLICATION OF OPERATIONAL AMPLIFIERS						9	
Linear and Nonlinear Circuits using operational amplifiers and their analysis, Inverting and Noninverting Amplifiers, Differentiator, Integrator, Voltage to Current converter, Instrumentation amplifier, Sine wave Oscillators, Low pass and band pass filters, Comparator, Multivibrator and Schmitt trigger, Triangle wave generator, Precision rectifier, Log and Antilog amplifiers, Non-linear function generator.								
Unit III	ANALOG MULTIPLIER AND PLL						9	
Analysis of four quadrants and variable Trans conductance multipliers, Analog multiplier MPY634 features, Voltage controlled oscillator, Closed loop analysis of PLL, AM, PM and FSK modulators and demodulators								
Unit IV	ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTORS						9	
Analog switches, High speed sample and hold circuit and IC's, Types of D/A converter, Current driven DAC, Switches for DAC, A/D converter - Flash, Single slope, Dual slope, Successive approximation, Voltage to Time and Voltage to Frequency converters.								
Unit V	SPECIAL FUNCTION ICS AND REAL TIME APPLICATIONS						9	
Timers, Voltage regulators, SMPS, Tuned amplifiers, Power amplifiers and Isolation Amplifiers, Video amplifiers, Digital stethoscope and digital blood pressure monitor, Digital blood glucose monitor and Thermometer.								
TEXT BOOK(S): - Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Mc Graw Hill Education, 2014. - Roy Choudhury and Shail Jain Linear Integrated Circuits, Wiley Eastern, New Delhi, 2014								
REFERENCE(S): - Gray and Meyer, "Analysis and Design of Analog Integrated Circuits", Wiley International, 2009. - Michael Jacob J., "Applications and Design with Analog Integrated Circuits", Prentice Hall of Inida,1996 - Ramakant A. Gayakwad, "OP AMP and Linear IC's", Prentice Hall, 2012 - Botkar K.R., "Integrated Circuits", Khanna Publishers, 1996 - Taub and Schilling, "Digital Integrated Electronics", Mc Graw Hill, 1977 - Coughlin and Driscoll, "Operational amplifiers and Linear Integrated Circuits", Prentice Hall, 1989 - Millman J. and Halkias C., "Integrated Electronics", Mc Graw Hill, 2001								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM403	MICROPROCESSORS AND MICROCONTROLLERS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Understand architecture and assembly language programming of Microprocessor and Microcontroller - Studies the architecture of 8085, 8086, 8051 and ARM. - Study the addressing modes and instruction set of 8085, 8086 8051 and ARM. - Explore the need and use of Peripherals and Interfacing. - Develop skill to explore system design technique.								
Course Outcomes: At the end of this course, learners will be able to: - Ability to relate any architecture and assembly language for a processor. - Ability to comprehend the architectural and pipelining concepts for Microprocessors. - Ability to design and deploy the Interfacing peripherals in real time scenario. - Ability to discriminate different microprocessor and microcontroller and its special function registers. - Ability to design, develop and trouble shoot microcontroller based system.								
Unit I	8- BIT and 16 - BIT MICROPROCESSOR						9	
8085 Architecture, Instruction set, Addressing modes, Interrupts Timing diagrams, Memory and I/O interfacing. 8086 Architecture, Instruction set and programming, Minimum and Maximum mode configurations.								
Unit II	PERIPHERALS AND INTERFACING						9	
Programmable Peripheral Interface (8255), Keyboard display controller (8279), ADC0808 and DAC0808 Interface, Programmable Timer Controller (8254), Programmable interrupt controller (8259), Serial Communication Interface (8251).								
Unit III	MICROCONTROLLER						9	
8051 - Architecture, Special Function Registers (SFRs), Instruction set, Addressing modes, Assembly language programming, I/O Ports, Timers / counters, Interrupts and serial communication.								
Unit IV	MICROCONTROLLER BASED SYSTEM DESIGN						9	
Interfacing to: matrix display, (16x2) LCD, high power devices, optical motor shaft encoder, Stepper Motor, DC Motor speed Control using PWM, RTC and EEPROM interface using I2C protocol.								
Unit V	32- BIT ARM PROCESSOR						9	
RISC Vs CISC Architecture, ARM Processor Architecture, ARM Core data flow model, Barrel Shifter, ARM processor modes and families, pipelining , ARM instruction Set and its Programming.								
TEXT BOOK(S): - Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085". Penram International Publishing reprint, 6th Edition, 2017. - Douglas V. Hall, "Microprocessor and Interfacing, Programming and Hardware", Tata McGraw Hill, Revised 2nd Edition 2006, 11th reprint 2015.								
REFERENCE(S): - Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2nd Edition, 2008, 12th impression 2018. - Krishna Kant, "Microprocessor and Microcontroller Architecture, programming and system design using 8085, 8086, 8051 and 8096", PHI, 2007, 7th Reprint, 2015. - Kenneth J. Ayala., "The 8051 Microcontroller, Thompson Delmar Learning", 3 rd Edition, 2012. - A.K. Ray, K.M. Bhurchandi, "Advanced Microprocessor and Peripherals", Tata McGraw-Hill, 2nd Edition, 2010. - Barry B. Brey, "The Intel Microprocessors Architecture, Programming and Interfacing", Pearson Education, 2007, 2 nd impression, 2010.								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester IV	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM404	INTERNET OF THINGS IN MEDICINE	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Understand Smart Objects and IoT Architectures - Learn about various IOT-related protocols - Build simple IoT Systems using Arduino and Raspberry Pi. - Understand data analytics and cloud in the context of IoT - Develop IoT infrastructure for popular applications								
Course Outcomes: At the end of this course, learners will be able to: - Explain the concept of IoT. - Analyze various protocols for IoT. - Design a PoC of an IoT system using Rasperry Pi / Arduino - Apply data analytics and use cloud offerings related to IoT. - Analyze applications of IoT in real time scenario.								
Unit I	FUNDAMENTALS OF IoT							9
Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects								
Unit II	IoT PROTOCOLS							9
IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks - Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT								
Unit III	DESIGN AND DEVELOPMENT							9
Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks -Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming								
Unit IV	DATA ANALYTICS AND SUPPORTING SERVICES							9
Structured Vs Unstructured Data and Data in Motion Vs Data in Rest - Role of Machine Learning - No SQL Databases - Hadoop Ecosystem - Apache Kafka, Apache Spark - Edge Streaming Analytics and Network Analytics - Xively Cloud for IoT, Python Web Application Framework -Django - AWS for IoT - System Management with NETCONF-YANG								
Unit V	APPLICATIONS OF IOT IN MEDICINE							9
NSUM Technique for Diabetes Patients, Healthcare Monitoring system through Cyber-physical system, An IoT Model for Neuro sensors, AdaBoost with feature selection using IoT for somatic mutations evaluation in Cancer, A Fuzzy-Based expert System to diagnose Alzheimer's Disease, Secured architecture for IoT enabled Personalized Healthcare Systems, Healthcare Application Development in Mobile and Cloud Environments, Approach to predict Diabetic Retinopathy through data analytics, Diagnosis of chest diseases using artificial neural networks.								
TEXT BOOK(S): - David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017. - Venkata Krishna, SasikumarGurumoorthy, Mohammad S. Obaidat, "Internet of Things and Personalized Healthcare Systems", Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019.								



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REFERENCE(S):

1. ArshdeepBahga, Vijay Madiseti, "Internet of Things - A hands-on approach", Universities Press, 2015,
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things - Key applications and Protocols", Wiley, 2012,
3. Jan Ho" ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis ,Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014,
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011,
5. Michael Margolis, Arduino Cookbook, "Recipes to Begin, Expand, and Enhance Your Projects", O'Reilly Media, 2nd Edition.


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS402	UNIVERSAL HUMAN VALUES 2 : UNDERSTANDING HARMONY	2	1	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- Facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- Highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature

Salient Features of the Course: The salient features this course is to

- It presents a universal approach to value education by developing the right understanding of reality (i.e. a worldview of the reality "as it is") through the process of self-exploration.
- The whole course is presented in the form of a dialogue whereby a set of proposals about various aspects of the reality are presented and the students are encouraged to self-explore the proposals by verifying them on the basis of their natural acceptance within oneself and validate experientially in living.
- The prime focus throughout the course is toward affecting a qualitative transformation in the life of the student rather than just a transfer of information.
- While introducing the holistic worldview and its implications, a critical appraisal of the prevailing notions is also made to enable the students discern the difference on their own right.

Course Methodology: The methodology of this course is :

- To explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
- The course is in the form of 28 lectures (discussions) and 14 practice sessions.
- It is free from any dogma or value prescriptions.
- It is a process of self-investigation and self-exploration, and not of giving sermons. Whatever is found as truth or reality is stated as a proposal and the students are facilitated to verify it in their own right, based on their Natural Acceptance and subsequent Experiential Validation – the whole existence is the lab and every activity is a source of reflection.
- This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous self evolution.
- This self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs.

Module 1 – Introduction to Value Education

6+3

Lectures - Understanding Value Education - Self-exploration as the Process for Value Education - Continuous Happiness and Prosperity – the Basic Human Aspirations - Right Understanding, Relationship and Physical Facility - Happiness and Prosperity – Current Scenario - Method to Fulfill the Basic Human Aspirations

Tutorials [Practice Session] - Sharing about Oneself - Exploring Human Consciousness - Exploring Natural Acceptance

Module 2 – Harmony in the Human Being

6+3

Lectures - Understanding Human being as the Co-existence of the Self and the Body - Distinguishing between the Needs of the Self and the Body – The Body as an Instrument of the Self - Understanding Harmony in the Self - Harmony of the Self with the Body - Programme to ensure self-regulation and Health

Tutorials [Practice Session] - Exploring the difference of Needs of Self and Body - Exploring Sources of Imagination in the Self - Exploring Harmony of Self with the Body


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Module 3 - Harmony in the Family and Society	6+3
Lectures - Harmony in the Family - the Basic Unit of Human Interaction - Values in Human-to-Human Relationship - 'Trust' - the Foundational Value in Relationship - 'Respect' - as the Right Evaluation - Understanding Harmony in the Society - Vision for the Universal Human Order	
Tutorials [Practice Session] - Exploring the Feeling of Trust - Exploring the Feeling of Respect - Exploring Systems to fulfill Human Goal	
Module 4 - Harmony in the Nature/Existence	4+2
Lectures - Understanding Harmony in the Nature - Interconnectedness, self-regulation and Mutual Fulfillments among the Four Orders of Nature - Realizing Existence as Co-existence at All Levels - The Holistic Perception of Harmony in Existence	
Tutorials [Practice Session] - Exploring the Four Orders of Nature - Exploring Co-existence in Existence	
Module 5 - Implications of the Holistic Understanding	6+3
Lectures - Natural Acceptance of Human Values - Definitiveness of (Ethical) Human Conduct - A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order - Competence in Professional Ethics - Holistic Technologies, Production Systems and Management Models-Typical Case Studies - Strategies for Transition towards Value-based Life and Profession	
Tutorials [Practice Session] - Exploring Ethical Human Conduct - Exploring Humanistic Models in Education - Exploring Steps of Transition towards Universal Human Order	
Course Outcomes: At the end of this course, learners will be able to:	
• Students are expected to become more aware of themselves, and their surroundings (family, society, nature) • Students would become more responsible in life, and in handling problems with sustainable solutions. • Students become sensitive to their commitment towards what they have understood (human values, human relationship and human society). • Students would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction. • Students would have better critical ability.	
TEXT BOOK(S):	
1. A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1	
2. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978- 93-87034-53-2	
REFERENCE(S):	
1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999	
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004	
3. The Story of Stuff (Book)	
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi	
5. Small is Beautiful - E. F Schumacher	
6. Slow is Beautiful - Cecile Andrews	
7. Economy of Permanence - J C Kumarappa	
8. Bharat Mein Angreji Raj – PanditSunderlal	
9. Rediscovering India - by Dharampal	
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi	



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester IV	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS04	QUANTITATIVE APTITUDE AND LOGICAL REASONING – II	2	0	0	0	30	100	
Course Objective (s): • Learn the basic of partnership and chain rule in simplified way, • Solve problems using fast track method by learning profit and loss with percentage. • Teach the angle of elevation and depression. • Know the relationship, direction concepts in easy way. • Know about coding and decoding through logical way.								
Course Outcomes: At the end of this course, learners will be able to: • Solve problems by using shortcut in partnership and chain rule. • Know the tips and tricks of profit and loss with percentage through fast track methods. • Understand the concepts of angles. • Evaluate critically the real life situations by resorting and analyzing analytical reasoning of key issues and factors. • Enhance the logical way of thinking by solving problems codes and rankings concepts.								
Unit I	PARTNERSHIP & CHAIN RULE						6	
PARTNERSHIP: Ratio of division of gains: Simple Partnership - Compound Partnership - Working and sleeping partners. CHAIN RULE: Definition - Direct proportion and Indirect proportion.								
Unit II	PROFIT & LOSS AND PERCENTAGE						6	
PROFIT AND LOSS: Basic definition and types of profit and loss - Concept of discount and marked price - Concept of true v/s false value - Application in data interpretation problems. PERCENTAGE: Percentage - Percentage using shortcuts.								
Unit III	HEIGHT AND DISTANCE						6	
HEIGHT AND DISTANCES: Line of sight - Angle of elevation - Angle of depression.								
Unit IV	BLOOD RELATIONSHIP & DIRECTION SENSE TEST						6	
BLOOD RELATIONSHIP: Analysis the gender relationship - Relationship diagram - Family tree. DIRECTION SENSE TEST: Distance between the starting and ending points - Sense the direction correctly.								
Unit V	LOGICAL SEQUENCE OF WORD, CODING AND DECODING, NUMBER RANKING & TIME SEQUENCE TEST						6	
LOGICAL SEQUENCE OF WORDS: Sequence of occurrence of events - Sequence of objects in a class or group - Sequence of increasing/decreasing size, value, intensity, etc. CODING AND DECODING: Introduction - Description of coding method, Coding patterns - Concepts of coding & decoding - Problems involving coding & decoding method. NUMBER RANKINGS & TIME SEQUENCE TEST: Number test - Ranking test - Time sequence test.								
REFERENCE(S): 1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012 2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012. 3. R.V.Praveen, "Quantitative Aptitude and Reasoning "Third Edition, PHI Learning, 2016. 4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017. 5. Arun Sharma "How to Prepare for Quantitative Aptitude "Eight Edition, McGraw Hill Education, 2018 6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication, 2020.								

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM405	ANALOG AND DIGITAL IC LABORATORY	0	0	4	2	60	100	
Course Objective(s): The purpose of learning this course is to • Study the Frequency response of CE, CB and CC Amplifier • Learn the frequency response of CS Amplifiers • Study the Transfer characteristics of differential amplifier • Perform experiment to obtain the bandwidth of single stage and multistage amplifiers • Perform SPICE simulation of Electronic Circuits • Design and implement the Combinational and sequential logic circuits								
Course Outcomes: At the end of this course, learners will be able to: • Design and Test rectifiers, filters and regulated power supplies. • Design and Test BJT/JFET amplifiers. • Analyze the limitation in bandwidth of single stage and multi stage amplifier • Measure CMRR in differential amplifier • Simulate and analyze amplifier circuits using PSpice. • Design and Test the digital logic circuits.								
NAME OF EXPERIMENTS								
List of Analog Experiments 1. Design of Regulated Power supplies 2. Frequency Response of CE amplifiers 3. Differential Amplifiers - Transfer characteristics, CMRR Measurement 4. Analysis of BJT with Fixed bias and Voltage divider bias using Spice 5. Analysis of FET with fixed bias, self-bias and voltage divider bias using simulation software like Spice								
List of Digital Experiments 1. Design and implementation of code converters using logic gates(i) BCD to excess-3 code (ii) Binary to gray 2. Design and implementation of Multiplexer and De-multiplexer using logic gates 3. Design and implementation of encoder and decoder using logic gates 4. Construction and verification of 4 bit ripple counter and Mod-10 Ripple counters 5. Design and implementation of 3-bit synchronous up/down counter								
S.No	NAME OF THE EQUIPMENT						QUANTITY	
1.	Dual Regulated Power Supplies (0 - 30V)						15	
2.	CRO / DSO (30 MHz)						15	
3.	Standalone desktop PCs with SPICE software						15	
4.	Transistor/FET (BJT-NPN-PNP and NMOS/PMOS)						15	
5.	Components and Accessories: Resistors, Capacitors, Inductors, diodes, Zener Diodes, Bread Boards, Transformers						As Required	
6.	SPICE Circuit Simulation Software: (any public domain or commercial software)						1	
7.	Bread board						15	
8.	IC Trainer Kit						10	
9.	Seven segment display						25	
10.	Multimeter						5	
11.	ICs 7400/ 7402 / 7404 / 7486 / 7408 / 7432 / 7483 / 74150 / 74151 / 74147 / 7445 / 7476/7491/ 555 / 7494 / 7447 / 74180 / 7485 / 7473 / 74138 / 7411 / 7474						25	

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester IV	ES
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM406	MICROPROCESSOR AND MICROCONTROLLER LABORATORY	0	0	2	1	30	100	

Course Objective(s): The purpose of learning this course is to

- Understand and analyze instruction sets of 8086 microprocessor and 89c51 microcontroller.
- Gain hands-on experience in doing experiments on microprocessors (8086) and 89c51 Microcontroller.
- Interface the microprocessor / microcontroller with various peripherals for various applications
- Able to use an Integrated Development Environment (IDE) as a modern software tool for embedded system development.

Course Outcomes: At the end of this course, learners will be able to:

- Perform the basic operations of 8086 microprocessor using Assembly language Programming.
- Perform various operations like sorting, finding the maximum & minimum numbers & string operations using 8086 microprocessor
- Interface 8085/8086 microprocessor to implement various operations like ADC, DAC, 8279, Traffic Light controller
- Perform basic operations using 89c51 Microcontroller.
- Generate an interrupt, LED operations using push button and Input capture operations using 89c51

NAME OF EXPERIMENTS

1. Arithmetic operations using 8086,
2. Sorting, searching and string manipulation using 8086,
3. Hex: to ASCII/BCD code conversion using 8086 microprocessor,
4. Matrix Addition / Subtraction using 8086 microprocessor,
5. Addition / Subtraction / Multiplication / Division using 89c51 microcontroller,
6. Interfacing of switch and LED with 89c51/8086 microcontroller,
7. Interfacing of ADC with 89c51/8086 microcontroller,
8. Interfacing of DAC with 89c51/8086 microcontroller,
9. Stepper Motor/DC Motor interfacing with 89c51/8086 microcontroller,
10. UART /LCD interfacing with 89c51/8086 microcontroller.

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	8086 Development Kits	30
2.	Interfacing Units	Each 10
3.	Microcontroller Kits	30
4.	Computer (MASM installed)	30
5.	8086 Assembler 8051 Cross Assembler	



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM501	BIO CONTROL SYSTEM	3	0	1	4	60	100	
Course Objective (s): The purpose of learning this course is to • Study the mathematical techniques for analysis of given system. • Study the given system in time domain and frequency domain analysis. • Study the stability analysis of the given system. • Study the concept of physiological control system.								
Course Outcomes: At the end of this course, learners will be able to: • Develop mathematical model for a given system • Determine and analyze the time domain specifications of different systems • Perform stability analysis of the given system using various techniques. • Determine and Analyze the frequency domain specifications of the different systems • Explain the concept and model of physiological control systems								
Unit I	CONTROL SYSTEM MODELING						12	
Terminology and basic structure of control system, example of a closed loop system, transfer function, modeling of electrical systems, translational and rotational mechanical systems, and electromechanical systems, block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph, conversion of block diagram to signal flow graph. Need for modeling physiological system.								
Unit II	TIMERESPONSE ANALYSIS						12	
Step and impulse responses of first order and second order systems, determination of time domain specifications of first and second order systems from its output responses, definition of steady state error constants and its computations. Introduction to PI,PD and PID controllers.								
Unit III	STABILITY ANALYSIS						12	
Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability, definition of dominant poles and relative stability.								
Unit IV	FREQUENCY RESPONSE ANALYSIS						12	
Frequency response, Nyquist stability criterion, Nyquist plot and determination of closed loop stability, definition of gain margin and phase margin, Bode plot, determination of gain margin and phase margin using Bode plot, use of Nichol's chart to compute frequency and bandwidth.								
Unit V	PHYSIOLOGICAL CONTROL SYSTEM						12	
Example of physiological control system, difference between engineering and physiological control systems, generalized system properties, models with combination of system elements, linear models of physiological systems-Examples, introduction to simulation. Illustration with real time applications.								
TEXT BOOK(S): 1. J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 6th Edition, 2008. 2. Michael C K Khoo, "Physiological control systems", IEEE Press, Prentice Hall of India, 2005.								



