B.E. (Biomedical Engineering)

Revised 2018 Regulations, Curriculum & Syllabi

(Candidates admitted during Academic Year 2021-2022)

Stay Ahead

BANNARI AMMAN INSTITUTE OF TECHNOLOGY

An Autonomous Institution Affiliated to Anna University - Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

SATHYAMANGALAM - 638401 ERODE DISTRICT TAMILNADU INDIA

Ph : 04295-226000/221289 Fax : 04295-226666 E-mail : stayahead@bitsathy.ac.in Web : www.bitsathy.ac.in

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VISION OF THE DEPARTMENT

Department of Biomedical Engineering envisages to propel creative engineering knowledge and advancements in biomedical technology to improve the healthcare conditions for the benefit of mankind.

MISSION OF THE DEPARTMENT

1. To focus on healthcare engineering that includes the study and understanding of biological systems.
2. To emphasize quantitative analysis and directly tying concepts with healthcare and diagnostics.
3. To encourage entrepreneurship in Biomedical Engineering fostering innovations in healthcare.
4. To inculcate interdisciplinary work and focus on research and development in Biomedical Engineering.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

I. Engage in professional development or post-graduate education for continuing self-development in biomedical engineering or other related fields.

II. Pursue a wide range of career options, including those in industry, academia, and medicine.

III. Practice professionally as biomedical engineers and/or biomedical scientists in the, field of health care sector for the wellbeing of humankind.

IV. Build careers addressing human health problems within a multidisciplinary, global industry.

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

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

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

c. **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.

d. **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.

e. **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f. **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.

g. **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.

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

i. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j. **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.

k. **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.

l. **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.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

m. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

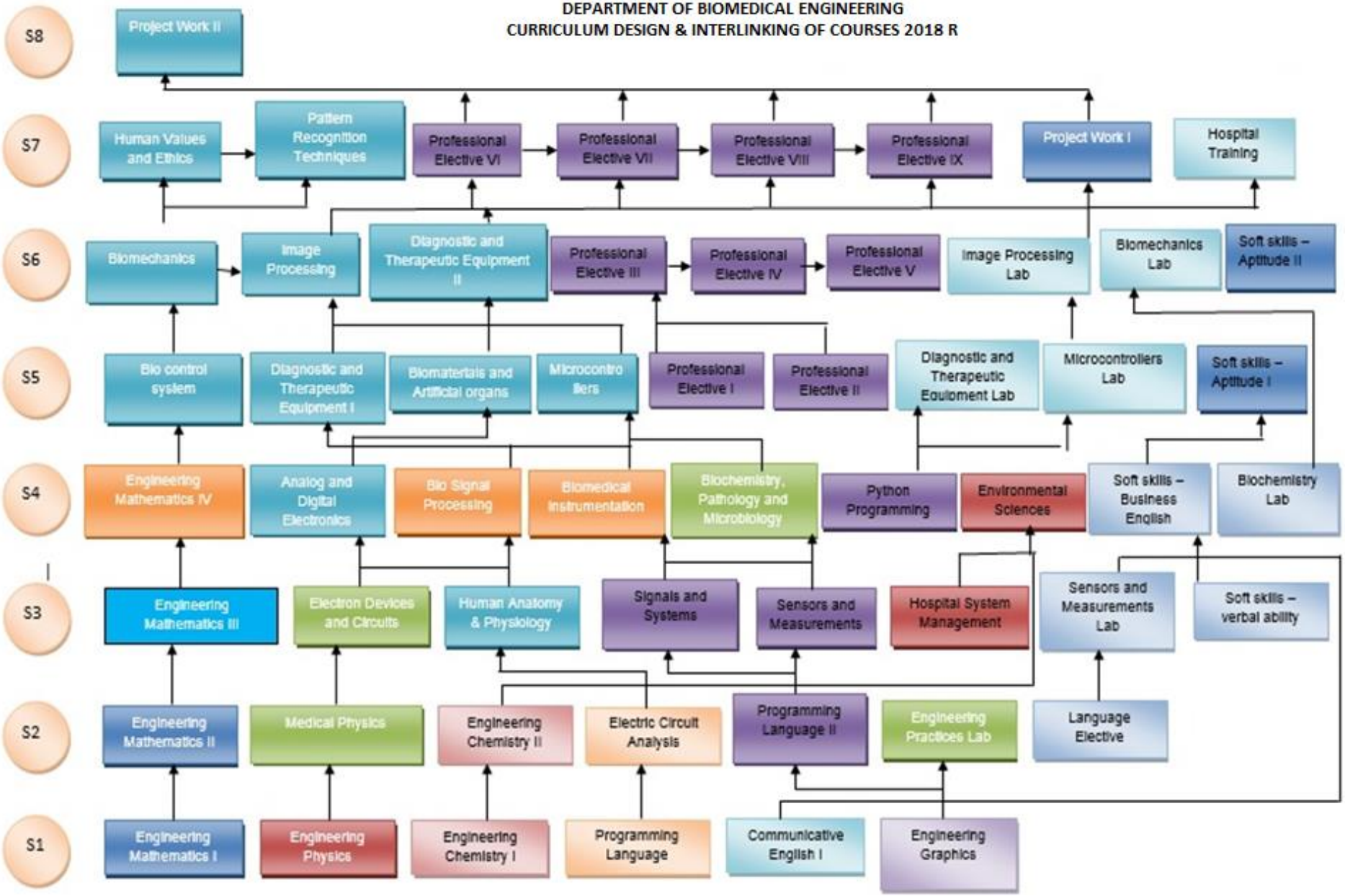
n. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

o. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

MAPPING OF PEOs AND POs

POs	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
PEO1	X						X					X	X		
PEO2						X	X	X	X	X					X
PEO3		X	X	X	X								X	X	
PEO4						X			X		X			X	X

DEPARTMENT OF BIOMEDICAL ENGINEERING
CURRICULUM DESIGN & INTERLINKING OF COURSES 2018 R



DEPARTMENT OF BIOMEDICAL ENGINEERING
Minimum Credits to be Earned : 161

I SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
19BM101	ENGINEERING MATHEMATICS I	3	1	0	4	4	40	60	100	BS
19BM102	ENGINEERING PHYSICS	2	0	2	3	4	50	50	100	BS
19BM103	ENGINEERING CHEMISTRY I	2	0	2	3	4	50	50	100	BS
19BM104	PROGRAMMING LANGUAGE I	2	0	2	3	4	50	50	100	ES
19HS101	COMMUNICATIVE ENGLISH I	1	0	2	2	3	100	0	100	HS
19BM106	ENGINEERING GRAPHICS	1	0	4	3	5	100	0	100	ES
Total		**11**	**1**	**12**	**18**	**24**	**-**	**-**	**-**	**-**

II SEMESTER

Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ES	Total	
19BM201	ENGINEERING MATHEMATICS II	3	1	0	4	4	40	60	100	BS
19BM202	MEDICAL PHYSICS	3	0	0	3	3	40	60	100	BS
19BM203	ENGINEERING CHEMISTRY II	2	0	2	3	4	50	50	100	BS
19BM204	ELECTRIC CIRCUIT ANALYSIS	3	1	0	4	4	40	60	100	ES
	LANGUAGE ELECTIVE	-	-	-	2	2	100	0	100	HS
19BM206	PROGRAMMING LANGUAGE II	2	0	2	3	4	50	50	100	ES
19BM207	ENGINEERING PRACTICES LABORATORY	0	0	4	2	4	100	0	100	BS
Total		**13**	**2**	**8**	**21**	**25**	**-**	**-**	**-**	**-**

III SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
19BM301	ENGINEERING MATHEMATICS III	3	1	0	4	4	40	60	100	BS
19BM302	SENSORS AND MEASUREMENTS	3	1	0	4	4	40	60	100	PC
19BM303	HUMAN ANATOMY AND PHYSIOLOGY	3	0	0	3	3	40	60	100	PC
19BM304	ELECTRON DEVICES AND CIRCUITS	3	1	0	4	4	40	60	100	ES
19BM305	SIGNALS AND SYSTEMS	3	1	0	4	4	40	60	100	PC
19BM306	HOSPITAL SYSTEM MANAGEMENT	3	0	0	3	3	40	60	100	PC
19BM307	SENSORS AND MEASUREMENTS LABORATORY	0	0	2	1	2	100	0	100	PC
19BM308	ELECTRON DEVICES AND CIRCUITS LABORATORY	0	0	2	1	2	100	0	100	ES
18GE301	SOFT SKILLS - VERBAL ABILITY	0	0	2	-	2	100	0	100	EEC
Total		**18**	**4**	**6**	**24**	**28**	**-**	**-**	**-**	**-**
IV SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
19BM401	ENGINEERING MATHEMATICS IV	3	1	0	4	4	40	60	100	BS
19BM402	ANALOG AND DIGITAL ELECTRONICS	3	1	0	4	4	40	60	100	ES
19BM403	BIOSIGNAL PROCESSING	3	1	0	4	4	40	60	100	PC
19BM404	BIOMEDICAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PC
19BM405	BIOCHEMISTRY, PATHOLOGY & MICROBIOLOGY	3	0	0	3	3	40	60	100	PC
19BM406	PYTHON PROGRAMMING	2	0	2	3	4	50	50	100	ES
19BM407	BIOSIGNAL PROCESSING LABORATORY	0	0	2	1	2	100	0	100	PC
19BM408	BIOCHEMISTRY & PHYSIOLOGY LABORATORY	0	0	2	1	2	100	0	100	PC
18HS001	ENVIRONMENTAL SCIENCE*	2	0	0	-	2	100	0	100	HS
18GE401	SOFT SKILLS – BUSINESS ENGLISH	0	0	2	-	2	100	0	100	EEC
Total		**19**	**3**	**8**	**23**	**30**	**-**	**-**	**-**	**-**

V SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21BM501	BIO CONTROL SYSTEMS	3	1	0	4	4	40	60	100	PC
21BM502	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT I	3	0	0	3	3	40	60	100	PC
21BM503	BIOMATERIALS AND ARTIFICIAL ORGANS	3	0	0	3	3	40	60	100	PC
21BM504	MICROCONTROLLERS	3	0	0	3	3	40	60	100	PC
	PROFESSIONAL ELECTIVE I	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE II	3	0	0	3	3	40	60	100	PE
21BM507	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY	0	0	2	1	2	100	0	100	PC
21BM508	MICROCONTROLLERS AND IOT LABORATORY	0	0	4	2	4	100	0	100	PC
18GE501	SOFT SKILLS - APTITUDE I	0	0	2	-	2	100	0	100	EEC
Total		**18**	**1**	**8**	**22**	**27**	**-**	**-**	**-**	**-**
VI SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21BM601	BIOMECHANICS	3	1	0	4	4	40	60	100	HS
21BM602	IMAGE PROCESSING	3	0	0	3	3	40	60	100	PC
21BM603	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT II	3	0	2	4	5	50	50	100	PC
	PROFESSIONAL ELECTIVE III	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IV	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE V	3	0	0	3	3	40	60	100	PE
21BM607	IMAGE PROCESSING LABORATORY	0	0	2	1	2	100	0	100	PC
21BM608	BIOMECHANICS LABORATORY	0	0	2	1	2	100	0	100	PC
18GE601	SOFT SKILLS - APTITUDE II	0	0	2	-	2	100	0	100	EEC
Total		**18**	**1**	**8**	**22**	**27**	**-**	**-**	**-**	**-**

VII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21HS002	HUMAN VALUES AND ETHICS	2	0	0	2	2	40	60	100	HS
21BM702	PATTERN RECOGNITION TECHNIQUES	3	0	0	3	3	40	60	100	PC
	PROFESSIONAL ELECTIVE VI	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE VIII	3	0	0	3	3	40	60	100	PE
	PROFESSIONAL ELECTIVE IX	3	0	0	3	3	40	60	100	PE
21BM707	HOSPITAL TRAINING	0	0	4	2	4	60	40	100	EEC
21BM708	PROJECT WORK I	0	0	6	3	6	60	40	100	EEC
Total		**17**	**0**	**10**	**22**	**27**	**-**	**-**	**-**	**-**
VIII SEMESTER										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours/ Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
21BM801	PROJECT WORK II	0	0	18	9	18	60	40	100	EEC
Total		**0**	**0**	**18**	**9**	**18**	**-**	**-**	**-**	**-**

ELECTIVES										
LANGUAGE ELECTIVES										
Code No.	**Course**	**L**	**T**	**P**	**C**	**Hours /Week**	**Maximum Marks**			**Category**
							CA	**ES**	**Total**	
18HS201	COMMUNICATIVE ENGLISH II	1	0	2	2	3	100	0	100	HSS
18HSH01	HINDI	1	0	2	2	3	100	0	100	HSS
18HSG01	GERMAN	1	0	2	2	3	100	0	100	HSS
18HSJ01	JAPANESE	1	0	2	2	3	100	0	100	HSS
18HSC01	CHINESE	1	0	2	2	3	100	0	100	HSS
18HSF01	FRENCH	1	0	2	2	3	100	0	100	HSS
PROFESSIONAL ELECTIVES										
VERTICAL I - SIGNALS AND IMAGE PROCESSING										
21BM001	SPEECH AND AUDIO SIGNAL PROCESSING	3	0	0	3	3	40	60	100	PE
21BM002	BIOMETRIC SYSTEMS	3	0	0	3	3	40	60	100	PE
21BM003	BRAIN COMPUTER INTERFACE	3	0	0	3	3	40	60	100	PE
21BM004	ADVANCED MEDICAL IMAGE ANALYSIS	3	0	0	3	3	40	60	100	PE
21BM005	MACHINE VISION	3	0	0	3	3	40	60	100	PE
21BM006	DEEP LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	PE
VERTICAL II - ADVANCE HEALTHCARE DEVICES										
21BM007	ASSISTIVE DEVICES	3	0	0	3	3	40	60	100	PE
21BM008	BIO MEMS AND NANO TECHNOLOGY	3	0	0	3	3	40	60	100	PE
21BM009	VIRTUAL INSTRUMENTATION	3	0	0	3	3	40	60	100	PE
21BM010	REHABILITATION AND ROBOTICS ENGINEERING	3	0	0	3	3	40	60	100	PE
21BM011	CRITICAL CARE EQUIPMENT	3	0	0	3	3	40	60	100	PE
21BM012	RADIOLOGICAL EQUIPMENT	3	0	0	3	3	40	60	100	PE
VERTICAL III- TECHNOLOGY IN BIOMEDICINE										
21BM013	CELL BIOLOGY	3	0	0	3	3	40	60	100	PE

21BM014	TISSUE ENGINEERING	3	0	0	3	3	40	60	100	PE
21BM015	GENETIC ENGINEERING	3	0	0	3	3	40	60	100	PE
21BM016	CANCER BIOLOGY	3	0	0	3	3	40	60	100	PE
21BM017	BIO COMPUTATIONAL TECHNIQUES	3	0	0	3	3	40	60	100	PE
21BM018	NEUROSCIENCE	3	0	0	3	3	40	60	100	PE
VERTICAL IV - BIOMECHANICS										
21BM019	CARDIOVASCULAR ENGINEERING	3	0	0	3	3	40	60	100	PE
21BM020	PHYSIOLOGICAL MODELLING	3	0	0	3	3	40	60	100	PE
21BM021	PROSTHETIC AND ORTHOTIC DEVICES	3	0	0	3	3	40	60	100	PE
21BM022	REGENERATIVE MEDICINE AND ERGONOMICS	3	0	0	3	3	40	60	100	PE
21BM023	FINITE ELEMENT ANALYSIS	3	0	0	3	3	40	60	100	PE
21BM024	HAPTICS	3	0	0	3	3	40	60	100	PE
VERTICAL V - COMMUNICATION IN HEALTHCARE										
21BM025	MEDICAL TEXTILES	3	0	0	3	3	40	60	100	PE
21BM026	WEARABLE SYSTEMS AND BODY AREA NETWORKS	3	0	0	3	3	40	60	100	PE
21BM027	TELEMEDICINE AND IOT	3	0	0	3	3	40	60	100	PE
21BM028	BIOINFORMATICS	3	0	0	3	3	40	60	100	PE
21BM029	VIRTUAL AND AUGMENTED REALITY IN HEALTHCARE	3	0	0	3	3	40	60	100	PE
21BM030	MEDICAL OPTICS	3	0	0	3	3	40	60	100	PE
VERTICAL VI – HEALTHCARE MANAGEMENT										
21BM031	MEDICAL WASTE MANAGEMENT	3	0	0	3	3	40	60	100	PE
21BM032	MEDICAL ETHICS	3	0	0	3	3	40	60	100	PE
21BM033	PATIENT SAFETY AND STANDARDS	3	0	0	3	3	40	60	100	PE
21BM034	MEDICAL DEVICE REGULATIONS	3	0	0	3	3	40	60	100	PE
21BM035	FORENSIC SCIENCE IN HEALTHCARE	3	0	0	3	3	40	60	100	PE
21BM036	CLINICAL ENGINEERING	3	0	0	3	3	40	60	100	PE

VERTICAL VII - MEDICAL DEVICE DESIGN AND DEVELOPMENT										
21BM037	MEDICAL DEVICE DESIGN	3	0	0	3	3	40	60	100	PE
21BM038	MEDICAL EQUIPMENT MAINTENANCE AND TROUBLESHOOTING	3	0	0	3	3	40	60	100	PE
21BM039	ADVANCED BIOSENSORS	3	0	0	3	3	40	60	100	PE
21BM040	DRUG DELIVERY SYSTEM	3	0	0	3	3	40	60	100	PE
21BM041	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	3	0	0	3	3	40	60	100	PE
21BM042	INTERVENTIONAL AND DIAGNOSTIC RADIOLOGY	3	0	0	3	3	40	60	100	PE
HONOURS DEGREE COURSES										
21BMH01	MEDICAL WASTE MANAGEMENT	3	0	0	3	3	40	60	100	PE
21BMH02	MEDICAL ETHICS	3	0	0	3	3	40	60	100	PE
21BMH03	MEDICAL DEVICE DESIGN	3	0	0	3	3	40	60	100	PE
21BMH04	MEDICAL EQUIPMENT MAINTENANCE AND TROUBLESHOOTING	3	0	0	3	3	40	60	100	PE
21BMH05	FORENSIC SCIENCE IN HEALTHCARE	3	0	0	3	3	40	60	100	PE
21BMH06	CLINICAL ENGINEERING	3	0	0	3	3	40	60	100	PE
OPEN ELECTIVE COURSES										
21OCE01	ENERGY CONSERVATION AND MANAGEMENT	3	0	0	3	3	40	60	100	OE
21OCS01	OBJECT ORIENTED PROGRAMMING	3	0	0	3	3	40	60	100	OE
21OCS02	JAVA FUNDAMENTALS	3	0	0	3	3	40	60	100	OE
21OCS03	KNOWLEDGE DISCOVERY IN DATABASES	3	0	0	3	3	40	60	100	OE
21OCS04	E-LEARNING TECHNIQUES	3	0	0	3	3	40	60	100	OE
21OCS05	SOCIAL TEXT AND MEDIA ANALYTICS	3	0	0	3	3	40	60	100	OE
21OEC04	PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS	3	0	0	3	3	40	60	100	OE
21OEI01	PROGRAMMABLE LOGIC CONTROLLER	3	0	0	3	3	40	60	100	OE
21OME01	DIGITAL MANUFACTURING	3	0	0	3	3	40	60	100	OE
21OME02	INDUSTRIAL PROCESS ENGINEERING	3	0	0	3	3	40	60	100	OE