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REFERENCE(S):

1. FaridGolnaraghi, Benjamin C. Kuo, "Automatic Control Systems", Wiley, 9 th Edition, 2014.
2. M. Gopal, "Control System, Principles and Design", McGraw-Hill, 2012
3. Constantine H.Houpis, Stuart N. Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Press, 6th Edition, 2013.
4. Richard C.Dorf& Robert H. Bishop, "Modern Control Systems", Prentice Hall, 12 th Edition, 2010
5. Joseph J.DiStefano, Allen R.Stubberud, Schaum's, "Outline of Feedback and Control Systems", McGraw-Hill Education, 2nd Edition, 2013.



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM502	BIOMECHANICS	3	0	1	4	60	100	
Course Objective (s): The purpose of learning this course is to • Discuss the mechanics of physiological systems. • Study about the mechanics involved with various physiological systems. • To gain knowledge in deriving the mathematical models related to blood vessels • To Study the deformability, strength, and visco elasticity of hard and flexible tissues • Illustrate the mathematical models used in the analysis of biomechanical systems								
Course Outcomes: At the end of this course, learners will be able to: • Understand the use of mechanics in medicine. • Understand the mechanics of physiological systems. • Distinguish the reason for abnormal patterns. • Analyze the biomechanical systems using mathematical models. • Design and develop the models specific to orthopedic applications.								
Unit I	INTRODUCTION						12	
Scope of mechanics in medicine, mechanics of bone structure, determination of in-vivo elastic modulus. Bio fluid mechanics, flow properties of blood. Anthropometry.								
Unit II	MECHANICS OFPHYSIOLOGICALSYSTEM						12	
Heart valves, power developed by the heart, prosthetic valves. Constitutive equations for soft tissues, dynamics of fluid flow in cardiovascular system and effect of vibration - shear stresses in extra-corporeal circuits.								
Unit III	ORTHOPAEDIC MECHANICS						12	
Mechanical properties of cartilage, diffusion properties of articular cartilage, mechanical properties of bone, kinetics and kinematics of joints, Lubrication of joints.								
Unit IV	MATHEMATICAL MODELS						12	
Introduction to Finite Element Analysis, Mathematical models - pulse wave velocities in arteries, determination of in-vivo elasticity of blood vessel, dynamics of fluid filled catheters.								
Unit V	ORTHOPAEDICAPPLICATIONS						12	
Dynamics and analysis of human locomotion - Gait analysis (determination of instantaneous joint reaction analysis), occupant response to vehicular vibration. Mechanics of knee joint during standing and walking.								
TEXT BOOK(S): 1. Y.C.Fung, "Bio-Mechanics, "Mechanical Properties ofTissues", Springer-Verilog, 1998. 2. C. Ross Ether and Craig A.Simmons, "Introductory Biomechanics from cells to organisms", Cambridge University Press, New Delhi, 2009.								
REFERENCE(S): 1. Susan J Hall, "Basics of Biomechanics", McGraw Hill Publishing.co. New York, 5 th Edition, 2007. 2. DhanjooN.Ghista, "Orthopaedic Mechanics", Academic Press, 1990. 3. Joseph D.Bronzino, "Biomedical Engineering Fundamentals", Taylor& Francis, 2006. 4. John Enderle, Susanblanchard, Joseph Bronzino, "Introduction to Biomedical Engineering", Elsevier, 2005.								

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM503	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	3	0	1	4	60	100	
Course Objective (s): The purpose of learning this course is to - Know the various bio potential recordings so as to enable students to record various bio signals, - Know the various functional blocks present in cardiac care units so that the students can handle these equipments with care and safety. - Develop an understanding of the physiotherapy and diathermy equipment so that the student can learn to operate. - Study the concept of various assist devices so as to enable the students to develop new assist devices. - Introduce the recent trends in field of diagnostic and therapeutic equipments.								
Course Outcomes: At the end of this course, learners will be able to: - Describe the working and recording setup of all basic cardiac equipment - Interpret the various assist devices used in the hospitals - understand the recording of diagnostic and therapeutic equipment's related to stimulation - Discuss the various extracorporeal and special diagnostic devices used in hospitals - Outline the importance of patient safety against electrical hazard								
Unit I	CARDIAC CARE UNITS						12	
Pacemakers – Need for pacemaker, different types and their comparison, batteries for pacemakers. Defibrillator- Need, AC defibrillators and demerits, DC Defibrillator, asynchronous and synchronous DC defibrillators, Hazards and safety issues, patient monitoring system.								
Unit II	ASSIST DEVICES						12	
Heart lung machines - Need for the unit, functioning of bubble, disc type and membrane type oxygenators, fingerpump, roller pump, electronic monitoring of functional parameter. Spirometer, Respiratory volume measurement, pneumograph, artificial respirator – IPR type, functioning, Pulse Oximetry. Indication and Principle of Hemodialysis, Membrane, Dialysate, Different types of hemodialysers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type								
Unit III	STIMULATORS						12	
Electrical stimulators: Strength-duration curve, types of stimulators, an electrodiagnostic / therapeutic stimulator. Nerve-muscle stimulator: peripheral nerve stimulator, Ultrasonic stimulators, stimulators for pain and relief.								
Unit IV	PATIENT MONITORING AND BIOTELEMETRY						12	
Patient monitoring systems, ICU/CCU Equipments, bed side monitors, Infusion pumps, Central console controls. Radio Telemetry (single, multi), Portable and Landline Telemetry unit, Applications in ECG and EEG Transmission.								
Unit V	RECENT DEVICES						12	
Principles and application of thermography, Detection circuits, Principles of cryogenic Technique and application, principles of Fiber optic cables, Endoscopy, Laparoscopy, principles of Lithotripsy.								
TEXT BOOK(S): - John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd, New Delhi, 2015 - Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012.								
REFERENCE(S): - Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015. - Khandpur R.S, "Handbook of Biomedical Instrumentation", 3rd edition, Tata McGraw-Hill, New Delhi, 2014. - L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008. - Antony Y.K.Chan "Biomedical Device Technology, Principles and design" Charles Thomas Publisher Ltd, Illinois, USA, 2008.								



Department	BIOMEDICAL ENGINEERING						R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks		
		L	T	P	C				
19BM504	BIOMEDICAL INSTRUMENTATION	3	0	0	3	45	100		
Course Objective (s): The purpose of learning this course is to • Illustrate origin of bio potentials and its propagations • understand the different types of electrodes and its placement for various recordings • design bio amplifier for various physiological recordings • Learn the different measurement techniques for non-physiological parameters. • Summarize different biochemical measurements									
Course Outcomes: At the end of this course, learners will be able to: • Differentiate different bio potentials and its propagations • Illustrate different electrode placement for various physiological recordings • Design bio amplifier for various physiological recordings • Explain various technique for non-electrical physiological measurement0073 • Demonstrate different biochemical measurement techniques.									
Unit I	MEDICAL INSTRUMENTATION							9	
Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, PC based medical Instruments, General constraints in design of medical Instrumentation system, Regulation of Medical devices.									
Unit II	BIOPOTENTIAL MEASUREMENTS							9	
Bio signals characteristics - frequency and amplitude ranges. ECG - Einthoven's triangle, standard 12 lead system, Principles of vector cardiography.EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG - unipolar and bipolar mode. Recording of ERG, EOG and EGG									
Unit III	BIOELECTRIC SIGNALS AND BIOELECTRIC AMPLIFIERS							9	
Origin of bioelectric signals, Electrodes, Electrode-tissue interface, Galvanic Skin Response, BSR, Motion artifacts, Need for bio-amplifier , Instrumentation amplifiers, isolation amplifiers, differential bio-amplifier, Right leg driven ECG amplifier, Special features of bioelectric amplifiers.									
Unit IV	MEASUREMENT OF NON - ELECTRICAL PARAMETERS							9	
Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers, Systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.									
Unit V	PATIENT MONITORING SYSTEMS							9	
Cardiac monitor, Selection of system parameters, Bedside monitors, Central monitors, Heart rate meter, Pulse rate meter, Measurement of respiration rate, Holter monitor and Cardiac stress test, Catheterization Laboratory Instrumentation , Organization and equipments used in ICCU & ITU									
TEXT BOOK(S): 1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology", Pearson Education, 4th Edition, 2014. 2. John G.Webster, "Medical Instrumentation Application and Design", John Wiley and Sons, New York, 4 th Edition, 2009.									
REFERENCE(S): 1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3 rd Edition, 2014 2. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", John Wiley and Sons, 3 rd Edition, Reprint 2008 3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Pearson Education India, 2 nd Edition, 2015. 4. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill Publisher, 2003									

Department	BIOMEDICAL ENGINEERING					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM505	BIOSIGNAL PROCESSING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand characteristics of some of the most commonly used biomedical signals, including ECG, EEG, EOG and EMG.
- To learn linear and non-linear filtering techniques to extract desired information
- Understand choice of filters to remove noise and artifacts from biomedical signals
- Analyze various biomedical signals through advanced techniques.
- To understand various techniques for automated classification and decision making to aid diagnosis

Course Outcomes: At the end of this course, learners will be able to:

- Preprocess the Bio signals
- Use different filters on biomedical signals and judge filter performance
- Apply wavelet detection techniques for bio signal processing.
- Use different filters on biomedical signals and judge filter performance.
- Extract the features using multivariate component analysis

Unit I INTRODUCTION TO BIOMEDICAL SIGNALS

9

Biosignal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrogastrogram (EGG), Electroneurogram (ENG), Event related potentials (ERPs), Phonocardiogram (PCG), Speech signal, Objectives of Biomedical signal analysis, Difficulties in Biomedical signal analysis, Computer-aided diagnosis.

Unit II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION

9

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

Unit III ADAPTIVE FILTERING AND WAVELET DETECTION

9

Filtering – LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in ECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

Unit IV BIOSIGNAL CLASSIFICATION AND RECOGNITION

9

Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats.

Unit V TIME FREQUENCY AND MULTIVARIATE ANALYSIS

9

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA.

TEXT BOOK(S):

1. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida, 1999.
2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis-A case study approach", Wiley, 2nd Edition, 2016.

REFERENCE(S):

1. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003.
2. KayvanNajarian and Robert Splerstor, "Biomedical signals and Image processing", CRC - Taylor and Francis, New York, 2nd Edition, 2012.
3. K.P.Soman, K.Ramachandran, "Insight into wavelet from theory to practice", PHI, New Delhi, 3 rd Edition, 2010.
4. D.C.Reddy, "Biomedical Signal Processing - Principles and Techniques", Tata McGraw-Hill Publishing Co. Ltd, 2005.

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester V	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS05	QUANTITATIVE APTITUDE AND LOGICAL REASONING – III	2	0	0	0	30	100	
Course Objective (s): The purpose of learning this course is to • Design to help people make sense of numerical data. • Calculate the calendars and series in simplified way. • Understand the concept of the interest amount in SI and CI. • Know the procedure to deal with a situation and sufficient to determine the answer. • Teach seating arrangements in rows or in small groups.								
Course Outcomes: At the end of this course, learners will be able to: • Demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken to solve Aptitude Questions. • Solve the question based on calendar, odd man out and series by using shortcut methods. • Calculate the interest by using shortcut methods instead of traditional methods. • Induce their critical thinking by solving the syllogism and course of action. • Analyze the conditions and do interpretation.								
Unit I	DATA INTERPRETATION & CLOCKS						6	
DATA INTERPRETATION: Tabulation - Bar graphs - Pie charts - Line graphs. CLOCKS: Definition - Important points - Angular difference between two hands at different timings - incorrect clock.								
Unit II	CALENDARS, ODDMAN OUT & SERIES						6	
CALENDARS: Odd days - Leap year - Ordinary year - Counting of odd days - Day of the week. ODDMAN OUT & SERIES: Odd man out - Power series - Number series - Sequence of real numbers.								
Unit III	SIMPLE & COMPOUND INTEREST						6	
SIMPLE INTEREST: Principal - Rate of interest - Number of years - Using formulae and shortcuts methods. COMPOUND INTEREST: Compounded Annually - Compounded Half-Yearly - Compounded Quarterly - Compounded annually - Rates are different for different years.								
Unit IV	STATEMENT & COURSE OF ACTION, SYLLOGISM						6	
STATEMENT AND COURSE OF ACTION: Courses of action - Decision taken - Improvement, Follow-up or further action in regard to the given statement. SYLLOGISM/ LOGICAL VENN DIAGRAMS: Relationship between the two things or not - Classification of pro positions - Immediate deductive inference - Immediate deductive inference.								
Unit V	SEATING ARRANGEMENTS & DATA SUFFICIENCY						6	
SEATING ARRANGEMENTS: Persons seating in the circular - Rectangular - Square. DATA SUFFICIENCY: Reasoning ability using a set of directions.								
REFERENCE(S): 1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012 2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012. 3. R.V.Praveen, "Quantitative Aptitude and Reasoning" Third Edition, PHI Learning, 2016. 4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017. 5. Arun Sharma "How to Prepare for Quantitative Aptitude" Eight Edition, McGraw Hill Education, 2018. 6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication, 2020.								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM506	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Demonstrate recording and analysis of different Bio potentials
- Provide practice on recording and analysis of different Bio potentials
- Study the function of different therapeutic equipments.
- Examine different therapeutic modalities

Course Outcomes: At the end of this course, learners will be able to:

- Measure different bioelectrical signals using various methods
- Assess different non-electrical parameters using various methodologies
- Illustrate various diagnostic and therapeutic techniques
- Examine the electrical safety measurements
- Analyze the different bio signals using suitable tools.

Name of Experiments

1. Measurement of visually evoked potential
2. Galvanic skin resistance (GSR) measurement
3. Study of shortwave and ultrasonic diathermy
4. Measurement of various physiological signals using biotelemetry
5. Study of hemodialysis model
6. Electrical safety measurements
7. Measurement of Respiratory parameters using spirometry.
8. Study of medical stimulator
9. Analyze the working of ESU - cutting and coagulation modes
10. Recording of Audiogram
11. Study the working of Defibrillator and pacemakers
12. Analysis of ECG, EEG and EMG signals
13. Study of ventilators
14. Study of Ultrasound Scanners
15. Study of heart lung machine model

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	Visually evoked potential setup	1
2.	GSR setup	1
3.	Multi-output power supply (+15v, -15v, +30V variable, +5V, 2A)	1
4.	Short wave Diathermy & Ultrasound diathermy	1
5.	Multiparameter biotelemetry system	1
6.	Electrical Safety Analyser	1
7.	Spirometry with associated analysis system	1
8.	Medical stimulator	1
9.	Surgical diathermy with analyzer	1
10.	Audiometer	1
11.	Pacemaker	1
12.	Defibrillator	1
13.	Haemodialysis model	1
14.	Ventilator	1
15.	Ultrasound Scanner	1



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester V	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM507	BIOMEDICAL INSTRUMENTATION LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Study and design Bio amplifiers
- Provide hands on training on Measurement of physiological parameters
- Estimation of haematological parameters
- Learnt the analysis of visual and hearing test

Course Outcomes: At the end of this course, learners will be able to:

- Design preamplifiers and amplifiers for various bio signal recordings
- Measure various non-electrical parameters using suitable sensors/transducers
- Record and analyze pulse rate and respiration rate
- Measure blood pressure and blood flow

Name of Experiments

1. Design of low noise pre-amplifier.
2. Design of ECG amplifier and Measurement of heart rate.
3. Design of EMG amplifier.
4. Measurement of heart sounds using PCG.
5. Measurement of pulse-rate using Photo transducer.
6. Measurement of respiration rate.
7. Measurement of blood flow velocity using ultrasound transducer.
8. Measurement of blood pressure using sphygmomanometer.
9. Study of characteristics of optical Isolation amplifiers.
10. Measurement of vital parameters using Patient Monitoring System
11. Study of Biotelemetry

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	pH meter and conductivity meter	1
2.	Photo transducer for pulse measurement	1
3.	Sphygmomanometer and Stethoscope	1
4.	Multiparameter (ECG, EMG, EEG) Simulator	1
5.	Spirometry with associated analysis system	1
6.	Blood flow measurement system	1
7.	Function generator	8
8.	DSO	8
9.	Regulated Power supplies	8
10.	Bread boards	8
11.	IC LM 324, AD 620, IC555	20
12.	Opto Isolator IC: MCT2E	1
13.	INA series (126,128 etc.)	20



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester V	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM508	HOSPITAL TRAINING	0	0	2	1	30	100	

Course Objective(s): The purpose of learning this course is to

- Observed Medical professionals at work in the wards and the roles of Allied Health Professionals,
- Provide access to Healthcare Professionals to get a better understanding of their work,
- Demonstrate patient – care in a hospital setting,
- Guide on the various procedures for validation of the product and analyze the cost effectiveness,
- Familiar with various medical imaging techniques and Gain some practical experience in servicing the equipments.

Course Outcomes: At the end of this course, learners will be able to:

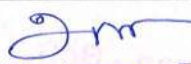
- Advocate a patient – centred approach in health care
- Communicate with other health professionals in a respectful and responsible manner
- Recognize the importance of inter professionals collaboration in healthcare
- Propose a patient – centred inter professionals health improvement plan based upon the patientsperceived needs

SYLLABUS

- Students need to complete training in any leading Multi speciality hospital for a period of 5 days — 15 days. They need to prepare an extensive report and submit to their respective course in-charges during the session,
- Out of the following departments, it is mandatory to complete training in any 5. The students can give a presentation of the remaining departments during laboratory hours.
 1. Cardiology
 2. ENT
 3. Ophthalmology
 4. Orthopedic and Physiotherapy
 5. ICU / CCU
 6. Operation Theatre
 7. Biomedical Engineering
 8. Histo Pathology
 9. Biochemistry
 10. Medical Records / Biotelemetry
 11. Neurology
 12. Nephrology
 13. Radiology
 14. Nuclear Medicine
 15. Pulmonology
 16. Urology
 17. Obstetrics and Gynecology
 18. Emergency Medicine
 19. Histo Pathology
 20. Paediatric / Neonatal
 21. Dental
 22. Oncology
 23. PAC's

Department	BIOMEDICAL ENGINEERING					R 2019	Semester V	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HS501	CAREER SKILLS	0	0	2	0	30	100	
Course Objective(s): The purpose of learning this course is to - Acquire soft skills, - Make effective presentations in general and technical, - Motivate learners to participate effectively in Group Discussion, - Develop their confidence and help them attend interviews successfully, - Enhance the Employability and Career Skills of students.								
Course Outcomes: At the end of this course, learners will be able to: - Develop adequate Soft Skills required for the workplace, - Make effective presentations, - Participate confidently in Group Discussions, - Develop their confidence and help them attend interviews successfully, - Make them Employability Graduates.								
Unit I	SOFT SKILLS						6	
Introduction to Soft Skills – Hard skills & soft skills – Employability and career Skills – Grooming as a professional with values – Time Management – General awareness of Current Affairs.								
Unit II	SPEAKING						6	
Self-Introduction – Organizing the material – Introducing oneself to the audience – Introducing the topic – Answering questions – Individual presentation practice – Presenting the visuals effectively – 5 minute presentations								
Unit III	GROUP DISCUSSION						6	
Introduction to Group Discussion – Participating in group discussions – Understanding group dynamics – Brainstorming the topic – Questioning and clarifying – GD strategies – Activities to improve GD skills.								
Unit IV	INTERVIEW SKILLS						6	
Interview etiquette – Dress code – Body language – Attending job interviews – Telephone / Skype interview – One to one interview & Panel interview – FAQs related to job interviews.								
Unit V	CAREER PLANNING						6	
Recognizing differences between groups and teams – Managing time – Managing stress – Networking professionally – Respecting social protocols – Understanding career management – Developing a long term career plan – Making career changes.								
LEARNING RESOURCES:								
REFERENCES:								
1. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015,								
2. Interact English Lab Manual for Undergraduate Students, Orient Black Swan: Hyderabad, 2016,								
3. E. Suresh Kumar et al. Communication for Professional Success. Orient Black swan: Hyderabad, 2015,								
4. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014,								
5. S. Hariharanetal. Soft Skills. MJP Publishers: Chennai, 2010.								
Web Sources:								
http://www.slideshare.net/rohitjsh/presentation-on-group-discussion http://www.washington.edu/doit/TeamN/present_tips.html								
http://www.oxforddictionaries.com/words/writing-job-applications http://www.kent.ac.uk/careers/cv/coveringletters.htm								
http://www.mindtools.com/pages/article/newCDV_34.htm								


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM601	MEDICAL IMAGE PROCESSING	3	0	0	3	45	100	
Course Objective(s): The purpose of learning this course is to - Understand the generation of X-ray and its uses in imaging - Describe the principle of Computed Tomography. - Know the techniques used for visualizing various sections of the body. - Learn the principles of different radio diagnostic equipment in Imaging - Discuss the radiation therapy techniques and radiation safety.								
Course Outcomes: At the end of this course, learners will be able to: - Discuss the principle and working of various radiography equipments, - Explain the tomography concept and image reconstruction techniques, - Describe the basic principle and working of Magnetic resonance imaging technique, - Explain the concept of nuclear imaging techniques and radiation detectors, - Demonstrate the effects of radiation, radiation safety and the principle of Radio therapy techniques,								
Unit I	INTRODUCTION AND FUNDAMENTALS						9	
Origin of DIP, examples of fields that use DIP, fundamentals of DIP, components of an DIP system, Digital image representation, Image characteristics & quality, Image viewing conditions, Elements of visual perception, light and the EM spectrum, a simple image formation model, image sampling and quantization, some basic relationships between pixels.								
Unit II	IMAGE ENHANCEMENT IN SPATIAL DOMAIN & FREQUENCY DOMAIN						9	
Image Enhancement in Spatial Domain: Background, some basic gray level transformations, Histogram processing, enhancement using arithmetic and logic operations, basic of spatial filtering, smoothing spatial filters, sharpening spatial filters. Image Enhancement in the Frequency Domain: Background, Introduction to FT and frequency domain, smoothing frequency domain filters, sharpening frequency domain filters, homomorphic filtering, additional properties of the 2-D FT, convolution and correlation theorems.								
Unit III	IMAGE COMPRESSION						9	
Fundamentals, image compression models, elements of information theory, error free Compression, run length coding, loss less predictive coding, lossy predictive coding, image compression standards, JPEG, video compression standards.								
Unit IV	IMAGE SEGMENTATION						9	
Detection of discontinuities, point detection, line detection, edge detection, gradient operators, laplacian, edge linking and boundary detection, thresholding, region based segmentation.								
Unit V	IMAGE REPRESENTATION, DESCRIPTION AND RECOGNITION						9	
Representation, Boundary descriptors, Regional descriptors, Principal component analysis, Recognition based on decision theoretic & structural methods.								
TEXT BOOK(S):								
1. Wolfgang Birkfellner, "Applied Medical Image Processing – A Basic course", CRC Press, 2011,								
2. KavyanNajarian and Robert Splerstor," Biomedical signals and Image processing",CRC – Taylor and Francis,New York,2006.								
REFERENCE(S):								
1. P. Suetens, Fundamentals of image processing, Cambridge University Press, 2002								
2. R. C. Gonzalez, R. E. Woods, S. L. Eddins , Digital Image Processing Using MATLAB(R) ,Course Technology, 1 edition, 2004								
3. Jerry L.Prince and Jnathan M.Links," Medical Imaging Signals and Systems"- Pearson Education Inc. 2006.								
4. Chanda & Majumdar, Digital image processing and analysis, PHI, 2003								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM602	HEALTH CARE ANALYTICS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Understand the health data formats, health care policy and standards, - Learn the significance and need of data analysis and data visualization, - Understand the health data management frameworks, - Learn the use of machine learning and deep learning algorithms in healthcare, - Apply healthcare analytics for critical care applications.								
Course Outcomes: At the end of this course, learners will be able to: - Use machine learning and deep learning algorithms for health data analysis, - Apply the data management techniques for healthcare data, - Evaluate the need of healthcare data analysis in e-healthcare, telemedicine and other critical care applications, - Design health data analytics for real time applications, - Design emergency care system using health data analysis.								
Unit I	INTRODUCTION TO HEALTHCARE ANALYSIS							9
Overview – History of Healthcare Analysis Parameters on medical care systems – Health Care Policy – Standardized Code Sets – Data Formats – Machine Learning Foundations: Tree Like reasoning , Probabilistic reasoning and Bayes Theorem, Weighted sum approach.								
Unit II	HEALTH CARE MANAGEMENT							9
IOT – Smart Sensors – Migration of Healthcare Relational database to NoSQL Cloud Database – Decision Support System – Matrix block Cipher System – Semantic Framework Analysis – Histogram bin Shifting and Rc6 Encryption – Clinical Prediction Models – Visual Analytics for Healthcare.								
Unit III	HEALTHCARE AND DEEP LEARNING							9
Introduction on Deep Learning – DFF network CNN – RNN for Sequences – Biomedical Image and Signal Analysis – Natural Language Processing and Data Mining for Clinical Data – Mobile Imaging and Analytics – Clinical Decision Support System.								
Unit IV	MACHINE LEARNING IN HEALTH CARE							9
Introduction – Medical Imaging and Diagnosis – Medical Data – Treatment and Prediction of Disease – Smart Health Records – Clinical Trial and Research – Personalized Medicine.								
Unit V	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING APPLICATIONS							9
Predicting Mortality for cardiology Practice – Smart Ambulance System using IOT – Hospital Acquired Conditions (HAC) program – Healthcare and Emerging Technologies – ECG Data Analysis.								
TEXT BOOK(S):								
1. Chandan K.Reddy, Charu C. Aggarwal, "Health Care data Analysis", First edition, CRC, 2015.								
2. Nilanjan Dey, Amira Ashour, Simon James Fong, Chintan Bhatl, "Health Care Data Analysis and Management, First Edition, Academic Press, 2018.								
3. Vikas Kumar, "Health Care Analysis Made Simple", Packt Publishing, 2018								
REFERENCE(S):								
1. Kulkarni, Siarry, Singh ,Abraham, Zhang, Zomaya , Baki, "Big Data Analytics in HealthCare", Springer, 2020								
2. Hui Jang, Eva K.Lee, "HealthCare Analysis: From Data to Knowledge to Healthcare Improvement", First Edition. Wiley. 2016.								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM603	PATTERN RECOGNITION AND NEURAL NETWORKS	3	0	0	3	45	100	
Course Objective(s): The purpose of learning this course is to - Study the fundamentals of pattern recognition and its application, - learn algorithms suitable for pattern classification, - Understand the applications of pattern recognition, - Understand the classification in image processing and computer vision, - Discuss the radiation therapy techniques and radiation safety.								
Course Outcomes: At the end of this course, learners will be able to: - Classify patterns using statistical pattern classifier. - Perform unsupervised classification using clustering techniques, - Explain the fundamentals of neural networks, - Design Back Propagation and Hopfield network, - Perform classification using competitive neural networks.								
Unit I	SUPERVISED LEARNING							9
Overview of Pattern recognition, Types of Pattern recognition, Parametric and Nonparametric approach, Bayesian classifier, Discriminant function, non-parametric density estimation, histograms, kernels, window estimators, k- nearest neighbor classifier, estimation of error rates.								
Unit II	UNSUPERVISED LEARNING AND CLUSTERING ANALYSIS							9
Unsupervised learning – Hierarchical clustering – Single – linkage Algorithm, Complete – linkage Algorithm, Average – Linkage Algorithm and Ward’s method. Partitional clustering – Forgy’s Algorithm and k-means algorithm. Case studies.								
Unit III	INTRODUCTION TO NEURAL NETWORK							9
Elementary neurophysiology and biological neural network –Artificial neural network – Architecture, biases and thresholds, Hebb net, Perceptron, Adaline and Madaline.								
Unit IV	BACK PROPAGATION NETWORK AND ASSOCIATIVE MEMORY							9
Back propagation network, generalized delta rule, Bidirectional Associative memory, Hopfield Network.								
Unit V	NEURAL NETWORKS BASED ON COMPETITION							9
Kohonen Self organizing map, Learning Vector Quantisation, Counter Propagation network, Case studies.								
TEXT BOOK(S):								
1. Duda R.O, Hart P.G, “Pattern Classification and scene analysis”, Wiley Edition, 2000.								
2. Earl Gose, Richard Johnsonbaugh Steve Jost, “Pattern Recognition and Image Analysis”, Prentice Hall of India Pvt Ltd., New Delhi, 1999.								
3. Freeman J. A., and Skapura B.M, “Neural networks, algorithms, applications and programming techniques”, Addison- Wesley, 2003								
REFERENCE(S):								
1. Hagan, Demuth and Beale, “Neural Network Design”, Vikas Publishing House Pvt Ltd., New Delhi, 2002.								
2. Robert Schalkoff, “Pattern recognition, Statistical, Structural and neural approaches”, John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2005.								
3. Laurene Fausett, “Fundamentals of Neural Networks- Architectures, Algorithms and Application”, Prentice Hall, 1994.								

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	EEC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19TPS06	QUANTITATIVE APTITUDE AND LOGICAL REASONING – IV	2	0	0	0	30	100	
Course Objective (s): The purpose of learning this course is to • Ascertains the occurrence of an event on the basis of already present information, • Use area models to represent the distributive property in mathematical reasoning, • Calculate the work capacity by chocolate based method, • Work with time, speed and distance by relative speed concepts, • Determine how various phenomena are related.								
Course Outcomes: At the end of this course, learners will be able to: • Know the outcome of an event developed the concept of probability, • Calculate the area and surface volume in real time application, • Understand the concepts of Times and Work and Pipes and Cistern and Correlating the Concepts of both, • Know the concepts of Time, Speed and Distance and concepts of Boats and Streams, • Analyze the cause and effect of problems by using critical thinking,								
Unit I	PROBABILITY & PERMUTATIONS & COMBINATIONS							6
PROBABILITY: Rolling an unbiased dice – Tossing a fair coin – Drawing a card from a pack of well shuffled cards – Picking up balls of certain color from a bag containing balls of different colors. PERMUTATIONS: Numbers with digits – Words with letters – Arrangements of person in a row – Arrangements of books on a shelf. COMBINATIONS: Formation of committee – Selection of questions from question papers.								
Unit II	AREA & VOLUME							6
AREA: Area – Perimeter – Important points about triangle – Quadrilateral – Fast track techniques. VOLUME: Cuboids – Cube – Cylinder – Cone – Frustum of a cone – Sphere – Hemisphere – Pyramid – their formulas.								
Unit III	TIME & WORK, PIPE & CISTERNS							6
TIME AND WORK: Introduction – Basic concepts – Leaving and joining – Alternative days – In between days the works starting and ending. PIPES AND CISTERNS: Introduction - Basic concepts – Capacity of the total liters –Water flow in the tank.								
Unit IV	TIME & DISTANCE, TRAINS, BOATS AND STREAMS							6
TIME AND DISTANCE: Definition – Average speed – Distance covered is same – Distance covered is different – Stoppage time per hour for a train – Time taken with two different modes of transport – Time and distance between two moving bodies. PROBLEMS ON TRAINS: Basic concepts – Basic formulae – Different types of objects –Two trains crossing each other in both directions – Shortcuts. BOATS AND STREAMS: Introduction – Speed of man (boat and streams) – Moving same and opposite directions – Important formulae.								
Unit V	STATEMENT – CONCLUSION , ARGUMENTS, CAUSE & EFFECT, ASSERTION AND REASON							6
STATEMENT AND CONCLUSION: Statement to be true – Two conclusions together – Logically follows. STATEMENT AND ARGUMENTS: Arguments strong with respect to the statement. CAUSE AND EFFECT: Cause and effect relationship between the two statements. ASSERTION AND REASON: Assertion (A) and Reason(R) – Both (A) and (R) are individually true and (R) - (A) is true but (R) is false – (A) is false but (R) is true.								

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REFERENCE(S):

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Tata McGraw-Hill Publishing Company Ltd, 2012
2. Arun Sharma, How to prepare for Data Interpretation for the CAT, First Edition, Tata McGraw-Hill Publishing Company Ltd, 2012.
3. R.V.Praveen, "Quantitative Aptitude and Reasoning" Third Edition, PHI Learning, 2016.
4. Dr.R S Aggarwal, Quantitative Aptitude, Revised and Enlarged Edition, S.Chand Publishing Company Ltd, 2017.
5. Arun Sharma "How to Prepare for Quantitative Aptitude" Eight Edition, McGraw Hill Education, 2018.
6. "Reasoning and Aptitude" for GATE and ESE Prelims, Made Easy Publication, 2020



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM604	BIO SIGNAL AND IMAGE PROCESSING LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Understand the analysis of bio signals,
- Understand the extraction of features in bio signals,
- Develop algorithms for power spectral density and classification of bio signals,
- Enhance the medical images by applying various filters,
- Segment the region of interest using various image processing algorithms.

Course Outcomes: At the end of this course, learners will be able to:

- Develop algorithms for preprocessing of Bio signals,
- Analyze the spectral characteristics of Bio signals,
- Develop algorithm for enhancement of medical images,
- Extract the region of interest from medical images,
- Perform the compression of medical images.

Name of Experiments

1. Preprocessing of Bio signals
2. Analysis of ECG signals – Removal of artifacts like power line interference, baseline, electrodemovement, wandering etc. and study of abnormalities in ECG pattern - using LABVIEW / MATLAB.
3. Analysis of EEG Signal – Extraction of rhythms (delta, theta, alpha, beta and gamma waves), calculate Power spectral density in each rhythms using LABVIEW / MATLAB Analysis of EEGbands.
4. Feature extraction in EMG signals
5. Preprocessing of medical images.
6. Denoising of medical images.
7. Image Enhancement using Python
8. Human Joint angle measurements using standard Goniometer
9. Human Joint angle measurements using electronic Goniometer
10. Study of DICOM standards.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	PCs with related accessories (Intel CORE 2 Duo(Minimum) or Intel I5, I7(latest), RAM2GB (Minimum), Hard Disk – 1TB)	1
2.	MATLAB (Latest Version) 17A or 18, Image processing tool box	1



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM605	MINI PROJECT	0	0	2	1	30	100	
Course Objective (s): The purpose of learning this course is to - Develop skills to formulate a technical project, - Estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model of a Biomedical / Electronics / Mechatronics / Instrumentation system, - Teach use of new tools, algorithms and techniques required to carry out the projects, - Give guidance on the various procedures for validation of the product and analyze the cost effectiveness, - Enabling the students to gain experience in organization and implementation of a small project and thus acquire the necessary confidence to carry out main project in the final year, - Provide guidelines to prepare technical report of the project								
Course Outcomes: At the end of this course, learners will be able to: - Formulate a real world problem, identify the requirement and develop the design solutions - Express the technical ideas, strategies and methodologies - Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project - Test and validate through conformance of the developed prototype and analysis the cost effectiveness - Prepare report and present the oral demonstrations								
Guidelines - Students should select a problem which addresses some basic home, office or other real life applications, - The circuit for the selected problem should have at least 20 to 25 components, - Students should understand testing of various components, - Students should develop a necessary circuit, - Students should see that final circuit submitted by them is in working condition, 5 – 25 pages report to be submitted by students, - Group of maximum four students can be permitted to work on a single mini project, - The mini project must have hardware part. The software part is optional, - Department may arrange demonstration with poster presentation of all mini projects developed by the students at the end of semester, - It is desirable that the electronic circuit/systems developed by the students have some novel features, - Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism, - Marks for the mini-project shall be awarded based on the evaluation of Mini-Project Report, Presentation skill and Question and Answer session								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VII	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM701	RADIOLOGICAL EQUIPMENTS	3	0	1	4	60	100	
Course Objective(s): The purpose of learning this course is to - Understand the generation of X-ray and its uses in imaging, - Describe the principle of Computed Tomography, - Know the techniques used for visualizing various sections of the body, - Learn the principles of different radio diagnostic equipment in Imaging, - Discuss the radiation therapy techniques and radiation safety.								
Course Outcomes: At the end of this course, learners will be able to: - Discuss the principle and working of various radiography equipments, - Explain the tomography concept and image reconstruction techniques, - Describe the basic principle and working of Magnetic resonance imaging technique, - Explain the concept of nuclear imaging techniques and radiation detectors, - Demonstrate the effects of radiation, radiation safety and the principle of Radio therapy techniques.								
Unit I	MEDICAL X – RAY EQUIPMENT						12	
Nature of X-rays, X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, Collimator, Bucky Grid, Power Supply. Digital Radiography – Discrete Digital Detectors, Storage Phosphor and Film Scanning. Fluoroscopy – X-ray Image Intensifier tubes – Digital Fluoroscopy. Angiography – Cine Angiography, Digital Subtraction Angiography. Mammography.								
Unit II	COMPUTED TOMOGRAPHY						12	
Principles of tomography, CT Generations – X- Ray sources, collimation, X- Ray Detectors, Viewing systems, Spiral CT Scanning, Ultra Fast CT Scanners. Image Reconstruction Techniques back projection and iterative method.								
Unit III	MAGNETICRESONANCE IMAGING						12	
Fundamentals of Magnetic Resonance – Interaction of Nuclei with static magnetic field and Radiofrequency wave, rotation and precession. Induction of magnetic resonance signals – bulk Magnetization, Relaxation processes T1 and T2. Block Diagram approach of MRI System System Magnet (Permanent, Electromagnet and Super conductors), Gradient Magnetic Fields, Radio Frequency Coils (sending and receiving), Shim Coils and Electronic Components. fMRI.								
Unit IV	NUCLEAR IMAGING SYSTEM						12	
Radio Isotopes – alpha, beta, and gamma radiations. Radiopharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors. Gamma camera – Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit, Pulse Height Analyzer. Principles of SPECT and PET.								
Unit V	RADIATION THERAPY AND RADIATION SAFETY						12	
Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT, Recent Techniques in radiation therapy – 3DCRT – IMRT – IGRT and Cyber knife – Radiation measuring instruments – Dosimeter, film badges, Thermo Luminescent Dosimeters – Electronic Dosimeter – Radiation protection in medicine – Radiation Protection Principles.								
TEXT BOOK(S):								
1. Jerrold T.Bushberg, J.Anthony Seibert, Edwin M.Leidholdt,Jr, John M.Boone, 'The Essential Physics of Medical Imaging", Lippincott Williams and Wilkins, 3rd Edition, 2012.								
2. R.Hendee and Russell Ritenour, "Medical Imaging Physics", William,Wiley- Liss, 4 th Edition, 2002.								
3. Steve Webb, "The Physics of Medical Imaging", Adam Hilger, Philadelphia, 1988.								

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REFERENCE(S):

1. P.Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine concepts and Techniques", Orient Longman, 2007.
2. Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine", Springer, 3 rd Edition 2006.
3. Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.
4. B.H.Brown, PV Lawford, RH Smallwood, DR Hose, DC Barber, "Medical physics and Biomedical Engineering", - CRC Press,1999.