21OME03	MAINTENANCE ENGINEERING	3	0	0	3	3	40	60	100	OE
21OBT01	BIOFUELS	3	0	0	3	3	40	60	100	OE
21OFD01	TRADITIONAL FOODS	3	0	0	3	3	40	60	100	OE
21OFD02	FOOD LAWS AND REGULATIONS	3	0	0	3	3	40	60	100	OE
21OFD03	POST-HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES	3	0	0	3	3	40	60	100	OE
21OFD04	CEREAL, PULSES AND OIL SEED TECHNOLOGY	3	0	0	3	3	40	60	100	OE
21OFT01	FASHION CRAFTSMANSHIP	3	0	0	3	3	40	60	100	OE
21OFT02	INTERIOR DESIGN IN FASHION	3	0	0	3	3	40	60	100	OE
21OFT03	SURFACE ORNAMENTATION	3	0	0	3	3	40	60	100	OE
21OPH05	PHYSICS OF SOFT MATTER	3	0	0	3	3	40	60	100	OE
21OCH01	CORROSION SCIENCE AND ENGINEERING	3	0	0	3	3	40	60	100	OE
21OCH02	POLYMER SCIENCE	3	0	0	3	3	40	60	100	OE
21OCH03	ENERGY STORING DEVICES	3	0	0	3	3	40	60	100	OE
21OMA01	GRAPH THEORY AND COMBINATORICS	3	0	0	3	3	40	60	100	OE
21OGE01	PRINCIPLES OF MANAGEMENT	3	0	0	3	3	40	60	100	OE
21OGE02	ENTREPRENEURSHIP DEVELOPMENT I	3	0	0	3	3	40	60	100	OE
21OGE03	ENTREPRENEURSHIP DEVELOPMENT II	3	0	0	3	3	40	60	100	OE
21OGE04	NATION BUILDING: LEADERSHIP AND SOCIAL RESPONSIBILITY	3	0	0	3	3	40	60	100	OE
ONE CREDIT COURSES										
19BM0XA	3D PRINTING	1	0	0	1	1	50	50	100	OC
19BM0XB	BIOMIMETICS	1	0	0	1	1	50	50	100	OC
19BM0XC	MEDICAL EQUIPMENTS TROUBLESHOOOTING AND CALIBRATION	1	0	0	1	1	50	50	100	OC
19BM0XD	INTRODUCTION TO HEALTHCARE SYSTEMS ENGINEERING	1	0	0	1	1	50	50	100	OC
19BM0XE	HEALTH INFORMATICS AND MEDICAL TECHNOLOGY	1	0	0	1	1	50	50	100	OC
19BM0XF	EMBEDDED SYSTEMS FOR MEDICAL APPLICATIONS	1	0	0	1	1	50	50	100	OC

19BM0XG	NON INVASIVE BI LEVEL UNIT VENTILATOR	1	0	0	1	1	50	50	100	OC
19BM0XH	BIOINFORMATICS TECHNIQUES FOR THE ANALYSIS OF BIOLOGICAL SEQUENCES	1	0	0	1	1	50	50	100	OC
19BM0XI	MODELING OF NANO BIOMATERIAL BASED SENSORS	1	0	0	1	1	50	50	100	OC
OPEN ELECTIVE COURSES (For other than BME Students)										
19BM0YA	AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT	3	0	0	3	3	40	60	100	OE
19BM0YB	HOSPITAL AUTOMATION	3	0	0	3	3	40	60	100	OE

SUMMARY OF CREDIT DISTRIBUTION

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	10	12	4	4	-	-	-	-	30	19	15%	20%
2	ES	6	7	5	7	-	-	-	-	25	16	15%	20%
3	HSS	2	2	-	-	-	4	2	-	10	6	5%	10%
4	PC	-	-	15	12	16	9	5	-	57	35	35%	45%
5	PE	-	-	-	-	6	9	12	-	27	17	15%	20%
6	EEC	-	-	-	-	-	-	3	9	12	7	5%	10%
Total		18	21	24	23	22	22	22	9	161	100	-	-

BS - Basic Sciences
ES - Engineering Sciences
HSS - Humanities and Social Sciences
PC - Professional Core
PE - Professional Elective
EEC - Employability Enhancement Course
CA - Continuous Assessment
ES - End Semester Examination

19BM101 ENGINEERING MATHEMATICS I 3 1 0 4

Course Objectives

- Understand the concepts of vectors and Eigen vectors for different matrices to describe the stability of the linear systems in engineering fields.
- Exemplify the concepts of differentiation and integration to identify the area of 2D and 3D surfaces in engineering problems.
- Explain the concepts of analytic functions in complex domain to predict the nature of different engineering systems.

Course Outcomes (COs)

1. Represent the different forms of coordinate system in complex plane and characteristics of linear systems by Eigenvalues and Eigenvectors.
2. Analyse various types of functions and their differentiation techniques involved in engineering fields.
3. Implement different methods of integration used in engineering problems.
4. Execute the suitable integration technique to calculate the area and volume of different surfaces.
5. Apply the concept of analytic function to estimate the integral in complex plane.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	3													
2	2	2													
3	2	2													
4	1	2													
5	1	2													

UNIT I **9 Hours**

COMPLEX NUMBERS, VECTORS AND MATRICES

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices : Eigen values and Eigen vectors, Properties of eigen values and eigen vectors.

UNIT II **9 Hours**

CALCULUS

Limits and Continuity of Functions: Limits of functions, types of limits, evaluation of limits, continuity of functions, properties of continuous functions. Derivatives: Derivatives, differentiability, rules and properties, differentiation of transcendental functions, higher order derivatives, implicit differentiation, and differentiation of hyperbolic functions. Integration: Anti-derivatives, Riemann Sum, indefinite and definite integration, Mean Value Theorem for definite integral, Fundamental Theorem of Calculus.

9 Hours

UNIT III

INTEGRATION METHODS

Basic integration formulae for algebraic and transcendental functions. Integration by special devices: integration by parts, rationalizing substitution or trigonometric substitution, partial fractions, reduction formulas, improper integrals, convergence tests.

UNIT IV **9 Hours**

APPLICATIONS OF DERIVATIVES AND INTEGRATIONS

Extreme values, points of inflection and curve sketching, Rolles Theorem, Mean Value Theorem, optimization, indeterminate forms, L Hopitals Rule.
Area between curves, volume of a general solid by slicing and cylindrical shell methods, volume of a solid of revolution, length of plane curves, area of a surface of revolution.

UNIT V **9 Hours**

COMPLEX ANALYSIS

Analytic Functions- Properties of Analytic function - Determination of Analytic Function using Milne Thompson method. Cauchys Integral Formula - Classification of Singularities - Cauchys Residue Theorem.

FURTHER READING

Quadratic forms -Reduction of a quadratic form to a canonical form - Application of conic sections, quadratic surfaces - discrete dynamical systems - Triple integral in polar coordinates-Formation of Bus Admittance Matrices. Applications of mass spring system in ordinary differential equations of higher order.

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.
3. Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999
4. Anton H, Calculus with Analytic Geometry, 5th edition, John Wiley & Sons, 1995.
5. Ayres F Jr and Mendelson E, Schaums Outline of Theory and Problems of Calculus, 4th edition, McGraw Hill, 1999.
6. S.C. Gupta, Fundamentals of Statistics, 7th Edition, Himalaya Publishing House Pvt. Ltd. 2018.

19BM102 ENGINEERING PHYSICS 2 0 2 3

Course Objectives

- Illustrate the Newtons laws of motion and wave motion with applications
- Understand the basic properties of electricity, magnetism and optics
- Differentiate the special theory of relativity and quantum physics from classical physics

Course Outcomes (COs)

1. Illustrate the Newtons three laws of motion and apply the same to solve the real world problems involving elevator, atwood machine and acceleration of objects
2. Exemplify the physical characteristics of simple harmonic motion, wave motion and find the solutions for wave equations
3. Infer the fundamental laws, properties of electricity and magnetism and apply the same to electric and magnetic elements
4. Apply the principles of physical and geometrical optics in the mirrors, lenses, microscopes and diffraction gratings
5. Outline the importance of special theory of relativity, quantum physics and analyse the wave and particle nature of matter

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	1							2						
2	2								2						
3	2	2													
4	2	2							2						
5	2	1							2						

UNIT I **6 Hours**

MECHANICS

Newtons laws of motion: Concept of force and its nature - Newtons first law and inertial frames - definition of mass -Newtons second law-gravitational force and weight -Newtons third law. Applications of Newtons laws: particle in equilibrium, particle under net force - weighing a mass in an elevator, the atwood machine and acceleration of two objects connected by a cord

UNIT II **6 Hours**

OSCILLATIONS AND WAVES

Fundamentals of simple harmonic motion-energy of simple harmonic oscillator -spring mass system - time period of simple pendulum, compound pendulum and torsional pendulum -Damped oscillations. Travelling wave motion -sinusoidal waves on strings -speed of a wave -reflection and transmission - rate of energy transfer in wave motion

UNIT III **6 Hours**

ELECTRICITY AND MAGNETISM

Point charges -electric fields -Gauss law and its applications -electric potential -capacitance -energy stored in a capacitor.
Concept and source of magnetic fields -Amperes theorem -determination of magnetic field due to different current distributions -Faradays law -self-induction and mutual induction -energy stored in an inductor

UNIT IV **6 Hours**

LIGHT AND OPTICS

Nature of light -laws of reflection and refraction -refractive index and Snells law -dispersion of light -total internal reflection -image formation:concave mirrors -convex mirrors -thin lenses -compound microscope -human eye.
Conditions of interference -Youngs double slit experiment -intensity distribution of interference -phase change due to reflection -diffraction-narrow slit diffraction -single slit and two slit -intensity distribution -diffraction grating -applications

UNIT V **6 Hours**

MODERN PHYSICS

Special theory of relativity- simultaneity and time dilation -twin paradox -length contraction -relativistic mass variation -space time graph.
Black body radiation and Planck hypothesis -allowed energy levels -thermal radiation from different objects -photoelectric and Compton effect. Matter waves -de-Broglie hypothesis -wave nature of particles - Davission-Germer experiment

5 Hours

EXPERIMENT 1

Determination of resultant of system of concurrent coplanar forces-Parallelogram law of forces