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VII	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM702	HUMAN ASSIST DEVICES	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Understand the various building blocks of Heart lung Machine and its working principle, - Study the working principle of various cardiac assist devices, - Learn the role and working of artificial kidney, - Study the type of assistive devices for rehabilitation, - Study the different types of respiratory assist devices and hearing aids.								
Course Outcomes: At the end of this course, learners will be able to: - Illustrate the various building blocks of Heart lung Machine and its working principle, - Understand the principle and working of various cardiac assist devices, - Understand the role and working of artificial kidney, - Ability to specify the type of assistive devices for rehabilitation, - Categorize the different types of respiratory assist devices and hearing aids.								
Unit I	HEART LUNG MACHINE AND ARTIFICIAL HEART							9
Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Mock test setup for assessing its Functions.								
Unit II	CARDIAC ASSIST DEVICES							9
Synchronous Counter pulsation, Assisted through Respiration Right Ventricular Bypass Pump, Left Ventricular Bypass Pump, Open Chest and closed Chest type, Intra Aortic Balloon Pumping Veno Arterial Pumping, Prosthetic Cardio Valves, Principle and problem, Biomaterials for implantable purposes, its characteristics and testing.								
Unit III	ARTIFICIAL KIDNEY							9
Indication and Principle of Haemodialysis, Membrane, Dialysate, Different types of heamodialysers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.								
Unit IV	PROSTHETIC AND ORTHOTIC DEVICES							9
Arm Replacement - Different Types of Models Externally Powered Limb Prosthesis, Lower Limb and Upper limb orthotic devices, Functional Electrical Stimulation, Sensory Assist Devices, Materials for Prosthetic and orthotic devices, Haptic Devices.								
Unit V	RESPIRATORY AND HEARING AIDS							9
Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, Construction and Functional Characteristics								
TEXT BOOK(S):								
1. Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering –Marcel Dekker Inc New York 2004								
2. John. G. Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2004								
REFERENCE(S):								
1. Andreas.F.Von racum, Hand book of bio material evalution, Mc-Millan publishers, 1980								
2. Albert M.Cook and Webster J.G., Therapeutic Medical Devices, Prentice Hall Inc.,New Jersey,1982								


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VII	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	L	T			
19BM703	HOSPITAL MANAGEMENT	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to • Provide knowledge an overview of hospital administration, • Understand the principles, practices and areas of application in Hospital management, • Learn the quality aspect specified by the international standards, • Enlighten with the Quality and safety issues in hospital, • Understand the principles, practices and areas of application in Hospital Management,								
Course Outcomes: At the end of this course, learners will be able to: • Explain the principles, practices and areas of application in Hospital Management • Understand the biomedical waste disposal concept • Explain the importance of supportive services • Comprehend the quality aspect specified by the international standards. • Knowledge on Hospital safety.								
Unit I	OVERVIEW OF HOSPITAL ADMINISTRATION							9
Distinction between Hospital and Industry, Challenges in Hospital Administration – Hospital Planning – Equipment Planning – Functional Planning – Current Issues in Hospital Management – Telemedicine – Biomedical Waste Management.								
Unit II	HUMAN RESOURCE MANAGEMENT ON HOSPITAL							9
Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD – Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines – Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer.								
Unit III	MARKETING RESEARCH & CONSUMER BEHAVIOUR							9
Marketing Information Systems – Assessing information needs, developing & disseminating information – Market Research process – Other market research considerations – Consumer Markets & Consumer Buyer Behaviour – Model of consumer behaviour – Types of buying decision behaviour – The buyer decision process – Model of business buyer behaviour – Major types of buying situations – Global marketing in the medical sector – WTO and its implications								
Unit IV	HOSPITAL INFORMATION SYSTEMS AND SUPPORTIVE SERVICES							9
Management Decisions and Related Information Requirement – Clinical Information Systems – Administrative Information Systems – Support Service Technical Information Systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy – Food Services – Laundry Services.								
Unit V	QUALITY AND SAFETY ASPECTS IN HOSPITAL							9
Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – Environment Management Systems. NABA, JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care – Medical Audit – Hazard and Safety in a hospital Setup.								
TEXT BOOK(S):								
1. R.C.Goyal, "Hospital Administration and Human Resource Management", Fourth Edition PHI, 2006.								
2. G.D.Kunders, "Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007								
REFERENCE(S):								
1. Arnold D. Kalcizony & Stephen M. Shortell, "Health Care Management", 6 th Edition Cengage Learning, 2011								
2. Blane, David, Brunner, "Health and Social Organization: Towards a Health Policy for the 21st Century" Eric Calrendon Press, 2002								


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VII	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	L	T			
19BM704	REHABILITATION ENGINEERING	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Understand the rehabilitation concepts and Rehabilitation team members for future development and applications, - Understand different types of Therapeutic Exercise Technique, - Understand the tests to assess the hearing loss, - Learn the development of electronic devices to compensate for the loss and various assist devices for visually and auditory impaired, - Study the various orthotic devices and prosthetic devices to overcome orthopedic problems.								
Course Outcomes: At the end of this course, learners will be able to: - Gain adequate knowledge about the needs of rehabilitations and its future development. - Have an in depth idea about Engineering Concepts in Sensory & Motor rehabilitation. Apply the different types of Therapeutic Exercise Technique to benefit the society. - Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society. - Gain in-depth knowledge about different types of models of Hand and arm replacement.								
Unit I	INTRODUCTION TO REHABILITATION							9
Definition – Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation. Rehabilitation team – members and their functions. Rehabilitation care – Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.								
Unit II	ENGINEERING CONCEPTS IN SENSORY REHABILITATION ENGINEERING							9
Sensory augmentation and substitution – Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system – Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution. Tactual system, Tactual augmentation, Tactual substitution, Computerized wheel chairs.								
Unit III	ORTHOPEDIC PROSTHETICS AND ORTHOTICS IN REHABILITATION							9
Engineering concepts in motor rehabilitation, Artificial limbs – body powered, externally powered and controlled orthotics and prosthetics, Myoelectric hand and arm prosthetics. Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS)								
Unit IV	VIRTUAL REALITY IN REHABILITATION							9
Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation								
Unit V	REHABILITATION MEDICINE AND ADVOCACY							9
Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device and provision available in education, job and in day-to-day life.								
TEXT BOOK(S):								
1. Sunder, "Textbooks of Rehabilitation", Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.								
2. Rory A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering)" CRC Press, 2006.								
REFERENCE(S):								
1. Warren E. Finn, Peter G. Lopressor, "Handbook of Neuroprosthetic Methods", CRC, 2002								
2. Joseph D Bronzino, "The Biomedical Engineering Handbook". 2nd edition, CRC Press, 2000.								
3. Robinson C.J, "Rehabilitation Engineering", CRC Press, 2006.								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester VII	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BM705	DATA ACQUISITION AND PROCESSING LABORATORY	0	0	2	1	30	100	

Course Objective (s): The purpose of learning this course is to

- Study the various aspects of acquisition and analysis of bio signals and medical images,
- Understand the importance of electrical safety of medical equipments,
- Study practically the concepts of physiological modeling,
- Engage in lifelong learning to stay current with their profession as it changes,
- Demonstrate professional competence, integrity and responsibility in diverse work environments.

Course Outcomes: At the end of this course, learners will be able to:

- Ability to acquire and analyze any physiological signal and model the physiological systems,
- Apply the techniques of medical image analysis and providing security to medical data
- Be able to identify a data acquisition system.
- Design and develop DATA acquisition and processing solutions by adapting existing tools, designing new ones or a combination of both.
- Be familiar with at least one Medical software package used to view data on a PC.

Name of Experiments

1. Acquisition and analysis of bio signals using workstation,
2. Study of auditory and visual evoked responses,
3. Development of software for basic telemedicine,
4. Development of neural network for signal classification,
5. Acquisition and analysis of medical images,
6. Development of software for medical image compression,
7. Development of algorithm for medical data security,
8. Study of IDL as a tool for medical image analysis,
9. Study of DICOM standards,
10. Study of lung and cardiovascular models,
11. Electrical safety testing of medical equipment.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

S.No	NAME OF THE EQUIPMENT	QUANTITY
1.	PCs with related accessories (Intel CORE 2 Duo(Minimum) or Intel I5, I7(latest), RAM2GB (Minimum), Hard Disk — 1TB)	1
2.	MATLAB (Latest Version) 17A or 18, Image processing tool box	1



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P				
19BMX01	TOTAL QUALITY MANAGEMENT	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Learn the basic concepts of quality and quality from organizational point of view.
- Learn the concept of total quality management from western and Japanese approach.
- Learn the internal politics, quality culture, education and training of the organization.
- Aware of international / national Quality awards.

Course Outcomes: At the end of this course, learners will be able to:

- Students should be able to Quality environment of the organization.
- Student should be able to know the TQM approach for manufacturing/service organization in length
- Student should be able to know various Quality terms like Tolerance and Variability, PDCA cycle, Crosby's 10 points and Deming's 14 Points
- Student should be able to know international/national Quality awards

Unit I | INTRODUCTION

9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints and Customer retention.

Unit II | TQM PRINCIPLES

9

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

Unit III | TQM TOOLS AND TECHNIQUES I

9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

Unit IV | TQM TOOLS AND TECHNIQUES II

9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

Unit V | QUALITY MANAGEMENT SYSTEM

9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards— AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation— Documentation—Internal Audits—Registration- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001— Benefits of EMS.

TEXT BOOK(S):

1. Dale H.Besterfield, Carol B.Michna,Glen H. Besterfield,MaryB.Sacre,HemantUrdhwareshe and RashmiUrdhwareshe, —Total Quality ManagementII, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCE(S):

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall(India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006. ISO9001-2015 standards.

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P				
19BMX02	DISASTER MANAGEMENT	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to • Provide students an exposure to disasters, their significance and types. • Ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction • Gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR) • Enhance awareness of institutional processes in the country • Develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity								
Course Outcomes: At the end of this course, learners will be able to: • Differentiate the types of disasters, causes and their impact on environment and society • Assess vulnerability and various methods of risk reduction measures as well as mitigation. • Draw the hazard and vulnerability profile of India, Scenarios in the Indian context, Disaster damage assessment and management.								
Unit I INTRODUCTION TO DISASTERS								9
Natural resources and its importance - understanding on fragile eco-system - characteristics and types of Disasters, Geological and Mountain Area Disasters: Earthquakes, Volcanic eruption, landslides - Wind and Water Related Natural Disaster: Floods, Droughts, Cyclones, Tsunamis - Man Made Disasters: Forest fires, Nuclear, Biological and Chemical disaster - Causes and effects - Disaster Profile of India - Disaster Management cycle.								
Unit II DISASTER PREPAREDNESS								9
Disaster management, mitigation and preparedness: Disaster Preparedness for People and Infrastructure, Community based Disaster Preparedness Plan - Roles & Responsibilities of Different Agencies and Government: Education, Communication & Training, Central, State, District and local administration, Armed Forces, Police, Para Military Forces, International Agencies, and NGO's - Disaster Mitigation: Strategies, Emerging Trends, Mitigation management and Role of Team and Coordination.								
Unit III INTER – RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT								9
Damage assessment — Development of Physical and Economic Infrastructure - Nature of Damage to Houses and Infrastructure due to Disasters - Funding Arrangements for Reconstruction - Monitoring and Evaluation of Rehabilitation Work: Training, Rescue and planning the rescue activities and rehabilitations - Role of Government and NGO's - Participative Rehabilitation Process: Case Studies								
Unit IV DISASTER RESPONSE AND DISASTER MANAGEMENT								9
Disaster Response Plan: Communication, Participation and Activation of Emergency Preparedness Plans, Search, Rescue, Evacuation and other logistic management - Human Behavior and Response Management: Psychological Response and Psychological Rehabilitation, Trauma and Stress Management, rumour and Panic Management, Medical and Health Response to Different Disasters - Relief Measures: Minimum Standard of Relief, essential components of Relief Management, and funding.								
Unit V DISASTER MANAGEMENT IN INDIA								9
Disaster Management Act, Disaster Management Agencies - National Disaster Management Authority (NDMA), National Executive Committee (NEC), State Disaster Management Authority (SDMA), District Disaster Management Authority (DDMA) & Local Authorities, Biological Disasters — Agencies, Bio safety level and classification, Prevention of Biological Hazards, Mainstreaming Covid -19 pandemic disaster management.								
TEXT BOOK(S): 1. Singhal J.P. —Disaster Managementll, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13:978-9380386423 2. Tushar Bhattacharya, —Disaster Science and Managementll, McGraw Hill India Education Pvt. Ltd.,2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361] 3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, NewDelhi, 2011 4. KapurAnu Vulnerable India: A GeographicalStudy of Disasters, IAS and Sage Publishers, New Delhi, 2010.								

REFERENCE(S):

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy, 2009.



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX03	HOSPITAL WASTE MANAGEMENT	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Know about the healthcare hazard control and accidents - Understand biomedical waste management - Learn the facility guidelines, infection control and patient safety. - Understand the hazardous materials used in hospital and its impact on health - Understand various waste disposal procedures and management.								
Course Outcomes: At the end of this course, learners will be able to: - Analyze various hazards, accidents and its control - Design waste disposal procedures for different bio wastes - Categories different bio wastes based on its properties - Design different safety facility in hospitals - Propose various regulations and safety norms								
Unit I	HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS							9
Healthcare Hazard Control: Introduction, Hazard Control: Management & Responsibilities, Hazard Analysis, Hazard Correction, Personal Protective Equipment, Hazard Control Committees, Accident Causation Theories, Accident Reporting, Accident Investigations, Accident Analysis, Accident Prevention, Workers" Compensation, Orientation, Education, and Training								
Unit II	BIOMEDICAL WASTE MANAGEMENT							9
Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling and disposal.								
Unit III	HAZARDOUS MATERIALS							9
Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Respiratory Protection.								
Unit IV	FACILITY SAFETY							9
Introduction, Facility Guidelines: Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Tool Safety, Electrical Safety, Control of Hazardous Energy, Landscape and Ground Maintenance, Fleet and Vehicle Safety.								
Unit V	INFECTION CONTROL, PREVENTION AND PATIENT SAFETY							9
Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Blood borne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Healthcare-Associated Infections, Medication Safety.								
TEXT BOOK(S): 1. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014). 2. Anantpreet Singh, SukhjittKaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers(P) Ltd (2012).								
REFERENCE(S): 1. R.C.Goyal, Hospital Administration and Human Resource Management, PHI - Fourth Edition, 2006 2. V.J. Landrum, Medical Waste Management and disposal, Elsevier, 1991.								


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX04	MULTIMEDIA COMPRESSION AND NETWORKS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Introduce probability related study of the characteristics of text, voice, image and video data - Introduce various compression schemes for text, voice, image and video - Analyze the compression schemes - Introduce communication protocols for voice over internet and multimedia networking								
Course Outcomes: At the end of this course, learners will be able to: - Ability to characterize the features of multimedia components. - Ability to develop audio and video processing systems. - Ability to develop compression algorithms for processing text and images. - Ability to tackle network issues in the transmission of text, audio and video signals.								
Unit I	MULTIMEDIA COMPONENTS							9
Introduction- Multimedia skills- Multimedia components and their characteristics- Text, sound, images, graphics, animation, video, hardware.								
Unit II	AUDIO AND VIDEO COMPRESSION							9
Audio compression-DPCM-Adaptive DPCM -adaptive predictive coding-linear Predictive coding code excited LPC-perpetual coding -Video compression principles-H.261, H.263, MPEG 1, 2, 4.								
Unit III	TEXT AND IMAGE COMPRESSION							9
Compression principles-source encoders and destination encoders-lossless and lossy compression-entropy encoding -source encoding- text compression -static Huffman coding dynamic Huffman coding -arithmetic coding -Lempel Ziv-Welsh Compression-image compression								
Unit IV	VoIP TECHNOLOGY							9
Basics of IP transport, VoIP challenges, H.323/ SIP -Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service - CODEC Methods-VOIP applicability.								
Unit V	MULTIMEDIA NETWORKING							9
Multimedia Networking- Applications-Streamed stored and audio-making - Best Effort service protocols for real time interactive Applications-distributing multimedia-beyond best effort service secluding and Policing Mechanisms-Integrated services-Differentiated Services-RSVP.								
TEXT BOOK(S): 1. Fred Halshall, "Multimedia Communication - Applications, Networks, Protocols and Standards", Pearson education, 2007. 2. Tay Vaughan, "Multimedia: Making It Work", TMH, 8 th Edition, 2007.								
REFERENCE(S): 1. Kurose and W. Ross, "Computer Networking a Top down Approach", Pearson education, 3 rd Edition, 2005. 2. Marcus Goncalves "Voice over IP Networks, McGraw Hill, 3. KR. Rao, Z S Bojkovic, D A Milovanovic, "Multimedia Communication Systems: Techniques, Standards, and Networks", Pearson Education, 2007 4. R. Steimnetz, K. Nahrstedt, "Multimedia Computing, Communications and Applications", Pearson Education, 1st Edition, 1995. 5. Ranjan Parekh, "Principles of Multimedia", TMH, 2006.								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX05	HUMAN BODY AREA NETWORKS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Know the hardware requirement of BAN - Understand the communication and security aspects in the BAN - Know the applications of BAN in the field of medicine								
Course Outcomes: At the end of this course, learners will be able to: - Comprehend and appreciate the significance and role of this course in the present contemporary world. - Design a BAN for appropriate application in medicine. - Assess the efficiency of communication and the security parameters. - Understand the need for medical device regulation and regulations followed in various regions. - Extend the concepts of BAN for medical applications.								
Unit I INTRODUCTION								9
Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BAN Architecture - Introduction.								
Unit II HARDWARE FOR BAN								9
Processor-Low Power MCUs, Mobile Computing MCUs ,Integrated processor with radio transceiver, Memory ,Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.								
Unit III WIRELESS COMMUNICATION AND NETWORK								9
RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology- Stand -Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1,IEEE P802.15.13, IEEE 802.15.14, Zigbee.								
Unit IV COEXISTENCE ISSUES WITH BAN								9
Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self-protection- Bacterial attacks, Virus infection, Secured protocols, Self-protection.								
Unit V APPLICATIONS OF BAN								9
Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.								
TEXT BOOK(S): - Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011. - Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, "Body Area Networks Safety, Security, and Sustainability", Cambridge University Press, 2013.								
REFERENCE(S): - Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems", Springer, 2013. - Guang-ZhongYang(Ed.), "Body Sensor Networks", Springer, 2006. - Mehmet R. Yuce, JamilY.Khan, "Wireless Body Area Networks Technology, Implementation, and Applications", Pan Stanford Publishing Pte. Ltd., Singapore, 2012.								


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX06	MOBILE APPS DEVELOPMENT	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Understand Mobility landscape & Aspects of Mobile Apps Development - Study Design and Develop of Mobile Apps - Understand Mobile apps deployment								
Course Outcomes: At the end of this course, learners will be able to: - Appreciate the Mobility landscape - Familiarize with Mobile apps development aspects - Design and develop mobile apps, using Android as development platform, with key focus on user experience design, native data handling and background tasks and notifications. - Appreciation of nuances such as native hardware play, location awareness, graphics and multimedia. - Perform testing, signing, packaging and distribution of mobile apps								
Unit I	GETTING STARTED WITH MOBILITY							9
Mobility landscape, Mobile platforms, Mobile apps development, Overview of Android platform, setting up the mobile app development environment along with an emulator, a case study on Mobile app development								
Unit II	BUILDING BLOCKS OF MOBILE APPS							9
App user interface designing - mobile UI resources (Layout, UI elements, Draw-able, Menu), Activity- states and life cycle, interaction amongst activities. App functionality beyond user interface - Threads, Async task, Services – states and life cycle, Notifications, Broadcast receivers, Telephony and SMS APIs Native data handling – on-device file I/O, shared preferences, mobile databases such as SQLite, and enterprise data access (via Internet/Intranet)								
Unit III	SPRUCING UP MOBILE APPS							9
Graphics and animation - custom views, canvas, animation APIs, multimedia - audio/video playback and record, location awareness, and native hardware access (sensors such as accelerometer and gyroscope)								
Unit IV	TESTING MOBILE APPS							9
Debugging mobile apps, White box testing, Black box testing, and test automation of mobile apps, JUnit for Android, Robotium, MonkeyTalk								
Unit V	TAKING APPS TO MARKET							9
Versioning, signing and packaging mobile apps, distributing apps on mobile market place								
Practical - Understand the app idea and design user interface/wireframes of mobile app - Set up the mobile app development environment - Develop and debug mobile app components - User interface, services, notifications, broadcast receivers, data components - Using emulator to deploy and run mobile apps - Testing mobile app - unit testing, black box testing and test automation•								
TEXT BOOK(S): - AnubhavPradhan, Anil V Deshpande, Mobile Apps Development, Edition 1 - Barry Burd, Android Application Development All in one for Dummies, Edition: I								
REFERENCE(S): Teach Yourself Android Application Development In 24 Hours , SAMS Publications								

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Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX07	TELEHEALTH TECHNOLOGY	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Learn the key principles for telemedicine and health - Understand telemedical technology. - Know telemedical standards, mobile telemedicine and it applications.								
Course Outcomes: At the end of this course, learners will be able to: - Apply multimedia technologies in telemedicine - Explain protocols behind encryption techniques for secure transmission of data - Apply telehealth in healthcare.								
Unit I	FUNDAMENTALS OF TELEMEDICINE						9	
History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.								
Unit II	TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE						9	
Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.								
Unit III	ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE						9	
Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues, intellectual property rights.								
Unit IV	PICTURE ARCHIVING AND COMMUNICATION SYSTEM						9	
Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.								
Unit V	APPLICATIONS OF TELEMEDICINE						9	
Teleradiology, Telepathology, Telecardiology, Teleoncology, Teledermatology, Telesurgery, e Health and Cyber Medicine.								
TEXT BOOK(S): 1. Norris A C, "Essentials of Telemedicine and Telecare", John Wiley, New York, 2002. 2. H K Huang, "PACS and Imaging Informatics: Basic Principles and Applications", Wiley, New Jersey, 2010.								
REFERENCE(S): 1. Olga Ferrer Roca, Marcelo Sosa Iudicissa, "Handbook of Telemedicine", IOS Press, Netherland, 2002. 2. Khandpur R S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003. 3. Keith J Dreyer, Amit Mehta, James H Thrall, "Pacs: A Guide to the Digital Revolution", Springer, New York, 2002. 4. Khandpur R S, "TELEMEDICINE - Technology and Applications", PHI Learning Pvt Ltd., New Delhi, 2017.								



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Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX08	BIOSTATISTICS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Introduce the techniques used in statistical & regression analysis. - Compare the various parameters used in statistical significance.								
Course Outcomes: At the end of this course, learners will be able to: - Classify common statistical tests and tools. - Distinguish between p-values and confidence intervals as measures of statistical significance. - Interpret commonly used regression analysis. - Explain the data tables and its interpretations in community health. - Evaluate commonly used statistical and epidemiologic measures.								
Unit I	INTRODUCTION							9
Biostatistics - Statistical problems in Biomedical research- Basic concepts: Population, Samples and Variables - Basic probability, likelihood & odds, distribution variability.								
Unit II	STATISTICAL PARAMETERS							9
Statistical parameters p-values, computation and level chi square test and distribution.								
Unit III	REGRESSION ANALYSIS							9
Regression - Linear regression - Multiple linear regression - Multiple co linearity, Determining Best regression - Nonlinear regression - Logistic regression - Poison regression.								
Unit IV	INTERPRETING DATA							9
Life table: Interpreting life table's clinical trials, epidemical reading and interpreting of epidemical studies, application in community health.								
Unit V	META ANALYSIS							9
META analysis for research activities, purpose and reading of META analysis, Forest graph, Funnel plots, Radial plots, L'Abbe plots, Criticisms of Meta analysis								
TEXT BOOK(S): - Joseph A. Ingel finger, Frederick Mosteller, Lawrence A. Thibodeau, James H. Ware 'Biostatistics in Clinical Medicine', Singapore, 3 rd Edition, 1994. - Gerald van Belle, Lloyd D. Fisher, Patrick J. Heagerty, Thomas Lumley, 'Biostatistics: A Methodology for the Health Sciences', John Wiley & Sons, 2004.								
REFERENCE(S): - Julien I.E. Hoffman, 'Biostatistics for Medical and Biomedical Practitioners', Elsevier Press,2015. - James F. Jekel, 'Epidemiology, Biostatistics, and Preventive Medicine', Elsevier Health Sciences, 2007. - Ray M. Merrill, 'Fundamentals of Epidemiology and Biostatistics, Jones & Bartlett Learning, 2013.								

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX09	EMBEDDED SYSTEMS IN MEDICINE	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to impart knowledge on - Basic concepts of Embedded Systems - Various techniques used for designing an embedded system. - Real time system with an examples								
Course Outcomes: At the end of this course, learners will be able to: - Discuss the basics of embedded systems and its hardware units - Identify the various tools and development process of embedded system - Demonstrate the various I/O interfacing with microcontroller - Summarize the real time models, languages and operating systems - Design a real time embedded system for biomedical applications								
Unit I	SYSTEM DESIGN							9
Embedded system, Processor embedded into a system, Embedded hardware units and devices in a system, Embedded software in a system, Embedded system architecture, Classifications, Skills required for an embedded system designer. Typical application scenario of embedded systems								
Unit II	EMBEDDED SYSTEMS DESIGN, DEVELOPMENT PROCESS AND TOOLS							9
Complex systems and microprocessor, Design process and metrics in embedded system, Design challenges, Optimizing the design metrics, Issues related to embedded software development, Hardware software code sign, Embedded system design technology, Embedded software development process and tools, Host and Target machine, Linking and Locating Software, Getting embedded software into the target system, Design process								
Unit III	REAL WORLD INTERFACING							9
Study of microcontroller, Processor and memory organization, Switch, Keypad and LED interfacing, Seven segment display interfacing, Data Acquisition system, A/D, D/A converters, Timers, Counters, Actuators.								
Unit IV	TECHNIQUES FOR EMBEDDED SYSTEMS							9
State Machine and state Tables in embedded system design, Simulation and Emulation of embedded systems. Real time models, Language and Operating Systems-Tasks and task states, operating system services, RTOS functions, Interrupt routine in RTOS environment.								
Unit V	BIOMEDICAL APPLICATIONS							9
Body temperature measurement, Stepper motor control. Embedded system in biomedical application Wireless sensor technologies, Body sensor network, Patient monitoring system.								
TEXT BOOK(S): - Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition Morgan Kaufmann Publisher (An imprint from Elsevier), 2012. - Wayne Wolf, "Computers as Components - Principles of Embedded Computing System Design", Morgan Kaufmann Publisher (An imprint of Elsevier), 3rd Edition, 2008. - Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide- Designing and Optimizing System Software", Elsevier/Morgan Kaufmann Publisher, 2008.								
REFERENCE(S): - LylaB.Das, "Embedded Systems: An Integrated Approach" Pearson Education, 2013. - Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012. - Jane. W. S. Liu, "Real-Time Systems", Pearson Education Asia, 2011. - David E-Simon, "An Embedded Software Prime", Pearson Education, 2010. - Tammy Noergaard, "Embedded Systems Architecture", Elsevier, 2006.								

Department	BIOMEDICAL ENGINEERING					R 2019	Semester VI	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX10	VIRTUAL INSTRUMENTATION	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Introduce virtual instrumentation concepts and applications. - Train to program virtual instrumentation software for biomedical applications								
Course Outcomes: At the end of this course, learners will be able to: - Comprehend and appreciate the significance and role of this course in the present contemporary world. - Identify salient traits of a virtual instrument. - Understand the use of VI for data acquisition. - Experiment, analyze and document different types of interfaces. - Apply the virtual instrumentation technologies for medical applications.								
Unit I	INTRODUCTION							9
History of Virtual Instrumentation(VI), advantages, block diagram and architecture of a virtual instrument, Programming paradigms – Virtual Instrumentation - LabVIEW software – LabVIEW basics – LabVIEW environment.								
Unit II	VI USING LABVIEW							9
Creating, Editing and debugging a VI in LabVIEW – Creating a sub VI – Loops and charts – Case and sequence structures – File I/O – VI customization.								
Unit III	DATA ACQUISITION AND CONTROL IN VI							9
Plug-in DAQ boards – Organization of the DAQ VI System – Performing analog input and analog output – Scanning multiple analog channels – Driving the digital I/Os – Buffered data acquisition – Simple problems								
Unit IV	INSTRUMENT INTERFACES							9
Current loop, RS 232C/RS 485, GPIB, System basics, Interface basics: USB, PCMCIA, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control. ADC, DAC, DIO, DMM, waveform generator.								
Unit V	APPLICATION OF VI IN BIOMEDICAL ENGINEERING							9
Design of virtual applications for Electrocardiography (ECG), Electromyography (EMG), Air Flow and Lung Volume, Heart Rate variability analysis, Noninvasive Blood Pressure Measurement, Biofeedback, Virtual Reality & 3D graphical modeling, Virtual Prototyping.								
TEXT BOOK(S): - Gary Johnson, "LABVIEW Graphical Programming", McGraw Hill, 2 nd Edition, 1997. - Lisa K. Wells and Jeffrey Travis, "LABVIEW for Everyone", PHI, 1997. - Skolkoff, "Basic concepts of LABVIEW 4", PHI, 1998. - Jerome, Jovitha, "Virtual Instrumentation and LABVIEW", PHI Learning, New Delhi, 1 st Edition, 2010. - Sanjay Gupta and Joseph John, " Virtual Instrumentation using LabVIEW", Tata McGraw – Hill Publishing Company Limited, New Delhi, 1st Edition, 2005.								
REFERENCE(S): - Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes, 2000. S. Gupta, J.P. Gupta, " PC Interfacing for Data Acquisition and Process Control", ISA, 2nd Edition, 1994. - Technical Manuals for DAS Modules of Advantech and National Instruments. - Jon B. Olansen, Eric Rosow, "Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in LabVIEW" Pearson Education, 2001.								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX11	ROBOTICS IN MEDICINE	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to impart knowledge on - Understand the basics of Robotics, Kinematics , - Understand the basics of Inverse Kinematics, - Know the vision of Robotics application in Medicine, - Explore various kinematic motion planning solutions for various Robotic configurations, - Explore various applications of Robots in Medicine.								
Course Outcomes: At the end of this course, learners will be able to: - Understand the basics of robotic systems - Identify the principle of Kinematics and Inverse Kinematics, - Design basic Robotics system and formulate Kinematics, - Construct Inverse Kinematic motion planning solutions for various Robotic configurations, - Design Robotic systems for Medical application.								
Unit I	INTRODUCTION						9	
Introduction Automation and Robots, Classification, Application, Specification, Notations, Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation – Five-axis robot, Four-axis robot, Six-axis robot								
Unit II	KINEMATICS						9	
Inverse Kinematics – General properties of solutions tool configuration, Five axis robots, Three-Four axis, Six axis Robot, Workspace analysis and trajectory planning work envelope and examples, workspace fixtures, Pick and place operations, Continuous path motion, Interpolated motion, Straight-line motion.								
Unit III	ROBOT VISION						9	
Robot Vision Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation – Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration.								
Unit IV	PLANNING						9	
Task Planning Task level programming, Uncertainty, Configuration, Space, Gross motion, Planning, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation.								
Unit V	APPLICATIONS						9	
Applications in Biomedical Engineering – Bio Engineering Biologically Inspired Robots, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynaecology, Orthopaedics, Neurosurgery								
TEXT BOOK(S):								
1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc., 2008								
2. J.J.Craig, —Introduction to RoboticsII, Pearson Education, 2005								
3. Andrew Davison, "Killer Game Programming in Java", Oreilly SPD, 2005,								
REFERENCE(S):								
1. K. S. Fu, R. C. Gonzales and C. S. G. Lee, —RoboticsII, McGraw Hill, 2008								
2. John Vince, "Virtual Reality Systems", Pearson Education, 2007								
3. William R.Sherman, Alan Craig, "Understanding Virtual Reality, interface, Application and Design", Elsevier, Morgan Kaufmann, 2002.								
4. David H.Eberly, "3D Game Engine Design Practical Approach to Real-Time Computer Graphics", Elsevier, 2007.								

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Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX12	NANOTECHNOLOGY IN MEDICINE	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the basic scientific concepts underpinning nano science,
- Understand the multidisciplinary aspects of synthesizing nano materials,
- Understand the different types of nano materials,
- Demonstrate specifically the characterization tools used in nanotechnology,
- Appreciate the emerging role of nanotechnology in society, the regulatory framework within which it operates and the ethical issues it raises.

Course Outcomes: At the end of this course, learners will be able to:

- Thorough knowledge of the general principles of physics, chemistry, electronics and biology that play a role on the nanometer scale
- Understanding the essential concepts used in nanotechnology, synthesis and fabrication,
- Understanding of materials and their properties at the atomic and nanometer level, including an understanding of the intimate relationship between material scale (nanostructure) and the properties/functionality of materials,
- Having a sound grounding knowledge in the characterization techniques,
- Demonstrate the socioeconomic impact of nanotechnology and toxicological issues associated with it.

Unit I INTRODUCTION TO NANOTECHNOLOGY

9

Basic Structure of Nano particles- Kinetics in Nano structured Materials- Zero dimensional, size and shape of nano particles; one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors, bio nano-particles.

Unit II GENERAL METHODS OF SYNTHESIS

9

Nano particles through homogeneous and heterogeneous nucleation-Growth controlled by surface and diffusion process- Oswald ripening process - influence of reducing agents. Fabrication methods – Top down processes: Milling, lithographics, Machining process, vapour deposition. Bottom-Up process: Colloidal and Sol – gel methods, electro deposition, Self Assembly.

Unit III NANOMATERIALS

9

Classification based on dimensionality- Quantum Dots, Wells and Wires- Carbon- based nano materials (bucky balls, nano tubes, graphene) – Metal based nano materials (nano gold, nano silver and metal oxides) -Nanocomposites- Nano polymers – Nano glasses – Nano ceramics – Biological nano materials.

Unit IV EXPERIMENTAL TECHNIQUES

9

Characterization – X- ray diffraction (XRD), Scanning Electron Microscopy, Transmission Electron Microscope, Atomic force microscopy, Scanning Tunneling microscopy (STM), Scanning probe microscopy (SPM), Optical and Raman spectroscopy.

Unit V NANOTECHNOLOGY IN HEALTH CARE

9

Nano tubes, nano wires, and nano devices – Introduction - Functional Nanostructures – Introduction to molecular electronics - Field emission and Shielding - Microelectromechanical systems (MEMs) – Nano electromechanical systems (NEMs) - Molecular and Supramolecular Switches – Biosensors – Qdots – Nanoshells – Nanobiotix – Cancer detection – Drug Delivery using Nanoparticles and Molecular Carriers.

TEXT BOOK(S):

1. Bio-Nanotechnology_ Concepts and applications. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey and Goldie Oza, Ane Books Pvt Ltd, 1 edition 2012
2. Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers and Architects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009
3. Akhlesh Lakhtakia (Editor), "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations". Prentice-Hall of India (P) Ltd, NewDelhi, 2007,

REFERENCE(S):

1. Niemeyer C. M., "Nano biotechnology: Concepts, Applications and Perspectives", Wiley –VCH, 2006
2. Handbook of Nano phase and Nano structured Materials (in four volumes), Eds: Z.L. Wang, Y. Liu, Z. Zhang, Kluwer Academic/Plenum Publishers, 2003
3. Springer Handbook of Nanotechnology by Bharat Bhushan 2004.
4. Encyclopedia of Nanotechnology - Hari Singh Nalwa 2004.



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Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX13	BIOMETRIC SYSTEMS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Understand the concept of Biometrics and its applications,
- Understand the various methodologies involved in fingerprint technology,
- identify issues in the realistic evaluation of biometrics-based systems,
- Demonstrate the multimodal biometrics and the methods for evaluating the performance,
- Distinguish the authentication mechanism of the biometric systems.

Course Outcomes: At the end of this course, learners will be able to:

- Understand the concept of Biometrics and its applications,
- Illustrate the various methodologies involved in fingerprint technology,
- Develop techniques for face recognition and hand geometry biometrics,
- Demonstrate the multimodal biometrics and the methods for evaluating the performance,
- Distinguish the authentication mechanism of the biometric systems.

Unit I	INTRODUCTION TO BIOMETRICS	9
Introduction and back ground – Biometric Technologies – Passive Biometrics – Active Biometrics -Biometric Systems – Enrollment – Templates – Algorithm – Verification – Biometric Applications –Biometric Characteristics- Authentication Technologies – Need for Strong Authentication – Protecting Privacy and Biometrics and Policy – Biometric Applications – Biometric Characteristics.		
Unit II	FINGERPRINT TECHNOLOGY	9
History of fingerprint pattern recognition - General description of fingerprints - Finger print feature processing techniques – finger print sensors using RF imaging techniques – fingerprint quality assessment – computer enhancement and modeling of fingerprint images – fingerprint enhancement – Feature extraction – fingerprint classification – fingerprint matching.		
Unit III	FACE RECOGNITION AND HAND GEOMETRY	9
Introduction to face recognition, Neural networks for face recognition – face recognition from correspondence maps – Hand geometry – scanning – Feature Extraction - Adaptive Classifiers -Visual-Based Feature Extraction and Pattern Classification - feature extraction – types of algorithm –Biometric fusion.		
Unit IV	MULTIMODAL BIOMETRICS AND PERFORMANCE EVALUATION	9
Voice Scan – physiological biometrics –Behavioral Biometrics - Introduction to multimodal biometric system – Integration strategies – Architecture – level of fusion – combination strategy –training and adaptability – examples of multimodal biometric systems – Performance evaluation- Statistical Measures of Biometrics – FAR – FRR – FTE – EER – Memory requirement and allocation.		
Unit V	BIOMETRIC AUTHENTICATION	9
Introduction - Biometric Authentication Methods - Biometric Authentication Systems – Biometric authentication by fingerprint – Biometric Authentication by Face Recognition. Expectation- Maximization theory - Support Vector Machines. Biometric authentication by fingerprint – biometric authentication by hand geometry- Securing and trusting a biometric transaction – matching location – local host - authentication server – match on card (MOC) – Multi biometrics and Two-Factor Authentication		
TEXT BOOK(S):		
1. James Wayman, Anil Jain, DavideMaltoni, Dario Maio, "Biometric Systems, Technology Design and Performance Evaluation", Springer, 2005		
2. S.Y. Kung, S.H. Lin, M.W.Mak, "Biometric Authentication: A Machine Learning Approach"Prentice Hall, 2005		


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REFERENCE(S):
1. Paul Reid, "Biometrics for Network Security", Pearson Education, 2004
2. L C Jain, I Hayashi, S B Lee, U Halici, "Intelligent Biometric Techniques in Fingerprint and Face Recognition" CRC Press, 1999
3. John Chirillo, Scott Blaul, "Implementing Biometric Security", John Wiley, 2003



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX14	BIOMATERIALS AND APPLICATIONS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Study the characteristics of Biomaterials and its reaction in the host and understand its degradation mechanism, - Understand different metals and ceramics used as biomaterials, - Study the different polymeric materials and their clinical application and role in drug delivery, - Study the different types of soft and hard tissue implants, - Understand the concept of biocompatibility and the methods of biomaterial testing.								
Course Outcomes: At the end of this course, learners will be able to: - Explain the properties of biomaterials and biomaterial- tissue reaction, - Identify metals and ceramic implants used for medical applications, - Compare different polymeric materials, their application in biomedical field and its function in drug delivery, - Outline the concept behind the different tissue replacements, - Demonstrate various testing and evaluation techniques for biomaterials.								
Unit I	INTRODUCTION TO BIO – MATERIALS							9
Definition and classification of bio-materials, Characterization of biomaterials: mechanical properties, surface properties, visco elasticity. Host reactions to biomaterials: Inflammation, Wound Healing and Foreign Body Response, Failure mechanisms: corrosion, fracture, degradation of Implanted materials in the biological environment.								
Unit II	METALLIC AND CERAMIC MATERIALS							9
Metallic implants: Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, applications. Ceramic implant: bioinert, biodegradable or bio resorbable, bioactive ceramics, applications.								
Unit III	POLYMERIC IMPLANT MATERIALS							9
Polymerization, Polyethylene, Clinical study of synthetic polymers, Bioerodible polymers, Blood compatible polymers, Bioactive polymers, Hydrogels; Methacrylates, Drug incorporation polymer gels, Biomedical application of polymers outside the body and temporary in vivo applications.								
Unit IV	TISSUE REPLACEMENT IMPLANTS							9
Soft tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, Prosthetic Cardiac Valves, hard tissue replacement Implants, Internal fixation device, joint replacements, dental implants.								
Unit V	TESTING OF BIOMATERIALS							9
Testing of blood-material interactions: blood compatibility and thrombogenicity, In vitro assessment of tissue compatibility: assay methods - direct contact test, agar diffusion test, elution test, clinical use. In vivo assessment of tissue compatibility: mechanical testing, criteria for assessing acceptability of the tissue response. Sterilization of implants: steam sterilization, EtO sterilization, radiation sterilization.								
TEXT BOOK(S):								
1. BD Ratner, AS Hoffmann,FJ Schoen, JE Lemmons, "An Introduction to Materials in Medicine" Academic Press, Third Edition, 2013								
2. Sujata V. Bhatt, "Biomaterials", Second Edition, Narosa Publishing House, 2005								
REFERENCE(S):								
1. Joseph D Bronzino, "Biomedical engineering Fundamentals", CRC press, Third Edition, 2006								
2. A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran, "Woodhead Medical Textiles and Biomaterials for Healthcare" Publishing limited 2006								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX15	COMPUTER APPLICATION IN MEDICINE	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to • Study the system of information managed in the hospital, • Understand the application of software's employed in medical data management, • Study the different types of medical imaging data with an assist of computers, • Learn the concept of maintaining digital patient records, • Understand the delivering instructions in medicine using computers.								
Course Outcomes: At the end of this course, learners will be able to: • Understand the system of information managed in the hospital, • Demonstrate the application of software's employed in medical data management, • Examine medical imaging data with an assist of computers, • Understand the concept of maintaining digital patient records, • Acquire knowledge in delivering instructions in medicine using computers.								
Unit I	HOSPITAL INFORMATION SYSTEM						9	
Introduction – Historical review of the development of computers and informatics –Foundation ontology – use of internet in medicine –Internet vs online services-computer based medical information retrieval.								
Unit II	COMPUTERISED PATIENT DATABASE MANAGEMENT						9	
Data base approach - Automated clinical laboratories – automated method in hematology – chromosome analysis by computer – computerized cytology and histology- Automatic scanning for cervical cancer – computer assisted semen analysis-Radio immuno assays-Intelligent laboratory information system-computerized ECG-computer aided analysis of ECG - computerized EEG and EMG. Computer assisted medical imaging-ultrasound –CT Radiation therapy planning-NMR.								
Unit III	COMPUTER ASSISTED MEDICAL IMAGING AND DECISION MAKING						9	
Computer Assisted Medical Decision Making-Model of CMD-Approaches-Decision Support Systems Algorithms –Analysis –CBR-Production Rule Systems-Cognitive Models - Somantic Networks –Decision Analysis in Clinical Medicine –Hospital Information System-Functional Capabilities –Need-Security-Cost Effectiveness. Clinical Information System –Benefits –Sources Of Data-Modes Of Decision –CIS in Obestrics and Gynecology-Clinical Decision Support								
Unit IV	COMPUTERISED PATIENT RECORD						9	
Computerized Patient Record –Introduction-History Taking By Computer-Dialogue With The Computer - Computerized Prescriptions For Patients-Introduction-Adverse Drug Reactions-Computer Assisted Patient Education And Health Care Information –Introduction –Health Online –Electronic Communication With Patients-Importance Of Behavior Modification –Patient Self Management Education-Computers In Case Of Critically Ill Patients- Introduction –Cognitive System, Engineering –Automated Computer Assisted Fluid And Metabolic Balance –Pulmonary Function Evaluation-Computer Aids For The Handicapped-Computer Assisted Surgery.								
Unit V	COMPUTER ASSISTED INSTRUCTION IN MEDICINE						9	
Computer Assisted Drug Discovery And Development, Molecular Modeling By Computer-Computational Representation Of Molecules-Modeling GPCRS-Pharmacophores-New Drugs For Cancer-0 from Gene To Screen –Combinational Chemistry-Metabolomics-Knowledge Based Drug Discovery-Pharmaco Metabolomics Role Of PET And SPECT In Drug Discovery.								
TEXT BOOK(S):								
1. R. D. Lee, Computers in Medicine, Tata McGraw Hill Publishing Company Limited, New Delhi, 1993								
REFERENCE(S):								
1. S.K.Chachan, PC Organisation, S.K. Kataria and Sons, Delhi 2000								