5 Hours

EXPERIMENT 2

Determination of moment of inertia-Torsional pendulum

5 Hours

EXPERIMENT 3

Determination of wavelength of mercury spectral lines-spectrometer

4 Hours

EXPERIMENT 4

Determination of refractive index of solid and liquid-travelling microscope

3 Hours

EXPERIMENT 5

Determination of wavelength of laser-diffraction grating

4 Hours

EXPERIMENT 6

Determination of frequency of a tuning fork-MeldeÃ¢??s apparatus

4 Hours

EXPERIMENT 7

Thickness of a thin wire using interference of light-Air wedge method

Total: 60 Hours

Reference(s)

1. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2011
2. Halliday and Resnick, Fundamentals of Physics, John Wiley and Sons, Inc, 2011
3. H C Verma, Concepts of Physics (Vol I & II), BharathiBhawan Publishers & Distributors, New Delhi, 2017
4. H D Young and R A Freedman, Sears and Zemanskys University Physics with Modern Physics, Pearson education, 2016
5. R K Gaur and S L Gupta, Engineering Physics, Dhanpat Rai Publications, 2012

19BM103 ENGINEERING CHEMISTRY I 2 0 2 3

Course Objectives

- Reproduce types of chemical bonding and explain its theory.
- Recall the principle and terminologies of electrochemistry
- Exemplify the causes and consequences of corrosion
- Interpret the two types of adsorption, role of catalyst and its mechanism in chemical reactions
- Explain the terminologies of photochemistry and its applications of biochemical process

Course Outcomes (COs)

1. Interpret the bonding interactions of biomolecules and its three dimensional orientations
2. Differentiate electrodes used in the electrochemical cells and outline its applications
3. Compare two types of corrosions and execute a method to control corrosion.
4. Illustrate reaction mechanism and assess role of catalyst for high yield
5. Analyze the materials, based on optical properties for selected bio-applications

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2				1										
2	3	2	1												
3	2	1	1												
4	3	2													
5	2	2													

UNIT I **6 Hours**

CHEMICAL BONDING

Bonding: Classification of bonds - primary bonds (covalent, electrovalent, dative and metallic bonds) - secondary bonds (dipole-dipole, ionic, H-bonding, Vander Waals and hydrophobic interactions) - theories of chemical bonding - valence bond and molecular orbital theory.

UNIT II **6 Hours**

ELECTROCHEMISTRY

Electrode potential, standard electrode potential - half-cell reactions - Nernst equation (equation only) - determination of single electrode potential. Cells - cell representation - types (difference between electrochemical and electrolytic cells) - Calomel electrode - silver-silver chloride electrode and ion-selective electrode (glass electrode - measurement of pH using glass electrode) - electrochemical series and its importance. Electroplating and electroless plating.

UNIT III **6 Hours**

CORROSION SCIENCE

Corrosion - chemical and electrochemical corrosion - Pilling-Bedworth rule - mechanism (types of oxide layer, oxygen absorption - hydrogen evolution) - Galvanic series -types of electrochemical corrosion: Galvanic corrosion - differential aeration corrosion: pitting, pipeline and waterline - factors influencing corrosion. Corrosion control: sacrificial anode - impressed current method.Protective coatings - paint -constituents and functions.

UNIT IV **6 Hours**

SURFACE CHEMISTRY AND CATALYSIS

Adsorption: Types of adsorption - adsorption of gases on solids - adsorption of solute from solutions - adsorption isotherms - Freundlich"s adsorption isotherm - Langmuir"s adsorption isotherm - kinetics of surface reactions, unimolecular reactions, Langmuir - applications of adsorption on pollution abatement.

Catalysis: Catalyst-types of catalysis - criteria - autocatalysis - catalytic poisoning and catalytic promoters - acid base catalysis - applications- enzyme catalysis- Michaelis - Menten equation.

UNIT V **6 Hours**

PHOTOCHEMISTRY

Photochemistry: Electromagnetic radiation- energy level- Electronic, Vibrational and rotational transitions. Laws of photochemistry - Grotthuss Draper law, Stark Einstein law and Lambert- Beer Law. Quantum efficiency - determination- photo-sensitization- photo processes - Internal conversion, Inter-system crossing, Fluorescence, Phosphorescence, Chemiluminescence

3 Hours

EXPERIMENT 1

Preparation of N/10 oxalic acid and N/10 sodium carbonate solution.

3 Hours

EXPERIMENT 2

Determination of strength of hydrochloric acid in a given solution using pH meter

4 **Hours**

EXPERIMENT 3

Measurement of rate of corrosion on mild steel in aerated / neutral / acidic / alkaline medium

4 Hours

EXPERIMENT 4

Determination of rate of a typical chemical reaction- Ester hydrolysis

4 Hours

EXPERIMENT 5

Estimation of iron (thiocyanate method) in the given solution by spectrophotometric method

3 Hours

EXPERIMENT 6

Estimation of curcumin content in a given sample using spectrophotometer

3 Hours

EXPERIMENT 7

Electroplating of Cu and Ni.

3 Hours

EXPERIMENT 8

Preparation of ethyl acetate by esterification and ester hydrolysis via saponification reactions.

3 Hours

EXPERIMENT 9

Preparation of simple organic fluorescence compound: Xanthene dyes

Total: 60 Hours

Reference(s)

1. Jain and Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2013
2. S. Vairam, Engineering Chemistry, John Wiley & sons, 2014.
3. P Atkins, J de Paula, and J. Keeler, Physical Chemistry, Oxford University Press, 11th Edition, 2017.

19BM104 PROGRAMMING LANGUAGE I 2 0 2 3

Course Objectives

- Understand the basics of C primitives, operators and expressions
- Gain knowledge about the different primitive and user defined data types
- Impart knowledge about the structural programming concepts

Course Outcomes (COs)

1. Implement C programs using operators, type conversion and input-output functions.
2. Apply decision making and looping statements in writing C programs.
3. Develop C programs using the concepts of Arrays and strings.
4. Apply the concepts of functions and pointers in writing C programs.
5. Design applications using structures, unions and files in C

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	2			2										
2	1	2			2										
3	1	3			2										
4	1	3			2										
5	1	2			2										

UNIT I **3 Hours**

INTRODUCTORY CONCEPTS

Introduction to C- Planning and writing a C program- Operators and Expressions- Arithmetic - Relational - Logical - Increment and decrement - Conditional - Bitwise - Comma - Sizeof() - Assignment - Shift operator Precedence and order of evaluation

UNIT II **3 Hours**

CONTROL STATEMENTS

Decision Making and Branching- Decision Making and Looping -Jump Statements.

UNIT III **3 Hours**

ARRAYS AND STRINGS

Arrays- Introduction, declaration - Initialization of one dimensional array, two-dimensional arrays, initializing two dimensional arrays. Strings- String handling functions.

UNIT IV **3 Hours**

FUNCTIONS

User Defined Functions- Elements of user defined functions - categories of function - call by value and call by reference - recursion

UNIT V **3 Hours**

STRUCTURES AND FILES

Structures - Introduction - defining a structure - declaring structure variables - accessing structure members -File Management in C

3 Hours

EXPERIMENT 1

Implement a C program which include a Fundamental Data types Integer, Float, double and Character.

3 Hours

EXPERIMENT 2

Implement a C program to perform the Arithmetic Operations using primitive data types

3 Hours

EXPERIMENT 3

Implementation of logical, relational, bitwise, increment/decrement and conditional Operators in C

3 Hours

EXPERIMENT 4

Implementation of Simple if else Conditional Statement.

3 Hours

EXPERIMENT 5

Implementation of nested if else Conditional Statement

3 Hours

EXPERIMENT 6

Implementation of Switch Case Statement.

3 Hours

EXPERIMENT 7

Implement a C program using for Looping Statement.

3 Hours

EXPERIMENT 8

Implement a C program using Do-While Looping Statement.

3 Hours

EXPERIMENT 9

Implement a C program using While Looping Statement.

3 Hours

EXPERIMENT 10

Implementation of Jumping Statements

3 Hours

EXPERIMENT 11
Implementation of One Dimensional Array and Two Dimensional Array.

3 Hours

EXPERIMENT 12
Implement a C program to perform String Manipulation Functions.

3 Hours

EXPERIMENT 13
Implement a C program using structures and files

3 Hours

EXPERIMENT 14
Implement a C program which includes four categories of functions and recursive functions.

3 Hours

EXPERIMENT 15
Implement a C program for Call by value and Call by Reference.

Total: 60 Hours

Reference(s)

1. Herbert Schildt, C -The complete Reference, Tata McGraw-Hill, 2017
2. Byron Gottfried , Programming with C, Schaum"s Outlines, Tata Mcgraw-Hill, 2013
3. E.Balagurusamy, Programming in ANSI C, Tata McGraw-Hill, 2012
4. Kernighan B W and Ritchie O M, The C programming Language. Prentice-Hall of India, 2009
5. Kelley A and I. Pohl, A Book on C : Programming in C, Pearson Education, 1998
6. Ashok.N.Kamthane,Programming in C,Pearson education,2013

19HS101 COMMUNICATIVE ENGLISH I 1 0 2 2

Course Objectives

- Read and understand the main points on familiar matters regularly encountered in work, school or leisure.
- Listen and respond in most common situations where English is spoken.
- Write simple connected texts on topics which are familiar or of personal interest.
- Describe experiences and events, hopes and ambitions and briefly give reasons and explanations for opinions and plans.

Course Outcomes (COs)

1. Use appropriate grammar & vocabulary that is expected at the BEC Preliminary exam level.
2. Understand the general meaning of non-routine letters within own work area, and short reports of a predictable nature.
3. Write straightforward, routine letters of a factual nature, and make notes on routine matters, such as taking/placing orders.
4. Follow simple presentations/demonstrations.
5. Deal with predictable requests from a visitor, state routine requirements, and offer advice within own job area on simple matters.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1															
2															
3															
4															
5															

UNIT I **9 Hours**

GRAMMAR

Tenses Future continuous, Past continuous, Past perfect, Past simple, Past tense responses, Present perfect continuous, Present perfect/past simple Reported speech Adverbs intensifiers Comparatives and superlatives Conditionals 2nd and 3rd Connecting words expressing cause and effect, contrast Phrasal verbs Prepositions of place Simple passive - Wh-questions in the past Question tags Will and going to, for prediction.