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VIII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX16	HEALTHCARE PRODUCT DEVELOPMENT	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to • Study the basic concept of engineering design • Understand the students understand various clinical needs • Make the students understand various clinical requirements, • Make the students understand the various steps and constraints involved in developing medical device, • Make the students to produce product that suits market requirements								
Course Outcomes: At the end of this course, learners will be able to: • Analyze various strategies in product development, • Identify clinical need in various application, • Provide engineering solution for medical applications, • Abide regulatory and ethical norms, • Develop product that suits market requirements.								
Unit I	BASICS ON PRODUCT DEVELOPMENT							9
Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development- planning for products –establishing markets- market segments- relevance of market research.								
Unit II	IDENTIFICATION OF CLINICAL NEEDS							9
Market survey, Conceptualizing the solution to clinical requirement, Researching the disease state – anatomy, physiology, pathophysiology, epidemiology, present pathways, setbacks, Feasibility screening – finance, technical and market, New technologies – brainstorming, literature and R&D forums, Ways of implementation.								
Unit III	ENGINEERING SOLUTION TO CLINICAL NEEDS							9
Document sketching, Modeling – software and physical, Model for all strategies, Testing and clinical correlation, Material selection – sensors, actuators, Instrumentation circuit design, Interface selection, Output visualization and calibration Case study: To identify a real time problem and to propose suitable engineering solution.								
Unit IV	REGULATORY AND ETHICAL ISSUES							9
Regulations and standards involved in the design – CE mark and FDA, Regulatory bodies in India, Biocompatibility of the test probes, ISO 14155 standards for clinical investigations, Steps for getting FDA approval, Function and role of ethical committee, Medical ethics proposed by ICMR.								
Unit V	MARKETING STRATEGY							9
Post market Surveillance and its role in design, Various tools – Process control chart, bathtub curve, Weibull plot, Measles chart, Pareto analysis, Exploring various contacts – early adopters, focus groups, conference, Vigilance, Promotion through media, Comparison with existing products – merits and demerits.								
TEXT BOOK(S):								
1. Beth Ann Fiedler, Managing medical devices within a regulatory framework, Elsevier, 2017								
2. Benjamin Blass, Basic Principles of Drug Discovery and Development, 1st Edition, Elsevier								
3. Davis, Organizational Behavior, Tata McGraw Hill, Eleventh Edition, New Delhi, 2005								


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REFERENCE(S):
1. Des O'brien, Medical Device Regulations Roadmap: A Beginners Guide, 2017
2. A Peter J. Ogrodnik, Medical Device Design Innovation from Concept to Market, Elsevier, 2013



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VIII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX17	PHYSIOLOGICAL MODELING	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Understand the application of Physiological models and Vital organs, - Understand methods and techniques for analysis and synthesis of dynamic models, - Model dynamically varying physiological system, - Develop differential equations to describe the dynamic models, - Simulate and visualize, dynamic responses of physiological models using software.								
Course Outcomes: At the end of this course, learners will be able to: - Explain application of Physiological models, - Model dynamically varying physiological system, - Analyze and synthesize dynamic models of physiological system, - Develop differential equations to describe the dynamic models, simulate and visualize, - Implement physiological models using software to get dynamic responses.								
Unit I	SYSTEM CONCEPT							9
Introduction to Physiological control systems, Purpose of physiological modeling and signal analysis, Illustration- example of a physiological control system. Difference between engineering and physiological control systems. System variables and properties – Resistance – both static and dynamic, Compliance and combination of resistance and compliance. Resistance and compliance models – respiratory system, aortic segments, lumped model of physiological thermal system, and step response of resistance – compliance system – dye dilution study of circulation								
Unit II	SYSTEM ANALYSIS							9
Review of transfer function, transfer function of coupled system. Impedance based transfer function – flexible tube feeding a single port compliant model, development of a lung model. Periodic signals: sinusoidal analysis of second order system, analysis of respiratory system based on sinusoidal excitation, pendelluft.								
Unit III	TRANSIENT AND FEEDBACK							9
Review of transient and stability analysis. Homeostasis, representation, finger tracking. Characterization of Physiological Feedback systems – Hypophysis adrenal systems. Nonlinear systems and linearization – transfer function analysis of pupillary control system as a closed loop and method of opening the closed loop, pupillary hippus.								
Unit IV	MODELING OF CARDIOPULMONARY SYSTEM							9
Model of cardiac output regulation - Starling's law, Physical Significance of under damped responses of post systolic operations in aortic arch, model of circadian rhythms, chemical regulation of ventilation, Cheyne-Stoke breathing, biot breathing.								
Unit V	OTHER PHYSIOLOGICAL MODELS AND SIMULATION							9
Steady state analysis of regulation of glucose, Hodgkin-Huxley model, Thermal system – model and simulation, modeling of eye movement- types of eye movement, saccade model, model of oculomotor control. Introduction to digital control system.								
TEXT BOOK(S):								
1. Micheal C.K.Khoo, "Physiological Control System Analysis, Simulation and Estimation", Prentice Hall of India, New Delhi, 2001								
2. William B.Blessner, "A System Approach to Biomedicine", McGraw Hill Book Co., New York, 1969.								
REFERENCE(S):								
1. Joseph D,Bronzino, "The Biomedical Engineering Handbook", CRC Press,3rd Edition, 2006								
2. F.C. Hoppensteadt and C.S.Peskin, "Modeling and Simulation in Medicine and the Life Sciences" Springer, 2nd Edition, 2002								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VIII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX18	MEDICAL ETHICS AND STANDARDS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Understand the Formulation of the project for the approval of various authorities - Learn the project performance and analyze the risks involved - Study the various key financial indicators in project financing - Know the concepts of infrastructure projects based on the different types of contract - Study the aspects of PPP in Infrastructure development projects								
Course Outcomes: At the end of this course, learners will be able to: - Formulate the project for the approval of various authorities, - Evaluate the project performance and analyze the risks involved, - Analyze the key financial indicators in project financing, - Implement the infrastructure projects based on the different types of contract, - Interpret the aspects of PPP in Infrastructure development projects.								
Unit I	INTRODUCTION TO MEDICAL ETHICS							9
Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities - The Doctor and the Patient, The Doctor And The Profession, Professional Independence, The Doctor And Society								
Unit II	ETHICAL THEORIES & MORAL PRINCIPLES							9
Theories-Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles- Non-Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research ,Bioethical issues in Human Genetics & Reproductive Medicine								
Unit III	HOSPITAL ACCREDITATION STANDARDS							9
Accreditation - JCI Accreditation & its Policies. Patient centered standards, Healthcare Organization management standards -Indian Perspective								
Unit IV	HOSPITAL SAFETY STANDARDS							9
Life Safety Standards- Protecting Occupants, Protecting the Hospital From Fire, Smoke, and Heat, Protecting Individuals From Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards-Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.								
Unit V	MEDICAL EQUIPMENT SAFETY STANDARDS							9
General requirements for basic safety & essential performance of medical equipments.IEC 60601 standards- Base Standard-general requirement of electrical medical devices, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device.								
TEXT BOOK(S):								
1. W.Ronald Hudson, Ralph Haas, Waheed Uddin, "Infrastructure Management: Integrating, Design, Construction, Maintenance, Rehabilitation and Renovation", McGraw Hill Publisher, 2013								
2. Raina V.K, "Construction Management Practice – The inside Story", Tata McGraw Hill Publishing Limited, 2009								
REFERENCE(S):								
1. Prasanna Chandra, "Projects – Planning, Analysis, Selection, Implementation Review", Tata McGraw Hill Publishing Company Ltd., New Delhi. 2019								
2. Leslie Feigenbaum, "Construction Scheduling With Primavera Project Planner", Prentice Hall, 2002								



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Department	BIOMEDICAL ENGINEERING				R 2019	Semester VII	PC
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19BMX19	BIO MEMS	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is to

- Understand the operation of different types of sensors and actuators at micro scale level.
- Understand the design issues at micro scale level
- Choose the material for any application.
- Apply the concepts to the design of different types of micro systems.
- Apply the knowledge of CAD tools for MEMS design.

Course Outcomes: At the end of this course, learners will be able to:

- Describe the various MEMS fabrication techniques,
- Outline different types of mechanical and thermal actuators and sensors,
- Explain different types of electrostatic and piezoelectric actuators and sensors,
- Analyze the fluid dynamics in Micro conduits and its applications,
- Illustrate various medical applications of MEMS.

Unit I MEMS AND MICROSYSTEMS

9

Typical MEMs and Microsystems, materials for MEMS - active substrate materials- Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers. Micromachining- photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA.

Unit II MECHANICAL AND THERMAL SENSORS AND ACTUATORS

9

Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermomechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever – microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor

Unit III ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATORS

9

Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

Unit IV MICROFLUIDIC SYSTEMS

9

Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in microconduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, dielectrophoresis, microfluid dispenser, microneedle, micropumps-continuous flow system, micromixers ,

Unit V APPLICATIONS OF BIOMEMS

9

CAD for MEMs, micro total analysis systems (MicroTAS) detection and measurement methods, Microsystem approaches to polymerase chain reaction (PCR), DNA sensor, MEMS based drug delivery, Emerging Bio-MEMS technology: Minimally invasive surgery, Oncology, Tissue Engineering, Biosensors.

TEXT BOOK(S):

1. Wanjun Wang, Stephen A. Soper, "BioMEMs: Technologies and Applications", CRC Press, New York, 2007.
2. Nitaigour Premchand Mahalik, " MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007

REFERENCE(S):

1. Chang Liu, ' Foundations of MEMS', Pearson Education International, New Jersey, USA, 2006.
2. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002
3. Nadim Maluf, Kirt Williams. "An introduction to Micro electro Mechanical Systems Engineering", Second Edition, Artech House Inc, MA, 2004



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VIII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX20	RESEARCH METHODOLOGY	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to • Study the Project formulation and report preparation process • Understand the Project performance and appraisal procedures • understand various Financing infrastructure projects • Know the concepts of Contracts, bidding process and implementation types • Study the Impacts of private sector participation								
Course Outcomes: At the end of this course, learners will be able to: • Formulate the project for the approval of various authorities, • Evaluate the project performance and analyze the risks involved, • Analyze the key financial indicators in project financing, • Implement the infrastructure projects based on the different types of contract, • Interpret the aspects of PPP in Infrastructure development projects.								
Unit I	RESEARCH FORMULATION AND DESIGN							9
Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.								
Unit II	DATA COLLECTION AND ANALYSIS							9
Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools,data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.								
Unit III	SOFT COMPUTING							9
Computer and its role in research, Use of statistical software SPSS, GRETL etcin research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems.								
Unit IV	RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING							9
Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability								
Unit V	INTERPRETATION AND REPORT WRITING							9
Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of L T P C 45 15 0 4 Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.								
TEXT BOOK(S):								
1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers								
2. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.								
REFERENCE(S):								
1. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications.								
2. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing								

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Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX21	CLINICAL ENGINEERING	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Study the classification of Hospitals and its Architecture,
- Understand the Electrical power systems in Hospital,
- Understand Air Conditioning & Gas Supply Systems in Hospital,
- Understand the basic concepts of Hospital management and Engineering,
- Get knowledge about the Hospital information.

Course Outcomes: At the end of this course, learners will be able to:

- Classify the architecture and types of hospitals
- Understand how an electrical system should be in a hospital
- Understand the air conditioning and gas systems
- Know about the importance of Biomedical Engineer
- Attain knowledge about the Hospital information.

Unit I	CLASSIFICATION OF HOSPITAL & ARCHITECTURE	9
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General hospital, specialized hospital, primary health care – their role and functions. Aspects of hospital services – inpatient, outpatient and emergency. Location and environment of hospital, Hierarchy of medical and paramedical staff & their functions and responsibilities. Modern Hospital Architecture- space in a hospital building, design of ward, intensive care units, air conditioning, plumbing & sanitation, gas supply, waste disposal, cleaning, dietary, sterilizing, laundry, storage and operation theatre systems, Radiology, Central labs, Blood banks, OPD, Causality.

Unit II	ELECTRICAL POWER SYSTEMS IN HOSPITALS	9
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Safety of electrical systems, Protective systems - interference of patient's protection grounding. Design of sub stations, breakers, Surge protectors, EMI filters, voltage stabilizers, generator sets and UPS. Uninterrupted power supply for ICU and computerized monitoring units. Specification & estimation for hospital wiring - small case study.

Unit III	AIR CONDITIONING & GAS SUPPLY SYSTEMS	9
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Air conditioning and refrigeration systems for small and large areas. Air changes, filtering and sterility. Deodorization, disinfection, dehumidification and cryogenic systems. Centralized supply of air, oxygen, nitrous oxide & vacuum - Principle of production of liquid oxygen. Management lifts fire fighting equipments.

Unit IV	HOSPITAL ENGINEERING & MANAGEMENT	9
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Definition of biomedical Engineering, clinical engineering & hospital engineering. Importance of BME department – servicing and maintenance, testing, acceptance & maintenance protocols, Computerized preventive maintenance planning, MROs. Training of men for medical equipments preventive and periodical maintenance procedures. Preparation of estimates, specifications, tender details etc. Importance of ISO 9000 Certificates - Obtaining ISO certificates in hospitals. Proposed protocols.

Unit V	HOSPITAL INFORMATION SYSTEM	9
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Role of database in HIS. Need of Networking in HIS. Overview of Networking, topologies and its configuration. Structuring medical records to carry out functions like admissions, discharges, treatment history etc. Computerization in pharmacy & billing. Automated clinical laboratory systems & radiology information system.

TEXT BOOK(S):

1. Hospital Engineering And Facilities Management 2007 - Report, Fifth official report of the International Federation of Hospital Engineering (IFHE), January 2007
2. Sakharkar, Principles of Hospital Administration and Planning, Jaypee Medical publishers 1/e, Reprint 2004

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REFERENCE(S):

1. Gupta, Kant, Chandrashekhar, Satpathy, Modern Trends in Planning and Designing of Hospitals Principles and Practice with CD-ROM, Jaypee Medical publishers, 1/e, 2007
2. Sharma, Essentials for Hospital Support Services and Physical Infrastructure, 1/e, Jaypee Medical Publishers 2003
3. Harold E. Smalley, "Hospital Management Engineering – A guide to the improvement of hospital management system", PHI.



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VIII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX22	PRINCIPLES OF TISSUE ENGINEERING	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to • Demonstrate knowledge of the difference between cells and tissues • Understand the Project performance and appraisal procedures • understand various Financing infrastructure projects • Understand different synthetic and biomaterials • Study the Impacts of private sector participation Course Outcomes: At the end of this course, learners will be able to: • Formulate the project for the approval of various authorities, • Evaluate the project performance and analyze the risks involved, • Analyze the key financial indicators in project financing, • Implement the infrastructure projects based on the different types of contract, • Interpret the aspects of PPP in Infrastructure development projects.								
Unit I FUNDAMENTALS OF TISSUE ENGINEERING								9
Tissue exchange and tissue development - Objectives of tissue engineering - Laboratory set up for tissue engineering. Cell cycle and differentiation - cell adhesion - cell adhesion molecules - cell migration - cell aggregation and tissue equivalent.								
Unit II STEM CELLS								9
Definition of stem cells – types of stem cells – differentiation, dedifferentiation maturation, proliferation, pluripotency and immortalization. Sources of stem cells: haematopoietic – fetal - cord blood – placenta - bone marrow - primordial germ cells - cancer stem cells - induced pluripotent stem cells.								
Unit III COMPONENTS OF TISSUE ENGINEERING								9
Cell and Drug delivery systems - Transplantation – Implantation - Synthetic components – nanotechnology in tissue engineering – Imaging methods: SEM, TEM, Fluorescent and Confocal microscopy.								
Unit IV MATERIALS IN TISSUE ENGINEERING								9
Biological materials – degradable and non degradable – extra cellular matrix – decellularization - Polymers: synthetic and natural – cell interaction with polymers – applications of polymer.								
Unit V APPLICATION OF TISSUE ENGINEERING								9
Replacement Engineering: Artificial organs – cartilage, skin blood, pancreas, kidney and liver. Regenerative engineering: Nerve regeneration – cardiac tissue regeneration – muscle regeneration.								
TEXT BOOK(S):								
1. Ketul Popat "Nanotechnology in Tissue Engineering and Regenerative Medicine" CRC Press Taylor and Francis 2011.								
2. R Cato T. Laurencin, Lakshmi S "Nanotechnology and Tissue Engineering: The Scaffold "CRC Press Taylor and Francis 2008.								
REFERENCE(S):								
1. Nair "Biologically Responsive Biomaterials for Tissue Engineering", Springer Series in Biomaterials Science and Engineering, Vol. 1 Antoniac, Iulian (Ed.) 2012								
2. R. Lanza, I. Weissman, J. Thomson, and R. Pedersen, "Handbook of Stem Cells", Two Volumes, Volume 1: Volume 1. Embryonic Stem Cells; Volume 2. Adult & Fetal Stem Cells, Academic Press. 2004								
3. Kun Zhou, David Nisbet, George Thouas, Claude Bernard and John Forsythe "Bio-nanotechnology Approaches to Neural Tissue Engineering", NC-SA 2010.								

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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VIII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX23	MEDICAL TEXTILES FUNDAMENTALS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Understand the technologies of medical textiles - Understand the general property of fabric materials - Know the various medical application of textiles - Study the development and applications of healthcare nano fibers - Explore the various healthcare applications of smart medical textiles								
Course Outcomes: At the end of this course, learners will be able to: - Demonstrate knowledge on basics of medical textiles, - Design and apply Nanofibers technology in medical textile fabrication, - Develop different fabrics and technology for specific medical applications, - Design and implement wearable sensors in the textiles using modern technology, - Determine new ways to use medical textiles with advancements for patient care.								
Unit I	INTRODUCTION TO MEDICAL TEXTILES							9
Characteristics of textile fibers - structures of natural and man-made fibers – physical, chemical and morphological structures. Molecular conformations – planar zig-zag, helical, lamellar, and spherulites conformations. Medical textiles – An overview, classification: Implants, Non implants, Extra corporeal, Health care and hygiene.								
Unit II	MEDICAL TEXTILE SCIENCE AND TEXTILE COATING							9
Medical textile products, processes and their applications - sutures - bandages – surgical implants - non-surgical implants - extracorporeal devices- non-woven technology – medical textile testing. Testing methods and international standards. Fabric coating: properties - polymer coatings - coating methods - medical applications – lamination.								
Unit III	MEDICAL AND HEALTHCARE NANOFIBERS							9
Fabrication of Nanofibers - Biopolymers Used for Nanofibers - Modification of Nanofibers - Biomedical Applications of Nanofibers.								
Unit IV	BIOTEXTILES AND WOUND CARE TEXTILES							9
Sutures – Vascular Grafts – Ligament Prosthesis – Hernia Repair Mesh Grafts – Artificial Kidney. Human skin wounds – Wound dressing – Pressure garments.								
Unit V	SMART MEDICAL TEXTILES AND ITS APPLICATIONS							9
Patient specific smart medical textiles – Smart medical textiles in rehabilitation – Monitoring pregnancy – Monitoring hospitalized children – Wearable textiles for mobile health monitoring.								
TEXT BOOK(S):								
1. Wen Zong, "An introduction to healthcare and medical Textiles", DEStech Publications, Inc. 2013.								
2. Volkmär T. Bartels, "Handbook of Medical Textiles", Wood head Publishing, 2011.								
3. Daniel Vallero, J. Jeffrey Peirce , "Engineering The Risks of Hazardous Wastes 1st Edition, Kindle Edition, 2003.								
REFERENCE(S):								
1. Subhash Anand, "Medical textiles and biomaterials for healthcare", Woodhead, 2006								
2. Van Langenhove, L. (2007), Smart textiles for medicine and healthcare, Wood head publishing Ltd, UK								


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VIII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P				
19BMX24	WEARABLE SYSTEMS	3	0	0	3	45	100	

Course Objective (s): The purpose of learning this course is to

- Study the various types of sensors that can be used for wearable systems
- Understand the Process the signals picked by the wearable sensors
- Know the sources of energy to be used for wearable systems
- Study the technical aspects of wireless health systems
- Explore the wearable sensors into novel medical applications

Course Outcomes: At the end of this course, learners will be able to:

- Differentiate the sensors that can be used for wearable systems,
- Process the signals picked by the wearable sensors,
- Utilize different sources of energy to be used for wearable systems,
- Analyze the technical aspects of wireless health systems,
- Apply the wearable sensors into novel medical applications.