UNIT II **9 Hours**

READING

Understanding short real-world notices, messages Detailed comprehension of factual material; skimming and scanning skills - Interpreting visual information Reading for detailed factual information Reading for gist and specific information - Grammatical accuracy and understanding of text structure - Reading and information transfer.

UNIT III **9 Hours**

WRITING

Internal communication including note, message, memo or email - arranging / rearranging appointments, asking for permission, giving instructions - Business correspondence including letter, fax, email apologising and offering compensation, making or altering reservations, dealing with requests, giving information about a product.

UNIT IV **9 Hours**

LISTENING

Listening for specific information Listening for numbers and letters Note completion Listening for gist listening to monologues (presentations, lectures, announcements and briefings) listening to interacting speakers (telephone conversations, face-to-face conversations, interviews and discussions).

UNIT V **9 Hours**

SPEAKING

Exchanging personal and factual information expressing and finding out about attitudes and opinions organise a larger unit of discourse Turn-taking, negotiating, collaborating, exchanging information, expressing and justifying opinions, agreeing and/or disagreeing, suggesting, speculating, comparing and contrasting, and decision-making.

Total: 45 Hours

Reference(s)

1. Alexander Garrett, Cambridge BEC Preliminary Students Book with Answers, Cambridge University Press, 2016.
2. Lan Wood, Anne Williams and Anna Cowper. Pass Cambridge BEC Preliminary, Second Edition, New Delhi, 2014.
3. Norman Whitby. Cambridge Business Benchmark. Pre-Intermediate to Intermediate, Students Book. South Asian Edition, 2018.

19BM106 ENGINEERING GRAPHICS 1 0 4 3

Course Objectives

- Provide knowledge on projection of points and lines.
- Impart skill in drawing projection of simple solids.
- Familiarize creation of orthographic views from isometric projections of simple solids and vice versa.
- Build the proficiency to create two dimensional sketches using software.
- Provide the skill to build three dimensional models and its orthographic views using software.

Course Outcomes (COs)

1. Illustrate the projection of points and lines in different quadrants.
2. Construct orthographic projections of simple solids.
3. Create the orthographic and isometric projections of simple solids.
4. Sketch the two dimensional views of engineering components using software.
5. Construct three dimensional models of engineering components and its orthographic views using software.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	-	-													
2	-	-													
3	-	-													
4	-	-													
5	-	-													

UNIT I **9 Hours**

PROJECTION OF POINTS

Practices on lettering, numbering and dimensioning of drawings. Principles of projection, Projection of points in four quadrants, first angle projection of straight lines- parallel, perpendicular and inclined to anyone plane.

UNIT II **9 Hours**

PROJECTION OF SOLIDS

Orthographic projection of simple solids - parallel, perpendicular and inclined to one plane using change of position method.

UNIT III **9 Hours**

ISOMETRIC AND PERSPECTIVE PROJECTION

Conversion of isometric to orthographic projection and vice versa.Perspective projection of simple solids.

UNIT IV **9 Hours**

CREATION OF 2D SKETCHES USING SOFTWARE

Sketch Entities - line, circle, arc, rectangle, slots, polygon, text, snap, and grid. Sketch Tools-fillet, chamfer, offset, convert entities, trim, extend,mirror, move, copy, rotate, scale, stretch, sketch pattern. Geometrical constraints, Dimensioning - smart, horizontal, vertical, ordinate.

UNIT V **9 Hours**

PART MODELING AND DRAFTING USING SOFTWARE

Part Modeling- extrude, cut, revolve, creation of planes, fillet, chamfer, shell, rib, pattern, mirror, loft, draft and swept. Drafting - Converting 3D models to orthographic views with dimensions.

6 Hours

EXPERIMENT 1

Create 2D sketch of different components used in engineering applications

6 Hours

EXPERIMENT 2

Create part model of a component from given isometric drawings.

6 Hours

EXPERIMENT 3

Create part model of a component from given orthographic views.

6 Hours

EXPERIMENT 4

Create an assembly model of product from detailed parts drawing

6 Hours

EXPERIMENT 5

Create stl file from CAD model, transfer file to 3D printer, setup the machine parameters, build and post process the component using Additive Manufacturing Technology

Total: 75 Hours

Reference(s)

1. K Venugpoal, Engineering Drawing and Graphics, Third edition, New Age International,2005
2. Basant Agrawal,Mechanical drawing,Tata McGraw-Hill Education, 2008.
3. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards- SP46-2008.
4. N.D.Bhatt and V.M.Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2008.
5. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010

19BM201 ENGINEERING MATHEMATICS II 3 1 0 4

Course Objectives

- Understand the concepts of partial derivatives and multiple integrals to define the area, volume and extreme values of various surfaces in engineering fields.
- Classify the sequences and series in linear systems is convergent or divergent.
- Formulate the real time engineering problem into mathematical model using ordinary differential equation and solve it by appropriate method.

Course Outcomes (COs)

1. Illustrate the various parameters in partial differentiation and characterize the maxima and minima functions for signals and systems.
2. Apply multiple integral concepts to calculate the area and volume by appropriate vector integral theorems.
3. Analyse the convergence and divergence of sequences and series by various tests.
4. Construct first order differential equations from real time phenomena and solve it by suitable method.
5. Execute the appropriate method to solve the second order differential equations.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	1													
2	2	2													
3	2	1													
4	2	1													
5	2	1													

UNIT I **9 Hours**

PARTIAL DIFFERENTIATION

Functions of several variables, plotting of 2-variable functions, introduction to cylindrical and spherical coordinates, chain rule, total differential, gradient, directional derivatives, normal lines and tangent planes, extreme of functions of two variables, applications.

UNIT II **9 Hours**

MULTIPLE INTEGRALS

Double integrals, regions of integrations, triple integrals, applications (Cartesian coordinates only-Greens theorem and Gauss Divergence theorem).

UNIT III **9 Hours**

SEQUENCES AND SERIES

Sequences and series, convergence and divergence of series, absolute convergence, conditional convergence, test for convergence and divergence. Power series for functions, interval of convergence, Taylor and Maclaurin series, Taylors Theorem with remainder.

UNIT IV **9 Hours**

FIRST ORDER DIFFERENTIAL EQUATIONS

Separable differential equations, homogeneous differential equations, exact differential equations, integrating factor, Bernoullis equation, applications.

UNIT V **9 Hours**

SECOND ORDER DIFFERENTIAL EQUATIONS

Second order homogeneous and non-homogeneous equations with constant coefficients, variation of parameters, method of undetermined coefficients, series solutions of differential equations, applications.

FOR FURTHER READING

Complex plane, polar coordinates and polar form of complex numbers, powers and roots, fundamental theorem of algebra. Vector algebra in 2-D and 3-D space, dot product and cross product. Matrices: Eigenvalues and Eigenvectors, Properties of Eigenvalues and Eigenvectors

Total: 60 Hours

Reference(s)

1. Finney RL, Weir MD and Giordano FR, Thomas Calculus, 10th edition, Addison-Wesley, 2001
2. Smith RT and Minton RB, Calculus, 2nd Edition, McGraw Hill, 2002.Kreysgiz E, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons, 1999.
3. Ray Wylie and C Louis Barrett, Advanced Engineering Mathematics, Sixth Edition, Tata McGraw-Hill Publishing Company Ltd, 2003.
4. Peter V. O Neil , Advanced Engineering Mathematics, Seventh Edition , Cengage Learning India Private Limited, 2012.
5. Glyn James, Advanced Engineering Mathematics, Third Edition,Wiley India, 2014.

19BM202 MEDICAL PHYSICS 3 0 0 3

Course Objectives

- Understand the interaction of radiation with matter and radiation detection in the materials
- Explain the properties of ultrasonic waves and interaction of nuclei with magnetic field for imaging applications
- Assess the various applications of Laser in the medicine and surgery

Course Outcomes (COs)

1. Understand the absorption and scattering interactions of radiation with matter through the attenuation mechanism and coefficients, Compton effect and photoelectric effect
2. Exemplify the requirements of a basic radiation detector system and illustrate the gas detector, semiconductor detector and scintillation detector systems
3. Apply the wave properties of ultrasonics for the three modes of ultrasonic imaging and assess the image time, dynamic range and image artefacts
4. Outline the interaction of nuclei with magnetic field, spin-lattice relaxation time, spin-spin relaxation time and pulse sequences for magnetic resonance imaging applications
5. Analyse the characteristics of laser used for medical and surgical applications and prevention of laser induced bio hazards

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	3	2	1										2	1	
2	3	1			1								1	2	
3	1	2				2							1	2	1
4	1	3											1	2	2
5	1	3				2							1	2	1

UNIT I **8 Hours**

INTERACTION OF RADIATION WITH MATTER

Linear attenuation-half value layer-relaxation length-attenuation coefficients-photoelectric effect-Rayleigh scattering-Compton effect-pair production-relative predominance of individual effects-macroscopic attenuation coefficients

UNIT II **9 Hours**

RADIATION DETECTION

Basic detector requirements-sensitivity-energy, time and position resolution-counting rate and dead time-gas filled detectors-proportional region-Geiger Muller region-semiconductor detectors-detector materials-scintillation detectors-inorganic and organic scintilator materials-photomultiplier tubes

UNIT III **8 Hours**

ULTRASONIC IMAGING

Properties of ultrasonic waves-decibel scale-three modes of ultrasonic imaging-time required to obtain images-system components of B-mode-dynamic range-image artefacts

UNIT IV **10 Hours**

MAGNETIC RESONANCE IMAGING

Interaction of nuclei with magnetic field-rotation, precession and nutation-induction of magnetic resonance-spin density-spin-lattice relaxation time-spin-spin relaxation time-magnetic field strength and gradients - pulse sequences-MRI instrumentation (block diagram)

UNIT V **10 Hours**

LASERS IN MEDICINE AND SURGERY

Characteristics of laser -construction and working of excimer laser - types of laser medical applications - laser in eye surgery -laser in photocoagulations-light induced biological hazards: eye and skin-eye damage: wavelength - dependence - human skin and damages-application of 308 nm excimer in psoriasis-homeostatics -dentistry -laser angioplasty-laser endoscopy

Total: 45 Hours

Reference(s)

1. 1.D L Bailey, J L Humm,A T Pokropek and A V Aswegan Nuclear Medicine Physics: A handbook to teachers and students, International Atomic Energy Agency, Vienna, 2014
2. 2.W R Hendee and E R Retenour, Medical Imaging Physics, John Wiley and Sons, Inc, 2002
3. 3.D J Dowsett, P A Kenney and R E Johnston, The Physics of Diagnostic Imaging, Hodder Arnold Publishers, London, 2006
4. 4. Gopal B. Saha, Physics and Radiobiology of Nuclear Medicine, Springer, 4th edition, 2013.
5. 5.M Arumugam, Biomedical Instrumentation, Anuradha Publications, Kumbakonam, 2014
6. Glenn F. Knoll, Radiation Detection and Measurement, Wiley, 4th edition, 2010

19BM203 ENGINEERING CHEMISTRY II 2 0 2 3

Course Objectives

- Explain the function of batteries and fuel cells with its electrochemical reactions.
- State the principle and classify chromatographic techniques
- Compare the functional mechanism of pollution monitoring sensors
- Extrapolate the instrumentation and applications of spectroscopic techniques
- Summarize nuclear fission and fusion and explain the uses of radioactive materials in biological applications.

Course Outcomes (COs)

1. Interpret construction and function of batteries and fuels cell
2. Predict the suitable techniques for the separation of molecule in a mixture.
3. Execute a method for the monitoring of pollutant
4. Differentiate spectroscopic techniques for material characterization
5. Outline the application of radioactive material in biomedical analytical studies

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2														
2	3	2													
3	2														
4	2	3													
5	1	2													

UNIT I **6 Hours**

ENERGY STORAGE DEVICES

Batteries - characteristics of battery - types of batteries. construction, working and applications: Primary (alkaline) and secondary (lead-acid and nickel-cadmium) - Modern batteries (zinc air battery and lithium batteries) - Fuel cells - Types of fuel cells: solid polymer electrolyte fuel cell - solid oxide fuel cells - microbial fuel cell. Hydrogen-oxygen fuel cell - construction, working, advantages and limitations.

UNIT II **6 Hours**

CHROMATOGRAPHY TECHNIQUES

Principles of chromatography. Column chromatography : High pressure liquid chromatography. Gel Filtration chromatography : Determination of native molecular weight of a protein using gel filtration chromatography-Oligomeric status of the protein - studying protein folding - desalting. Thin Layer Chromatography.

UNIT III **6 Hours**

INSTRUMENTATION FOR POLLUTION MONITORING

INSTRUMENTATION FOR POLLUTION MONITORING

Gas analyzers: Oxygen analyzers: Paramagnetic and electrochemical method. NO2 analyzers. Hydrogen sulfide analyzers. Estimation of NO2, CO, hydrocarbon, dust and smoke measurement

UNIT IV **6 Hours**

SPECTROSCOPY

Electromagnetic spectrum - Absorption of radiation - Electronic, Vibrational and rotational transitions. UV-visible and IR spectroscopy - principles, instrumentation (Block diagram only).NMR Spectroscopy-I: Introduction of theory, 1H and 13C NMR, Spin-Spin Coupling. Mass Spectrometry-I: Introduction of theory, ionization methods, molecule fragmentation.

UNIT V **6 Hours**

NUCLEAR CHEMISTRY AND RADIOACTIVE DECAY

Isotopes - nucleus particles - Nuclear Binding Energy - Nuclear Stability - Types of Particles in Nuclear Reactions - Balancing Nuclear Reactions - Types of Radioactive Decay- Nuclear fission, The fission of uranium, The production of energy by nuclear fission, Nuclear reprocessing - Nuclear fusion, Applications of isotopes. - Positron emission tomography (PET) scan - Radioactive Decay Series - Radioactive Half-Lives - Radiometric Dating

3 Hours

EXPERIMENT 1

Estimation of iron in the given sample by potentiometric method using saturated calomel electrode

6 Hours

EXPERIMENT 2

Preparation of TLC plate, separation of organic mixture using TLC plates and identification of spot using UV chamber

3 Hours

EXPERIMENT 3

Estimation of heavy metal in effluent water

3 Hours

EXPERIMENT 4

Estimation of dye present in the given solution by spectrophotometry

3 Hours

EXPERIMENT 5

Presentation about the mechanism of a bio-analytical instrument using radioactive material

6 Hours

EXPERIMENT 6

Estimation of carotene content in a given sample using spectrophotometer

6 Hours

EXPERIMENT 7

Characterization of organic fuctional groups using FTIR spectroscopy

Total: 60 Hours

Reference(s)

1. Jain and Jain, Engineering Chemistry, 16th Edition, DhanpatRai Publishing Company, New Delhi, 2013
2. Inamuddin, Mohammad, Ali, Green Chromatographic Techniques: Separation and Purification of Organic and Inorganic Analytes, Springer, 2013
3. B K Sharma, Spectroscopy, Krishna Prakashan Media, New Delhi, 2015

19BM204 ELECTRIC CIRCUIT ANALYSIS 3 1 0 4

Course Objectives

- To formulate the solution for basic electric circuit problems
- To differentiate single phase and three phase circuits.
- To compute electrical parameters like current, voltage and power using network theorems
- To impart knowledge in resonance and coupled circuits
- To analyze the transient response of RL and RC series circuits and to solve problems in time domain using Laplace Transform

Course Outcomes (COs)

1. Solve the DC Electric circuit problems using mesh and node analysis
2. Analyse the basic concepts of AC circuits
3. Apply network theorems to find solutions for electric circuits
4. Identify the behavior of resonance and coupled circuits
5. Analyze the transient response of RL and RC series circuits

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2		3												
2	2		2												
3	2	3	3												
4	2	2	2												
5	2	3	2												

UNIT I **8 Hours**

DC CIRCUITS

Electric circuit components - Ohm"s law - statement, Illustration and limitation - Kirchoff"s laws statement and Illustration -Resistance in series and voltage division technique - Resistance in parallel and current division technique - Simple problems - Mesh loop current method - Nodal voltage method

UNIT II **9 Hours**

AC CIRCUITS

Types of waveforms - Advantages of Sinusoidal waveform - Average Value and RMS Value - Form factor and Peak factor - V-I relationships between R, L and C - Phasor relation in pure resistor, inductor and capacitor - Power and power factor - Concepts of impedance and admittance - Analysis of simple circuits - Three phase AC waveform - Phase sequence - Advantages of three phase circuits

UNIT III **10 Hours**

NETWORK THEOREMS AND ITS APPLICATIONS

Super position theorem - Thevenins theorem - Nortons theorem - Maximum power transfer theorem - Star Delta Transformations

UNIT IV **10 Hours**

RESONANCE

Series resonant circuits - Bandwidth of an RLC circuit - Q factor and its effect on bandwidth - Parallel resonance -Simple problems on resonance - Applications of resonance - Coupled circuits - Self and mutual inductance - Inductances in series and parallel - Mutual and leakage flux - Coefficient of coupling

UNIT V **9 Hours**

TRANSIENTS

Introduction - Transient response of RL & RC series circuits with step and ramp inputs - Time Constant - Rise and fall times

Total: 61 Hours

Reference(s)

1. Charles K.Alexander, Fundamentals of Electric Circuits, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2015
2. William H. Hayt, Jack E. Kemmerly, and Steven M. Durbin, Engineering Circuit Analysis, Tata McGrawHill Publishing Co Ltd, New Delhi, 2012
3. Ravish R Singh, Electrical Networks, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2012

19BM206 PROGRAMMING LANGUAGE II 2 0 2 3

Course Objectives

- Understand the concept of Object Oriented Programming
- Apply the Object oriented concepts to solve problems using C++
- Develop programs using files and templates

Course Outcomes (COs)

1. Implement CPP programs using operators, classes and objrcts
2. Apply arrays and strings concept in writing CPP programs
3. Develop CPP programs using the concept of Inheritance
4. Apply the concepts of functions and streams in writing CPP programs
5. Design applications using files, streams and exception in CPP

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	2			2										
2	1	2			2										
3	1	3			2										
4	1	3			2										
5	1	3			2										

UNIT I **3 Hours**

CLASSES AND OBJECTS

Classes and Objects: Simple Class - Nesting of Member functions - Static Data Members and Member Functions - Constructors and Destructors

UNIT II **3 Hours**

ARRAYS, STRINGS AND OVERLOADING

Arrays as Class Member Data - Arrays of Objects - String Manipulations - Operator overloading - Data Conversion

UNIT III **3 Hours**

INHERITANCE

Derived Class and Base Class - Derived Class Constructors - Overriding Member Functions - Types of Inheritance

UNIT IV **3 Hours**

FUNCTIONS AND STREAMS

Pointers - Pointers to Objects and Derived Classes - Virtual Function - Friend Function - Static Function - Streams

UNIT V **3 Hours**

FILES, STREAMS AND EXCEPTION HANDLING

File Stream Operations - Class Templates - Function Templates - Exception Handling Mechanism: Try Throw and Catch

3 **Hours**

EXPERIMENT 1

Introduction to OOP lab (Simple C program) - Classes and Objects

3 Hours

EXPERIMENT 2

Programs using inheritance

3 Hours

EXPERIMENT 3

Programs using static polymorphism

3 Hours

EXPERIMENT 4

Programs on dynamic polymorphism

3 Hours

EXPERIMENT 5

Programs on operator overloading

3 **Hours**

EXPERIMENT 6

Programs on dynamic memory management using new, delete operators

3 Hours

EXPERIMENT 7

Programs on copy constructor and usage of assignment operator

3 Hours

EXPERIMENT 8

Programs on exception handling

3 Hours

EXPERIMENT 9

Programs on generic programming using template function

3 Hours

EXPERIMENT 10

Programs on file handling

Total: 60 Hours

Reference(s)

1. E Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing, New Delhi, 2011.
2. Robert Lafore, Object Oriented Programming in C++, Galgotia Publication, 2010
3. H M Deitel and P J Deitel, C++ How to Program, Seventh Edition, Prentice Hall, 2010
4. Herbert Schildt, C++: The Complete Reference, Fourth Edition, Tata McGraw-Hill, 2010
5. K R Venugopal, Rajkumar and T Ravishankar, Mastering C++, Tata McGraw Hill Publishing, New Delhi, 2010

19BM207 ENGINEERING PRACTICES LABORATORY **0 0 4 2**

Course Objectives

- To understand the electrical and physical parameters using suitable instruments for biomedical applications.
- To implement adequate knowledge about pH and conductivity measurement for analyzing biological liquids.
- To design electrical and electronic circuits for analyzing health-ill conditions of human being.