Unit I	WEARABLE DEVICES SENSORS	9
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Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS – Based Biosensors, E-Textiles, Bio compatibility.

Unit II	SIGNAL PROCESSING FOR WEARABLE DEVICES	9
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Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Data mining.

Unit III	ENERGY HARVESTING FOR WEARABLE DEVICES	9
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Solar cell, Thermal based human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

Unit IV	HEALTH CARE SYSTEMS	9
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Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication techniques.

Unit V	APPLICATIONS OF WEARABLE SYSTEMS	9
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Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics, Defense Application – Military Clothing, Tracking Devices and Biometric Sensors for Health Monitoring.

TEXT BOOK(S):

1. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkatasubramanian, "Body Area Networks Safety, Security, and Sustainability," Cambridge University Press, 2013.
2. Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore, 2012

REFERENCE(S):

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
2. Hang, Yuan-Ting, "wearable medical sensors and systems", Springer-2013
3. Guang-Zhong Yang (Ed.), "Body Sensor Networks, "Springer, 2006
4. Andreas Lymberis, Danilo de Rossi, 'Wearable eHealth systems for Personalised Health Management - State of the art and future challenges ' IOS press, The Netherlands, 2004.



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester VIII	PE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19BMX25	MEDICAL OPTICS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Establish a basic background of tissue optics - Employ quantitative approaches to analyze photon-tissue interactions - Understand the basic principles, capabilities, and limitations of various light microscopy techniques - Develop the capability of applying the right microscopy technique(s) to address specific biomedical questions - Explore the advanced methods in optical imaging and application. Course Outcomes: At the end of this course, learners will be able to: - Implement, model, value and verify light-tissue interaction models and apply light tissue interaction models for diagnostic and therapeutic use, - Describe and choose suitable light sources, detectors and wavelengths applicable to specific medical applications and demands, - Applying and understanding the role of lasers in medicine, their applications in diagnostic and therapeutic processes, - Applying fundamental processes of light interaction with biological tissues for optical spectroscopy and imaging, - Understanding the advanced topics in optical imaging								
Unit I FUNDAMENTALS OF TISSUE OPTICS								9
Interaction of Light with Matter-Characteristics of Light – What is Biomedical Optics? – Tissue Optical Properties – Mathematical Models for Light Transport in Turbid Media like Tissues: Radiative Transport Equation: First Order Approximation – Diffusion Approximation-Monte Carlo Modelling, KubelkaMunk Theory – Laser Characteristics – Laser Tissue Interaction – Chemical – Thermal – Electromechanical – Photoablation Processes.								
Unit II BASIC INSTRUMENTATION IN BIOPHOTONICS								9
Instrumentation for Absorption-Scattering and Emission Measurements, Excitation Light Sources – High pressure Arc Lamp – Light Emitting Diode (LED) – Lasers, Photoplethysmography, Optical Filters – Polarizer, Optical Detectors: Single Channel and Multichannel Detectors – Optical Fibers – Time Resolved and Phase Resolved Detection Methods.								
Unit III MEDICAL APPLICATIONS OF LASERS								9
Laser Tissue Welding-Applications of Lasers in: Gynaecology: Treatment of Intraepithelial Neoplasia-Endometriosis-Sterilization-Dermatology and Cosmetics: for Treating Port Wine Stains, Hemangioma-Tattoo and Hair Removal-Laser Skin Resurfacing-Ophthalmology: Surgery of the Cornea-Anterior Chamber Angle-Iris and Lens-Neurosurgery: Concept of Stereotactic Laser Neurosurgery-Dentistry: Treatment of Hard Tissues and Root Canal Treatment.								
Unit IV OPTICAL SPECTROSCOPY AND IMAGING TECHNIQUES								9
Spectroscopy – Definition – Diagnostic Applications of Fluorescence, Raman and Diffuse Reflectance Spectroscopy – Imaging: Basic Principles and Clinical Applications of Optical Coherence Tomography – Optical Elastography – Fluorescence Microscopy – Basic Principles of: Confocal Microscopy – Photoacoustic Microscopy								
Unit V ADVANCED METHODS IN BIOMEDICAL OPTICS								9
Fundamentals of – Surface Enhanced and Coherence Anti – Stokes Raman Spectroscopy (SERS and CARS) – Holographic Imaging – Multiphoton Microscopy – Light Sheet Microscopy – Stimulated Emission Depletion (STED) Microscopy.								

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TEXT BOOK(S):

1. Gerd Keiser, "Biophotonics-Concepts to Applications" 1st Edition, Springer, 2016
2. Irving J. Bigio, Sergio Fantini, "Quantitative Biomedical Optics Theory, Methods, and Applications", 1st Edition, Cambridge University Press, 2016.
3. Markolf H.Niemz, "Laser-Tissue Interaction Fundamentals and Applications", 4th Edition Springer, 2019
4. Tuan Vo-Dinh, "Biomedical Photonics Handbook", 2nd Edition, Taylor & Francis,

REFERENCE(S):

1. Francesco Pavone, Paul Campagnola, "Second Harmonic Generation Imaging", Taylor & Francis, 2019
2. Kevin Tsia, "Understanding Biophotonics: Fundamentals, Advances, and Applications", 1st Edition, Taylor & Francis, 2015
3. Ashley J Welch, Martin J C van Gemert, "Optical-Thermal Response of Laser-Irradiated Tissue", 2nd Edition, Springer, 2011
4. Robert Splinter, "An Introduction to Biomedical Optics", 1st Edition, Taylor & Francis, 2007.



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LANGUAGE ELECTIVE

Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HX201	ENGLISH FOR ENGINEERS	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Acquire usage of grammar in English language. - Develop listening skills which will enable to listen lectures and comprehend different types of texts. - Enhance the reading skill to comprehend technical writings. - Improve writing skills to express thoughts freely. - Help learners develop their speaking skills and speak fluently in real contexts.								
Course Outcomes: At the end of this course, learners will be able to: 1. Improve their language usage in LSRW skills. 2. Develop listening skills to understand sentence stress and intonations. 3. Acquire the ability to understand different written texts. 4. Enhance the writing skills to express the ideas of the learners. 5. Communicate fluently in pair / team.								
Unit I	LANGUAGE FOCUS							9
Prepositions - Articles - Conjunctions - Voice(Active & Passive) - Reported speech - Conditionals - Collocations -Discourse markers - One word substitution - Phrasal verbs								
Unit II	LISTENING							9
Listening to identify topic, content, function - Sentence stress - Rhythm - Intonation								
Unit III	READING							9
Reading graphs and charts - Skimming and scanning texts - Read business articles for specific information - Understanding the structure of a text - Error identification								
Unit IV	WRITING							9
Application for a job - Recommendations - Report writing (accident and survey) - Writing review (book and movie) - Transcoding								
Unit V	SPEAKING							9
Collaborative task - Turn taking (initiating and responding appropriately) - Negotiating - Exchanging - Language Functions: suggesting - comparing and contrasting – expressing - Finding out facts, attitudes and opinions - Commonly mispronounced words								
TEXT BOOK(S): 1. Communicative English by KN Shoba ,Lourdes JoavaniRayenPublised by Cambridge university 2017								
REFERENCE(S): 1. Jeremy Comfort, Pamela Rogerson, Trish Stott, and Derek Utley, Speaking Effectively and Developing Speaking Skills for Business English, Cambridge: Cambridge University Press, 2002. 2. Eric H. Glendinning and Beverly Holmstrom, Study Reading: A Course In Reading for Academic Purposes.United Kingdom: Cambridge University Press, 2004. 3. Murphy, Raymond. English Grammar in Use - A Self-Study Reference and Practice Book for Intermediate learners Of English .Ived. United Kingdom: Cambridge University Press. 2012. 4. Seely, John. Oxford Guide to Effective Writing and Speaking. Indian Ed. New Delhi: Oxford University Press. 2005.								



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Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HX202	HINDI	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - To help students to acquire the basics of Hindi - To teach them how to converse in Hindi on various occasions - To help learners acquire the ability to understand a simple technical text in Hindi								
Course Outcomes: At the end of this course, learners will be able to: An ability to communicate effectively with: (a) Improved fluency in Hindi (b) Clarity on the basic sounds of the Hindi language (c) Proper vocabulary								
Unit I	HINDI ALPHABET							9
Genders (Masculine & Feminine Nouns ending in a ,e,i,o, u,)- Masculine & Feminine - Reading Exercises.Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu&Visarg -Table of Alphabet -Vocabulary.								
Unit II	NOUNS IN HINDI							9
Genders (Masculine & Feminine Nouns ending in a ,e,i,o, u,)- Masculine & Feminine - Reading Exercises.								
Unit III	PRONOUNS AND TENSES							9
Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.								
Unit IV	CLASSIFIED VOCABULARY							9
Parts of body - Relatives - Spices- Eatables- Fruit & Vegetables - Clothes - Directions-Seasons - Professions.								
Unit V	SPEAKING							9
Model Sentences - Speaking practice for various occasions.								
TEXT BOOK(S): - Elementary Hindi: Learn to Communicate in Everyday Situations by Richard Delacy Tuttle Publication 2013 - Colloquial Hindi: The Complete Course for Beginners by Tej K. Bhatia								
REFERENCE(S): B. R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009. - Syed, PrayojanMulak Hindi, RahamathullahVaniPrakasan, New Delhi, 2002. - Ramdev, VyakaranPradeep, SaraswathiPrakasan, Varanasi, 2004.								


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Department	BIOMEDICAL ENGINEERING					R 2019	Semester II	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HX203	JAPANESE	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to • help students acquire the basics of Japanese language • teach them how to converse in Japanese in various occasions • teach the students the Japanese cultural facets and social etiquette								
Course Outcomes: At the end of this course, learners will be able to communicate effectively with: • Improved fluency in Japanese • Clarity on the basic sounds of the Japanese language • Proper vocabulary								
Unit I Introduction to Japanese								9
Introduction to Japanese - Japanese script - Pronunciation of Japanese (Hiragana) - Long vowels - Pronunciation of in,tsu,ga - Letters combined with ya,yu,yo - Daily Greetings and Expressions Numerals. N1 wa N2 des - N1 wa N2 jaarimasen - S ka - N1mo - N1 no N2 - .san - Kanji - Technical Japanese Vocabulary (25 Numbers) - Phonetic and semantic resemblances between Tamil and Japanese								
Unit II Introduction - Kore								9
Introduction - Kore - Sore - are - Kono N1 - Sono N1 - ano N1 - so des - so jaarimasen - S1 ka - S2 ka - N1 no N1 - so des ka ' koko - soko - asoko - kochira - sochira - achira - N1 wa N2 (Place) des - dhoko-N1 no N2 - Kanji-10 - ima-.ji-fun des - Introduction of verb - V mas - V masen - V mashitha-V masendeshitha - N1(Time)ne V - N1 kara N2 des - N1 tho N2 / S ne Kanji-10 - Technical Japanese Vocabulary (25 Numbers) - Dictionary Usage.								
Unit III Technical Japanese Vocabulary								9
N1 (Place) ye ikimas - ki mas - kayerimasu - Dhoko ye moikimasen - ikimasendheshitha - N1(vehicle) de ikimasu - kimasu - kayerimasu - N1(Personal or Animal) tho V ithsu - S yo. - N1 wo V (Transitive) - N1 woshimus - Naniwoshimasuka - Nan & Nani - N1(Place) de V - V masenka - V masho - Oo. Kanji-10 , N1(tool - means) de V - Word / Sentence wa go nan des ka - N1(Person) ne agemus - N1(Person) ne moraimus - mo V shimashitha - , Kanji-10 - Japanese Typewriting using JWPCE Software, Technical Japanese Vocabulary (25 Numbers)								
Unit IV Introduction to Adjectives								9
Introduction to Adjectives - N1wanaadj des. N1 wa ii adj des - naadjna N1 - ii adj ii N1 - Thothemo - amari - N1 wadho des ka - N1 wadhonna N2 des ka - S1 ka S2 - dhore - N1 gaarimasu - wakarimasu - N1 gasukimasu - N1 gairaimasu - jozu des - hetha des - dhonna N1 - Usages of yoku - dhaithai - thakusan - sukoshi - amari - zenzen - S1 kara S2 - dhoshithe, N1 gaarimasu - imasuN1(Place) ne N2 gaarimasu - iimasu - N1 wa N2(Place) ne arimasu - iimasu - N1(Person,Place,or Thing) no N2 (Position) - N1 ya N2, Kanji-10 - Japanese Dictionary usage using JWPCE Software, Technical Japanese Vocabulary (25 Numbers)								
Unit V Saying Numbers								9
Saying Numbers , Counter Suffixes , Usages of Quantifiers -Interrogatives - Dhonokurai - gurai - Quantifier- (Period) ne -.kai V - Quantifier dhake / N1 dhake Kanji - Past tense of Noun sentences and na Adjective sentences - Past tense of ii-adj sentences - N1 wa N2 yoriadj des - N1 tho N2 thoDhochiragaadj des ka and its answering method - N1 [no naka] de {nani/dhoko/dhare/ithsu} ga ichiban adj des ka - answering -N1 gahoshi des- V1 mas form dhake mas - N1 (Place) ye V masu form ne ikimasu/kimasu/kayerimasu - N1 ne V/N1 wo V - Dhokoka - Nanika - gojumo - Technical Japanese Vocabulary (25 Numbers)								
TEXT BOOK(S): 1. Modern Japanese Vocabulary: A Guide for 21st Century Students Edward P. Trimnell Publisher:Beechmont Crest Publishing (April 28) 2. Japanese Verbs & Essentials of Grammar" Rita Lampkin Passport Books , 2013								

REFERENCE(S):

1. Japanese for Everyone: Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.



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Department	BIOMEDICAL ENGINEERING					R 2019	SemesterII	HS
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks	
		L	T	P	C			
19HX204	FRENCH	3	0	0	3	45	100	
Course Objective (s): The purpose of learning this course is to - Help students acquire the basics of French language - Teach them how to converse in French in various occasions								
Course Outcomes: At the end of this course, learners will be able to: The students will become familiar with the basics of French language and start conversing in French.								
Unit I Alphabet Français								6
Alphabet Français (alphabets) - Les Accents Français (the accents in French) - aigu - grave - circonflexe - trémacédille - écrire son nom dans le français (spellingone -sname in French) - Les noms de jours de la semaine (Days of the week)								
Unit II Grammaire								6
Les noms de mois de l'année (Months) - Numéro 1 à 100 (Numbers 1 to 100) GRAMMAIRE :Conjugaison								
Unit III Moyens de transport								10
Moyens de transport (Transport) - Noms de Professions (Professions) - Nomsd'endroitscommuns (Places) - Nationalités (Nationalities) ECOUTER : (Listening) Écouter I - alphabet associéà des prénomsfrançais - Écouter et répondre PARLER (Speaking)Présntation - même /Présentez - Vous (Introducingoneself)LIRE :Lireles phrases simples								
Unit IV Pronoms								12
Pronoms (Pronouns) - Nomscommunsmasculins et de femme (Common masculine and Femininenouns) - Verbescommuns (Common verbs)COUTER :couter et crier les prnoms - Observer les dessins et couter les dialogues LIRE : Lire les profilsd'utilisateursd'interlingua (alter ego)PARLER :Parler de saviile - Parler de sa profession								
Unit V Europe PARLER								11
Narration de son nom et l'endroitoù on vit - Son âge et date de naissance - Numéro de téléphoneet'dresse -Narration du temps - La France en Europe PARLER :Conversation entre deuxamis - Jouer la scène ÉCOUTER :Ecouter les conversations (CD alter ego)ÉCRIRE :Écrireune carte postale								
TEXT BOOK(S): 1. <u>Le Bon Usage</u> by M. Grevisse Publisher- Duculot 14 edition (25 January 2001) 2. <u>Advanced French</u> by Monique L'Huillier, Cambridge University Press,2013								
REFERENCE(S): 1. Alter ego+ Niveau a1 2. Grammaire Progressive du Français 3. Collins Easy Learning French Verbs& Practice 4. Français Linguaphone 5. FrançaisI.Harrisonburg: The Rosetta Stone: Fairfield Language Technologies								



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**OPEN ELECTIVE
OFFERED BY
BIOMEDICAL ENGINEERING**

Department - BMS
Department - BMS

Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19BMY01	BASICS OF BIOMEDICAL INSTRUMENTATION	3	0	0	3	45	100
Course Objective (s): The purpose of learning this course is to - Study about the different bio potential and its propagation - Understand the different types of electrodes and its placement for various recording - Study the design of bio amplifier for various physiological recording - Learn the different measurement techniques for non-physiological parameters - Familiarize the different biochemical measurements							
Course Outcomes: At the end of this course, learners will be able to: - Learn the different bio potential and its propagation, - get Familiarize the different electrode placement for various physiological recording, - Students will be able design bio amplifier for various physiological recording, - Students will understand various technique non electrical physiological measurements, - Understand the different types of biochemical measurements.							
Unit I	BIO POTENTIAL GENERATION AND ELECTRODES TYPES						9
Origin of bio potential and its propagation. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.							
Unit II	BIO SIGNAL CHARACTERISTICS AND ELECTRODE CONFIGURATIONS						9
Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven"s triangle, standard 12 lead system. EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode.							
Unit III	SIGNAL CONDITIONING CIRCUITS						9
Need for bio-amplifier - differential bio-amplifier, Impedance matching circuit, isolation amplifiers, Power line interference, Right leg driven ECG amplifier, Band pass filtering							
Unit IV	MEASUREMENT OF NON-ELECTRICAL PARAMETERS						9
Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution, and dye dilution method, ultrasound blood flow measurement.							
Unit V	BIO-CHEMICAL MEASUREMENT						9
Blood gas analyzers and Non-Invasive monitoring, colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer.							
TEXT BOOK(S):							
1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.							
2. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004							
REFERENCE(S):							
1. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2003.							
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.							
3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.							



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Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19BM02	BIOSENSORS AND TRANSDUCERS	3	0	0	3	45	100
Course Objective (s): The purpose of learning this course is to - Understand the fundamental concepts various types of biosensors, - Analyze how biosensors are characterized, compared to each other, and designed to suit particular applications, - Study the biochemical functionality is coupled to a biosensor transducer, - Expose students to several of the most important emerging biosensor technologies - Encourage the practice of critical thinking when considering a new detection technology and to develop the ability to communicate well-researched opinions to others.							
Course Outcomes: At the end of this course, learners will be able to: - Gain a broad knowledge of the applications of various sensors and transducers, - Describe the fundamental transduction and bio-sensing principles, - Understand various measurement devices and techniques, - Develop a clear concept and perform logical analysis of various measurement systems using different types of sensors, electrodes, signal conditioning circuits for acquiring and recording various physiological parameters, - Critically review the literature in the application area and apply knowledge gained from the course to analyze simple bio-sensing and transduction problems.							
Unit I	TRANSDUCERS PRINCIPLES AND MEDICAL APPLICATIONS						9
Classification of transducers, characteristic of transducers, Temperature transducers: Resistance temperature detector (RTD), Thermistor, Thermocouple, p-n junction, chemical thermometry, Displacement transducers: potentiometer, resistive strain gauges, inductive displacement, capacitive displacement transducer, Pressure transducer: variable capacitance pressure transducers, LVDT transducers, strain gauge transducers, semiconductor transducers, catheter tip transducers, Piezoelectric transducer, Photoelectric transducers: photo-emissive tubes, photovoltaic cell, photoconductive cell, photodiodes, Flow transducers: magnetic, resistive and ultrasonic.							
Unit II	BIOPOTENTIAL ELECTRODES						9
Electrode electrolyte interface, polarization, polarizable and non-polarizable electrodes, Electrode Behavior and, Circuit Models, Electrode-skin Interface and Motion Artifact, Body-Surface Recording Electrodes, Internal Electrodes: Needle & wire electrodes, Electrode Arrays, Microelectrodes: Metal supported metal, micropipette (metal filled glass and glass micropipette electrodes) and properties of microelectrodes. Electrodes for Electric Stimulation of Tissue (i.e. for ECG, EMG & EEG).							
Unit III	CHEMICAL BIOSENSORS						9
Electrochemical sensors (Amperometric, Potentiometric, Conductimetric), Noninvasive Blood-Gas Monitoring, Blood-Glucose Sensors, Transducers for the measurement of ion and dissolved gases, Reference electrodes - Hydrogen electrodes, Silver- Silver Chloride electrode, Calomel electrodes, glass pH electrodes, Measurement of PO₂, PCO₂ - Catheter type electrodes.							
Unit IV	OPTICAL SENSOR AND RADIATION DETECTORS						9
Principles of optical sensors, optical fiber sensors, Indicator mediated transducers, optical fiber temperature sensors, Proportional counter, Gas-ionisation chamber, Geiger counters and Scintillation detectors.							
Unit V	BIOLOGICAL SENSORS						9
Sensors / receptors in the human body and their basic mechanism of action, organization of nervous system-neural mechanism, Chemoreceptor: hot & cold receptors, barro receptors, sensors for smell, touch, sound, vision and taste, Ion exchange membrane electrodes, enzyme electrode, glucose sensors, Immuno sensors, Principles of MOSFET & BIOMEMS, Basic idea about Smart sensors.							