Course Outcomes (COs)

1. Select and use the proper instruments to measure the electrical parameters in AC and DC power circuits.
2. Carry-out the procedure to measure mechanical parameters such as distance, force, touch, vibration and pressure using suitable instruments
3. Use suitable sensors for measuring the physical parameter such as temperature, humidity, moisture, turbidity and sound
4. Determine pH and conductivity of liquids.
5. Design and construct circuits for measuring health parameters such as Heart rate, Sound and Blood pressure.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	3	1		2						2		3		
2	2	3	1		2						2		3		
3	2	3	2		2						2		2		
4	2	2											3		
5													2		

6 **Hours**

EXPERIMENT 1

(i) Measurement of resistance, capacitance, inductance used in DC power source circuit
(ii) Measurement of voltage, current and power in a DC power source circuit by connecting a load.
(iii) Linear and Nonlinear system identification using resistive and RLC circuit.

6 Hours

EXPERIMENT 2

(i) Measurement of vibration in a given plateform in terms of frequency and amplitude using vibrometer.
(ii) Phase angle measurement in an inductive load (ex: fan, motor) using CRO.
(iii) Velocity/speed measurement using LVDT and tachometer.

6 Hours

EXPERIMENT 3

i) Measurement of temperature using thermistor, RTD and Thermocouple.
(ii) Measurement of air pressure using strain gauge and Bourdon tube based pressure gauge.
(iii) Measurement of level using capacitive and differential pressure transmitter

6 **Hours**

EXPERIMENT 4

(i) Touch measurement using capacitive transducer
(ii) Force measurement using piezoelectric sensor and strain gauge
(iii) Distance measurement using photoelectric and ultrasonic sensors

6 Hours

EXPERIMENT 5

(i) Measurement of humidity using Capacitive Relative Humidity (RH) Sensors,
(ii) Soil moisture measurement using conductivity sensor
(iii) Measurement of water turbidity using photoelectric sensor

6 Hours

EXPERIMENT 6

Wired communication between field instruments and controller (CPU/PC) with RS232, RS485, USB, Ethernet, and Coaxial Cable.

6 **Hours**

EXPERIMENT 7

pH and Conductivity measurement for various liquids

6 Hours

EXPERIMENT 8

i) Design of Heart sound measurement
ii) Design of Heart rate measurement

6 Hours

EXPERIMENT 9

Blood pressure Measurement

6 Hours

EXPERIMENT 10

Design of Hearing Aid

Total: 60 Hours

19BM301 ENGINEERING MATHEMATICS III 3 1 0 4

Course Objectives

- Develop the knowledge of periodic and non periodic functions and their representations using Fourier analysis.
- Understand the Laplace Transform to solve real world problems.
- Predict the changes in the manufacturing process using the concepts of statistics.

Course Outcomes (COs)

1. Use the properties of periodic and non-periodic vibrations with the help of Fourier analysis in Biomedical engineering.
2. Formulate a function in frequency domain for which the function defined in time domain through the techniques of Laplace transforms.
3. Compute the position of a particle that depends on more than one parameter, using partial differential equations.
4. Predict the outcome of Biomedical engineering problem using the concepts of probability and its distributions.
5. Justify and validate the mathematical model for a Biomedical engineering problems with the help of hypothesis testing.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3	1										1			
2	1	3	1									1			
3	1	3	1									1			
4	1	2										1			
5	1	2										1			

UNIT I **10 Hours**

FOURIER ANALYSIS

Review of Fourier series for periodic functions. Orthogonal functions. The Euler coefficients. Fourier transforms. Properties of Fourier transform. Applications of Fourier series and transform analysis.

UNIT II **9 Hours**

LAPLACE TRANSFORM

Properties and theorems of Laplace transform. Shifting theorems.Convolution.Applications to ordinary differential equations.Applications to linear system analysis.

UNIT III **11 Hours**

PARTIAL DIFFERENTIAL EQUATION

Introduction to partial differential equations.One-dimensional wave equation.Method of separation of variables.D""Alemberts solution of the wave equation.Heat equation.Laplace equation. Telegraph equations. Laplace transform method of solution

UNIT IV **8 Hours**

PROBABILITY THEORY

Probability.Random variables, probability densities and distributions, mean and variance of a distribution.Conditional probability.Bayes theorem.Binomial, Poisson and normal distributions

UNIT V **7 Hours**

MATHEMATICAL STATISTICS

Sample mean and variance.Sampling distributions.Statistical estimation of parameters, confidence intervals. Testing of hypotheses, one-sample and two-sample inferences. Applications to statistical quality control and reliability analysis.

Total: 60 Hours

Reference(s)

1. Erwin Kreyszig , Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016.
2. Johnson Richard A. and BhaltacharyyaGouri K., Statistics, Principles and Methods, 3rd Edition, John Wiley, 1996.
3. O"Neil Peter V., Advanced Engineering Mathematics, 4th Edition, PWS-Kent, 1995
4. James Glyn, Advanced Modern Engineering Mathematics, Addison-Wesley, 1993.
5. Milton J. S. and Arnold Jesse C., Introduction to Probability and Statistics: Principles and Applications for Engineering and The Computing Sciences, McGraw Hill Inc, 3rd Edition, 1995

19BM302 SENSORS AND MEASUREMENTS 3 1 0 4

Course Objectives

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.
- To know the different display and recording devices

Course Outcomes (COs)

1. Describe the purpose and methods of measurements.
2. Explain the principle of different sensors and its applications
3. Analyze the characteristics of different transducers
4. Describe the need and function of various signal conditioning circuits.
5. Explain different display and recording devices for various applications

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	1	1			2							2	1	
2	2	2	1	1		2							2	2	1
3	2	1	2	1		2							2	1	1
4	2	1	2	2		2							2	1	1
5	1	2	2	1		2							2	1	1

UNIT I **7 Hours**

SCIENCE OF MEASUREMENT

Measurement System - Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements - Calibration - Primary and secondary standards.

UNIT II **11 Hours**

DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS

Resistive Transducers: Strain Gauge: Gauge factor, sensing elements, configuration, biomedical applications; strain gauge as displacement & pressure transducers, RTD materials & range, Characteristics, thermistor characteristics, biomedical applications of Temperature sensors Capacitive transducer, Inductive transducer, LVDT, Active type: Thermocouple - characteristics

UNIT III **9 Hours**

PHOTOELECTRIC AND PIEZOELECTRIC SENSORS

Phototube, scintillation counter, Photo Multiplier Tube (PMT), photovoltaic, Photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers, spectrophotometric applications of photo electric transducers. Piezoelectric active transducer and biomedical applications as pressure & Ultrasound transducer

UNIT IV **9 Hours**

SIGNAL CONDITIONING

AC and DC Bridges - Wheat stone bridge, Kelvin, Maxwell, Hay, Schering - Concepts of filters, Pre-amplifier - impedance matching circuits - isolation amplifier, Spectrum analyzer.

UNIT V **9 Hours**

DISPLAY AND RECORDING DEVICES

Digital voltmeter - Multi meter - CRO - block diagram, CRT - vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder. Demonstration of the display and recording devices.

Total: 60 Hours

Reference(s)

1. Doebelin E.O. and Manik D.N., "Measurement Systems", Tata McGraw-Hill Education Pvt.Ltd., 6th Edition, 2011.
2. L.A Geddes and L.E.Baker , "Principles of Applied Biomedical Instrumentation", - John Wiley and sons, 3rd Edition, Reprint 2008.
3. Albert D.Helfrick and William D.Cooper, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 2007
4. A.K.Sawhney, "Electrical & Electronics Measurement and Instrumentation", DhanpatRai & Co, New Delhi, 17th Edition, 2004.
5. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
6. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurement", Prentice Hall India Pvt. Ltd, New Delhi, 2nd Edition, Reprint, 2013

19BM303 HUMAN ANATOMY AND PHYSIOLOGY 3 0 0 3

Course Objectives

- To identify all the organelles of an animal cell and their function
- To understand structure and functions of the various types of systems of human body
- To demonstrate their knowledge of importance of anatomical features and physiology of human systems

Course Outcomes (COs)

1. Understand the structure and function of cells and tissues
2. Identify the importance of Skeletal, Muscular and Respiratory systems
3. Illustrate the importance and working of Cardiovascular and Lymphatic systems
4. Outline the working of Nervous, Endocrine and Special sensory systems
5. Structure the functions of components of digestive system and evaluate the role of urinary system in maintaining homeostasis

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	3		2										3		
2	3		2										3		
3	3												3		
4	3		2		1								3	1	
5	3		2										3		

UNIT I **9 Hours**

BASIC ELEMENTS OF HUMAN BODY

Cell: Structure and organelles - Functions of each component in the cell. Cell membrane - transport across cell membrane - origin of cell membrane potential - Action potential- Cell to cell signaling- Cell Division.

Tissue: Types - Specialized tissues - functions.

UNIT II **9 Hours**

SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS

Skeletal: Bone types and functions - Joint-Types of Joint-Types of Cartilage and functions.

Muscular: Parts of Muscle - Movements.

Respiratory: Components of respiratory system - Respiratory Mechanism. Types of respiration - Oxygen and carbon dioxide transport and acid base regulation

UNIT III **9 Hours**

CARDIOVASCULAR AND LYMPHATIC SYSTEM

Cardiovascular: Blood composition - functions of blood - functions of RBC. WBC types and their functions. Blood groups - Importance of blood groups - Identification of blood groups. Structure of heart - Conducting system of heart- Properties of Cardiac muscle - Cardiac cycle -Types of Blood Vessel- ECG - Heart sound - Volume and pressure changes and regulation of heart rate - Coronary Circulation. Factors regulating Blood flow.