TEXT BOOK(S):

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.
2. John G. Webster, "Medical Instrumentation Application and Design" 4th Ed, Wiley, 2011
3. Shakti Chatterjee & Aubert Miller, "Biomedical Instrumentation Systems", Delmer Cengage Learning, 1St Ed, 2010.

REFERENCE(S):

1. Deric P. Jones, "Biomedical Sensors", Momentum press, 1St Ed, 2010.
2. Carr & Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.
3. Rao & Guha, "Principles of Medical Electronics & Biomedical Instrumentation", University Press, India..



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Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19BMY03	BIOTELEMETRY & TELEMEDICINE	3	0	0	3	45	100
Course Objective (s): The purpose of learning this course is to • Study about the different bio potential and its propagation • Understand the different types of electrodes and its placement for various recording • Study the design of bio amplifier for various physiological recording • Learn the different measurement techniques for non-physiological parameters • Familiarize the different biochemical measurements							
Course Outcomes: At the end of this course, learners will be able to: • Learn the different bio potential and its propagation, • get Familiarize the different electrode placement for various physiological recording, • Students will be able design bio amplifier for various physiological recording, • Students will understand various technique non electrical physiological measurements, • Understand the different types of biochemical measurements.							
Unit I	BASICS OF TELEMETRY						9
Fundamental concepts - Significance, Principle, functional blocks of Telemetry and Tele control system, Methods of telemetry - Electrical, Pneumatic, Hydraulic and Optical Telemetry - State of the art-Telemetry standards.							
Unit II	BIOTELEMETRY						9
Components of telemetry system, Bio-telemetry and its importance, Single and multi-channel biotelemetry, ECG telemetry system, Temperature telemetry system, Telemetry of ECG and Respiration, Sports telemetry, Multi-patient telemetry, Ambulatory patient monitoring, Implantable telemetry systems, transmission of physiological signals over telephone line, Telemedicine and applications,							
Unit III	FUNDAMENTALS OF TELEMEDICINE						9
History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems – Functional diagram, benefits & limitations of telemedicine, Applications of Telemedicine - Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health and Cyber Medicine.							
Unit IV	TELEMEDICINE TECHNOLOGIES						9
Principles of Multimedia - Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare. Internet technology and telemedicine using world wide web (www). Clinical data – local and centralized, PACS architecture. Encryption, Cryptography..							
Unit V	TELEMEDICAL APPLICATIONS						9
Telemedicine access to health care services – health education and self care. · Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services – health education and self care, Business aspects - Project planning and costing, Usage of telemedicine.							
TEXT BOOK(S):							
1. Khandpur R S, "Telemedicine – Technology and Applications", PHI Learning Pvt Ltd., New Delhi, 2017.							
2. H K Huang, "PACS and Imaging Informatics: Basic Principles and Applications" Wiley, New Jersey, 2010							

REFERENCE(S):

1. Rajarao C and Guha S.K. "Principles of Medical Electronics and Bio-medical Instrumentation", Universities press (India) Ltd, First Edition, Orient Longman Ltd, 2001
2. Ferrer-Roca, O., Sosa - Iudicissa, M. (Eds.), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54, 2002
3. Mohan Bansal, "Medical Informatics", Tata McGraw-Hill, 2004



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Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19BMY04	BIOMEDICAL ENGINEERING IN FITNESS	3	0	0	3	45	100
Course Objective (s): The purpose of learning this course is to							
• Study the basics of soft tissue mechanics • Understand the mechanics of head and neck after having an injury • Understand the mechanics of different joints of the human body • Learn the different gait analysis of a human • Understand the functions of human organs during Yoga							
Course Outcomes: At the end of this course, learners will be able to:							
• Illustrate the basics of soft tissue mechanics, • Analyze the mechanics of head and neck after having an injury, • Distinguish the mechanics of different joints of the body, • Interpret the gait analysis, • Discuss the functions of human organs during Yoga.							
Unit I	CONCEPT OF PHYSICAL EDUCATION AND HEALTH						9
Definition, Aims and Objectives of Physical Education, Importance and Scope of Physical Education Modern concept of Health, Physical fitness and Wellness, Health related Physical Fitness and Assessment, Kinetic Diseases and its Management							
Unit II	COMPONENTS OF PHYSICAL FITNESS						9
Physical fitness components - Speed, Strength, Endurance, Flexibility and Coordinative Abilities Types of Physical Fitness - Health related Physical Fitness, Performance Related Physical Fitness and Cosmetic fitness, Fitness Balance.							
Unit III	PRINCIPLES OF EXERCISE PROGRAMME						9
Activities for developing Physical Fitness Components, Exercise and Heart rate Zones, Principles of First Aid Nutritional Balance. Stress control exercise – Sitting meditation, Walking meditation, Progressive muscular relaxation, Gentle stretches and Massage.							
Unit IV	YOGA AND STRESS MANAGEMENT						9
Impact of Yoga on Muscular system, Respiratory System, Circulatory system, Nervous system, Digestive system and Endocrine system, Physiology of Stress on: Autonomic Nervous System (ANS), Endocrine System, Hypothalamus, Cerebral Cortex and Neurohumours.							
Unit V	HEALTH CARE FITNESS						9
Cardiac and Diabetes Health Care, Respiratory Care, Stress and Anxiety Management, Health Fitness, Assessment and Maintenance (HFAM) System, Mental and Neurological Rehabilitation.							
TEXT BOOK(S):							
1. Ravishankar.N.S., (2001). Yoga for Health. New Delhi: Pustak Maha							
2. ACSM's "Health Related Physical Fitness Assessment Manual Lippincott Williams and Walkins USA, 2005							
REFERENCE(S):							
1. Yogendra, Hansa Jayadeva and Desai, Armaiti Neriosand., (1991) Yoga for back and joint disorders. Mumbai: Dr.Jayadeva Yogendra for the yoga institute.							
2. Iyengar, BKS., (2003). The Art of Yoga. New Delhi: Harper Collins Publishers.							

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Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P			
19BMY05	PRINCIPLES OF GENETIC ANALYSIS	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is to

- Learn different forms of inheritance patterns and identify them in genetic data,
- Get knowledge in evolutionary analysis of genetic sequence
- Understand outcomes of statistical analysis associated with the research project
- Study the molecular genetic information to conduct a research project
- Study the Impacts of genetic variation

Course Outcomes: At the end of this course, learners will be able to:

- Interpret different forms of inheritance patterns and identify them in genetic data
- Acquire in depth knowledge in evolutionary analysis of genetic sequence
- Interpret and critically evaluate the outcomes of statistical analysis associated with the research project
- Exploit relevant molecular genetic information with skill and confidence to conduct a research project involving the analysis of real molecular genetic data with minimal supervision
- Interpret the aspects of genetic variation.

Unit I GENETIC INHERITANCE

9

Organization of DNA, Chromosomal inheritance, Eukaryotic genomes – repetitive and non-repetitive sequence, Genetic mapping - restriction cleavage, RFLP and SNPs.

Unit II DNA AND PHENOTYPE

9

DNA structure and replication, DNA sequencing, amplification and hybridization. DNA Polymorphism, RNA transcription and processing, translation and its post translation modification. Regulation of gene expression.

Unit III ENGINEERING OF GENES

9

Gene isolation and manipulation, mutations, repair and recombination, site directed mutagenesis, in vivo techniques of genetic manipulation, tools for analyzing gene expression and genetically modified organisms.

Unit IV HUMAN GENOME PROJECT

9

Human Genome Project (HGP) – an overview of the project, goals of the project, major scientific strategies & approaches used in HGP, physical mapping, gene ontology, gene annotation, techniques in HGP – microsatellite markers, STS, EST, DNA sequencing and DNA microarray, scientific & medical benefits of this project.

Unit V IMPACT OF GENETIC VARIATION

9

Genetic variation in wild and agricultural population, Basic Cyto-Genetics Techniques, Immunology Testing, Bacterial and Virus cytogenetic evaluation.

TEXT BOOK(S):

1. Anthony J.F. Griffiths, Susan R. Wessler, Sean B. Carroll, John Doebley, Introduction to Genetics Analysisll, – W.H Freeman & company, New York 11th Edition – 2015.
2. Watson. J. etal, — Molecular Biology of the Gene —, 7th Edition, Pearson Publication, 2014.

REFERENCE(S):

1. Karp, Gerald - Cell and Molecular Biology. Concepts and Experiments, 7th Edition, John Wiley Sons, 2013.
2. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten —Molecular Biotechnology, Principles and application of Recombinant DNA 4th Edition ASM Press, 2010.


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Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19BMY06	MEDICAL ELECTRONICS	3	0	0	3	45	100
Course Objective (s): The purpose of learning this course is to							
- Understand the human body electro- physiological parameters and recording of bio-potentials - Know the non-electrical physiological parameters and their measurement - Study the various assist devices used in the hospitals - Learn the physical medicine methods and Biotelemetry principle - Know the recent trends in medical instrumentation							
Course Outcomes: At the end of this course, learners will be able to:							
- Know the human body electro- physiological parameters and recording of bio-potentials, - Comprehend the non-electrical physiological parameters and their measurement – body temperature, blood pressure, pulse, blood cell count, blood flow meter etc. - Interpret the various assist devices used in the hospitals viz. pacemakers, defibrillators, dialyzers and ventilators - Comprehend physical medicine methods eg. ultrasonic, shortwave, microwave surgical diathermies , and bio-telemetry principles and methods - Know about recent trends in medical instrumentation							
Unit I	ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING						9
Sources of bio medical signals, Bio-potentials, Bio potential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, typical waveforms and signal characteristics							
Unit II	BIO-CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT						9
pH, PO ₂ , PCO ₂ , Colorimeter, Blood flow meter, Cardiac output, respiratory, blood pressure, temperature and pulse measurement, Blood Cell Counters.							
Unit III	ASSIST DEVICES						9
Cardiac pacemakers, DC Defibrillator, Dialyser, Ventilators, Magnetic Resonance Imaging Systems, Ultrasonic Imaging Systems.							
Unit IV	PHYSICAL MEDICINE AND BIOTELEMETRY						9
Diathermies – Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy, Biotelemetry.							
Unit V	RECENT TRENDS IN MEDICAL INSTRUMENTATION						9
Telemedicine, Insulin Pumps, Radio pill, Endomicroscopy, Brain machine interface, Lab on a chip.							
TEXT BOOK(S):							
1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007							
2. John G.Webster, "Medical Instrumentation Application and Design", 3rd Edition, Wiley India Edition, 2007							
REFERENCE(S):							
1. Khandpur, R.S., "Handbook of Biomedical Instrumentation", TATA Mc Graw-Hill, New Delhi, 2003							
2. Joseph J.Carr and John M.Brown, "Introduction to Biomedical Equipment Technology", John Wiley and Sons, New York, 2004.							

Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19BMY07	MEDICAL INFORMATICS	3	0	0	3	45	100
Course Objective (s): The purpose of learning this course is to - Understand the structure of medical informatics and its systems - Explore the patient record digitization techniques - Study the clinical approaches and advancements in applying informatics using computers in imaging - Understand the theories and practices adopted in Hospital Information Systems in medical data formats - Learn ICT applications in medicine with an introduction to health informatics.							
Course Outcomes: At the end of this course, learners will be able to: - Gain knowledge on the structure of medical informatics and its functioning, - Learn about the clinical information system computerization - Discuss about automatic computerization in different bio signal acquisition - Explain the function of Hospital Information Systems - Discuss about health informatics and different ICT applications in medicine							
Unit I	INTRODUCTION TO MEDICAL INFORMATICS						9
Structure of Medical Informatics –Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, e-health services, Health Informatics – Medical Informatics, Bioinformatics							
Unit II	COMPUTERISED PATIENT RECORD						9
Introduction - History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.							
Unit III	COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING						9
Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging-nuclear medicine, ultrasound imaging ultrasonography-computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance							
Unit IV	COMPUTER ASSISTED MEDICAL DECISION AND MAKING						9
Neuro computers and Artificial Neural Networks application, Expert system – General model of CMD, Computer – assisted decision support system-production rule system cognitive model, semester networks analysis, decisions analysis in clinical medicine-computers in the care of critically patients-computer assisted surgery-designing.							
Unit V	RECENT TRENDS IN MEDICAL INFORMATICS						9
Virtual reality applications in medicine, IOT healthcare and medical information distribution Computer assisted surgery , Surgical simulation Telemedicine - Tele surgery computer aids for the handicapped, computer assisted instrumentation in Medical Informatics – Computer assisted patient education and health - Medical education and health care information.							
TEXT BOOK(S):							
1. OrpitaBosu and Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University press, 2007							
2. R.D.Lele Computers in medicine progress in medical informatics, Tata McGraw Hill Publishing computers Ltd,2005, New Delhi							

REFERENCE(S):
1. Yi Ping Phoebe Chen, "Bioinformatics Technologies", Springer International Edition, New Delhi, 2007.
2. Mohan Bansal, Medical informatics Tata McGraw Hill Publishing computers Ltd, 2003 New Delhi.
3. Alain Venot -Medical Informatics, e-Health, Fundamental and Applications, Springer-Verlag Paris, 2013.
4. H M Dietel, Internet and World Wide Web, AB Goldberg publishers, New Delhi, 2007



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Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19BMY08	DESIGN OF MEDICAL ELECTRONIC DEVICES	3	0	0	3	45	100

Course Objective (s): The purpose of learning this course is to

- Understand the human body electro- physiological parameters and recording of bio-potentials
- Know the non-electrical physiological parameters and their measurement
- Study the various assist devices used in the hospitals
- Learn the physical medicine methods and Biotelemetry principle
- Know the recent trends in medical instrumentation

Course Outcomes: At the end of this course, learners will be able to:

- Know the human body electro- physiological parameters and recording of bio-potentials,
- Comprehend the non-electrical physiological parameters and their measurement
- Interpret the various assist devices used in the hospitals
- Comprehend physical medicine methods eg. ultrasonic, shortwave, microwave surgical diathermies , and bio-telemetry principles and methods
- Know about recent trends in medical instrumentation

Unit I	DATA ACQUISITION AND NOISE ISSUES	9
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Physical Principles of Sensing, Sensor Interfacing, Driving Bridges, Signal Conditioning Amplifiers, Data Acquisition: Sample and Hold Conversion, Multi channel Acquisition, Internal Noise In OPAMPS, Bypass Capacitors and Resonances, Electromagnetic Interference, interference from external electric field, conductive interference, electrical safety and signal isolation, Overload Protection, Output Filtering, Power Failure Warning

Unit II	DESIGN METHODOLOGIES	9
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EDR design methodologies, PCB assembly, mechanical assembly, product design and modeling, fabrication and assembly, Multi-layer circuit design, Advanced OrCAD design, Design rule specifications

Unit III	DIAGNOSTIC EQUIPMENT DESIGN	9
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ECG, EEG, Blood pressure monitor, Thermometer, System description and diagram of pulse oximeter, Optical fiber optics for circulatory and respiratory system measurement, Magnetic resonance imaging (MRI) Hardware design

Unit IV	THERAPEUTIC EQUIPMENT DESIGN	9
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Pacemaker, External cardio-vector defibrillator, Implantable cardio-vector defibrillator, Deep brain stimulation, Functional electrical stimulator (FES), Hemodialysis delivery system, Mechanical ventilator

Unit V	IMPLANT AND PROSTHESIS DESIGN	9
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Intraocular lens implant, Cochlear implants, Heart valves, Design of artificial pancreas, Drug eluting stent and its engineering design, synthetic crafts, Total hip prosthesis, Joint replacement

TEXT BOOK(S):

1. Theodore R. Kucklick, —The Medical Device Ramp-D Handbookll, Taylor &Francis Group LLC, 3rd edition 2013.
2. Anthony Y.K.Chan, —Biomedical device technology: principles and designll, Charles C Thomas, 2008.

REFERENCE(S):

1. Martin Culjat, Rahul Singh, Hua Lee, "Medical Devices: Surgical and Image-Guided Technologiesll, John Wiley & Sons, Reinaldo Perez, "Design of medical electronic devicell, Elsevier science, 2002.
2. Richard C. Fries, "Handbook of Medical Device Design", Marcel Dekker AG, 2nd edition 2005.
3. David Prutchi, Michael Norris, "Design and Development of Medical Electronic Instrumentation: A Practical perspective of the design, construction and test of medical devicesll, John Wiley & Sons, 2005



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Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19BMY09	HOSPITAL ENGINEERING AND MANAGEMENT	3	0	0	3	45	100
Course Objective (s): The purpose of learning this course is to • Provide knowledge an overview of hospital administration • Understand the principles, practices and areas of application in Hospital management • Learn the quality aspect specified by the international standards • Enlighten with the Quality and safety issues in hospital • Understand the principles, practices and areas of application in Hospital Management							
Course Outcomes: At the end of this course, learners will be able to: • Explain the principles, practices and areas of application in Hospital Management • Understand the biomedical waste disposal concept • Explain the importance of supportive services • Comprehend the quality aspect specified by the international standards. • Knowledge on Hospital safety							
Unit I	OVERVIEW OF HOSPITAL ADMINISTRATION						9
Sole proprietorship, Partnership, Company-public and private sector enterprises, Principles of management, Evolution of management.							
Unit II	HUMAN RESOURCE MANAGEMENT IN HOSPITAL						9
Management of Hospital organization, Nursing section Medical Sector, Central Services, Technical Department, Definition and Practice of Management by Objective, Transactional Analysis Human relation in Hospital, Importance to Team Work, Legal aspect in Hospital Management.							
Unit III	MARKETING STANDARDS & CONSUMER BEHAVIOUR						9
FDA Regulation, joint commission on Accreditation for Hospitals, National Fire Protection Association Standard, IRPC.							
Unit IV	HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES						9
Organizing Maintenance Operations, Paper Work Control, Maintenance Job, Planning Maintenance Work Measurement and Standards, Preventive Maintenance, Maintenance Budgeting and Forecasting, Maintenance Training, Contract Mainframe.							
Unit V	QUALITY AND SAFETY ASPECTS IN HOSPITAL						9
Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards. Health and Safety Standard, Environment Management Systems. NABA, JCI, NABL, NABH and FDA. Health Insurance & Managing Health Care - Medical Audit – Hazard and Safety in a hospital Setup.							
TEXT BOOK(S):							
1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI–4th edition							
2. G.D.Kunders, "Hospitals – Facilities Planning and Management", TMH, New Delhi – 5th edition Reprint 2007							
REFERENCE(S):							
1. Cesar A.Caceres and Albert Zara, "The Practice of Clinical Engineering", Academic Press,New York,1977.							
2. Norman Metzger , "Handbook of Health Care Human Resources Management", Aspen Publication Inc. Rockville, Maryland, USA. 2nd Edition 1990							


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Department	BIOMEDICAL ENGINEERING					R 2019	OE
Course Code	Course Name	Hours / Week			Credit	Total Hours	Maximum Marks
		L	T	P	C		
19BMY10	MEMS AND NEMS	3	0	0	3	45	100
Course Objective (s): The purpose of learning this course is to							
• Provide knowledge an MEMS and NEMS • Introduce the concepts of micro and nano electromechanical devices • Know the fabrication process of Microsystems • Know the design concepts of micro sensors and micro actuators • Introduce the concepts of quantum mechanics and nano systems							
Course Outcomes: At the end of this course, learners will be able to:							
• Gain knowledge on the MEMS and NEMS, • Interpret the basics of micro/nano electromechanical systems including their applications and advantages • Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA • Analyze the key performance aspects of electromechanical transducers including sensors and actuators • Comprehend the theoretical foundations of quantum mechanics and nano systems							
Unit I	INTRODUCTION TO MEMS AND NEMS						9
Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electro mechanical Systems, Applications of Micro and Nano electro mechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals.							
Unit II	MEMS FABRICATION TECHNOLOGIES						9
Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA.							
Unit III	MICRO SENSORS						9
MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester.							
Unit IV	MICRO ACTUATORS						9
Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces.							
Unit V	NANO DEVICES						9
Atomic Structures and Quantum Mechanics, Shrodinger Equation, ZnO nanorods based NEMS device: Gas sensor.							
TEXT BOOK(S):							
1. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006							
2. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2002							
REFERENCE(S):							
1. Tai Ran Hsu ,"MEMS and Microsystems Design and Manufacture" ,Tata Mcraw Hill, 2002							
2. Stephen D. Senturia," Micro system Design", Kluwer Academic Publishers,2001							
3. Marc Madou, "Fundamentals of Microfabrication", CRC press 1997							


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