Lymphatic: Parts and Functions of Lymphatic systems - Types of Lymphatic organs and vessels

UNIT IV **9 Hours**

NERVOUS, ENDOCRINE AND SPECIAL SENSORY SYSTEMS

Nervous: Structure of a Neuron - Types of Neuron. Synapses and types. Conduction of action potential in neuron. Brain - Divisions of brain lobes - Cortical localizations and functions - EEG. Spinal cord - Tracts of spinal cord - Reflex mechanism - Types of reflex. Autonomic nervous system and its functions.

Endocrine - Pituitary and thyroid gland.

Special sensory: Optics of Eye - Retina - Photochemistry of Vision - Accommodation Neurophysiology of Vision - EOG. Structure and functions Internal Ear - Mechanism of Hearing - Auditory pathway, Hearing Tests

UNIT V **9 Hours**

DIGESTIVE AND URINARY SYSTEMS

Digestive: Organs of Digestive system - Digestion and Absorption.

Urinary: Structure of Kidney and Nephron. Mechanism of Urine formation and acid base regulation - Urinary reflex - Homeostasis and blood pressure regulation by urinary system

Total: 45 Hours

Reference(s)

1. Elaine.N. Marieb , "Essential of Human Anatomy and Physiology", Eight Edition, Pearson Education, New Delhi,2007
2. Gillian Pocock, Christopher D. Richards, "The human Body - An introduction for Biomedical and Health Sciences", Oxford University Press, USA,2009
3. William F.Ganong, "Review of Medical Physiology", 22nd Edition, McGraw Hill, New Delhi,2005
4. Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", W.B. Saunders Company, Harcourt Brace Jovanovich, 2003
5. Guyton & Hall, "Medical Physiology", 12th Edition, Elsevier Saunders,2010

19BM304 ELECTRON DEVICES AND CIRCUITS 3 1 0 4

Course Objectives

- Understand the structure of basic electronic devices and be exposed to active and passive circuit elements.
- Familiarize the operation and applications of transistor like BJT and FET and explore the characteristics of amplifier gain and frequency response.
- Learn the required functionality of positive and negative feedback systems.

Course Outcomes (COs)

1. Explain the structure and working operation of basic electronic devices.
2. Identify and differentiate both active and passive elements.
3. Analyze the characteristics of different electronic devices such as diodes and transistors.
4. Choose and adapt the required components to construct an amplifier circuit.
5. Employ the acquired knowledge in design and analysis of oscillators.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3	2	2			2						2	1		
2	3	1	2			2						1	2		
3	3	2	3		1	1						1	1	2	
4	3	2	1		1	1						1			
5	3	1	2		1	1						1	1		-

UNIT I **9 Hours**

UNIT I SEMICONDUCTOR DEVICES

Introduction to semiconductor devices, PN junction diode -structure, operation and V-I characteristics, diffusion and transition capacitance - Rectifiers - Half Wave and Full Wave Rectifier, Bridge Rectifier Display devices- LED, Laser diodes, Zener diode characteristics - Zener Reverse characteristics- Zener as regulator

UNIT II **9 Hours**

UNIT II TRANSISTORS

BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Determination of h-parameters, Bias Configuration - Fixed, self and Voltage divider.

UNIT III **9 Hours**

UNIT III AMPLIFIERS

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 **9 Hours**

UNIT IV MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER

BIMOS cascade amplifier, Instrumentation amplifier, Differential amplifier-Common mode and Difference mode analysis-FET input stages- Single tuned amplifiers- Gain and frequency response-Neutralization methods, power amplifiers-Types (Qualitative analysis).

UNIT V **9 Hours**

UNIT V FEEDBACK CIRCUITS AND OSCILLATOR CIRCUITS

Feedback concepts, Feedback connection types, Practical feedback circuits - Theory of sinusoidal oscillators - Phase shift oscillator, Wien bridge oscillator - Colpitt""s oscillator, Hartley oscillator, Crystal
oscillator.

Total: 60 Hours

Reference(s)

1. David A. Bell, Electronic devices and circuits, Oxford University higher education, 5th edition 2008.
2. Jacob. Millman, Christos C. Halkias and SathyabrataJit, Electronic Devices and Circuits, Tata McGraw Hill, New Delhi, 2011
3. Sedra and smith, Microelectronic circuits,7th Ed., Oxford University Press
4. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory, Pearson Education, Tenth edition, 2012
5. Theodre F. Boghert, Electronic Devices & Circuits, Pearson Education, Sixth edition, 2011
6. Solid State Circuits, NPTEL - IIT, Chennai, Link: http://nptel.iitm.ac.in/courses.php

19BM305 SIGNALS AND SYSTEMS 3 1 0 4

Course Objectives

- Understand the Mathematical Representation of Signals and Systems
- Explain the concept of Linear Time Invariant Systems and the Convolution property
- Represent a given Continuous Time signal in frequency domain using fourier Series and Fourier Transform
- Represent a given Discrete Time signal in frequency domain using fourier Series and Fourier Transform
- Understand Spectrum Analysis of Continuous Time signals and sampled version of the CT signal

Course Outcomes (COs)

1. Classify a given signal or a system by analyzing the mathematical representation.
2. Apply the concept of Convolution to predict the behavior of a given Linear Time Invariant System
3. Analyze the frequency domain behaviour of a given Continuous Time signal using Fourier Analysis and Laplace Analysis
4. Analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Time Fourier Analysis and Z Transform Analysis
5. Analyze the Spectrum of Continuous Time Signals and its sampled versions.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	3		2									2		
2	3	3		1									2		
3	3	3		1									2		
4	2	3		1									2		
5	2	3		1									2		

UNIT I **9 Hours**

INTRODUCTION TO SIGNALS AND SYSTEMS

Introduction to Signals and Systems, Classification of Signals based on Independent Variable,Elementary Signals, Amplitude and Time Operation on Signals, Types of Systems, Properties of Systems.

UNIT II **9 Hours**

ANALYSIS OF LINEAR TIME INVARIANT SYSTEMS

Concept of Impulse Response, Convolution Integral and Convolution Sum, Causality and Stability of LTI Systems, Interconnection of LTI Systems, Correlation of Signals, Orthogonality of Signals.

UNIT III **9 Hours**

FREQUENCY DOMAIN REPRESENTATION OF CT SIGNALS

Fourier Series, Properties of CTFS, Fourier Transform, Properties of CTFT, Gibbs Phenomena,Dirichlet Conditions, Laplace Transforms, Properties of Laplace Transforms.

UNIT IV **9 Hours**

FREQUENCY DOMAIN REPRESENTATION OF DT SIGNALS

Frequency domain representation of DT Signals Discrete Time Fourier Series, Properties of DTFS, Discrete Time Fourier Transform, Properties of DTFT, Z Transform, Properties of Z Transforms .

UNIT V **9 Hours**

SPECTRUM ANALYSIS OF LTI SYSTEMS

Spectrum Analysis of Continuous-Time Systems, Spectrum Analysis of Discrete-Time Systems, Sampling Theorem with Proof.

Total: 60 Hours

Reference(s)

1. 1.Signals and Systems, Alan V. Oppenheim, Alan S. Willsky, Syed Hamid Nawab, 2nd Edition, Pearson, 2013.
2. 2.Signals and Systems, Simon Haykin, Barry Van Veen, 2nd Edition, John Wiley & Sons, 2007.
3. 3.Principles of Linear Systems and Signals, B. P. Lathi, 2nd Edition, Oxford University Press, 2009.
4. 4.Signals, Systems, Transforms, and Digital Signal Processing with MATLAB, Michael Corithios, CRC Press, 2018.
5. 5.Signals and Systems, Tarun Kumar Rawat, Oxford University Press, 2010.

19BM306 HOSPITAL SYSTEM MANAGEMENT 3 0 0 3

Course Objectives

- To understand the fundamentals of hospital administration and management.
- To explore various information management systems and relative supportive services.
- To learn the quality and safety aspects in hospital.

Course Outcomes (COs)

1. Explain the principles of Hospital administration/ Management.
2. Identify the importance of Human resource management in Hospital.
3. Implement the various marketing research techniques and its challenges involved in Hospital system management.
4. Outline the quality and safety aspects to be maintained in the Hospital environment.
5. Structure the Information system to be retrieved in Hospital environment.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1					2		3		2				2		1
2				3				2	3	2	2				1
3	2		2	2			3	2	1	2					2
4			1		2	3	2	1	2				1	1	
5									2	3	2	3			1

UNIT I **9 Hours**

HOSPITAL MANAGEMENT

Nature and Scope of a Hospital, History of Indian Hospitals, 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 **9 Hours**

HUMAN RESOURCE MANAGEMENT IN HOSPITAL

Human Resource Management - Principle, Characteristics, Functions, Significance and Importance - Profile of HRD Manager, Good HR Practices, Causes for Poor Human Resource Management, Tools of HRD, Human Resource Inventory-Manpower Planning, Recruitment, Selection, Induction,Training Guidelines, Promotion, Termination and Communication.

UNIT III **9 Hours**

CHALLENGES IN HOSPITAL MANAGEMENT

Managing A Service Organization - Hospital Service Delivery - Quality Control - Six Sigma, NABH. Hospital Queuing Systems - Simple Queuing Systems,Interdependent Queuing Systems- Hospital Management Functions - Operation Management, Finance And Cost Management, HR Management, Materials Management - Case Studies

UNIT IV **9 Hours**

QUALITY AND SAFETY ASPECTS IN HOSPITAL

Quality system - Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000-9004-Features of ISO 9001 -ISO 14000 - Environment Management Systems. NABA, JCI, NABL. Security- Loss Prevention - Fire Safety- Alarm System - Safety Rules. Health Insurance & Managing Health Care- Medical Audit-Hazard and Safety in a hospital Setup.

UNIT V **9 Hours**

HOSPITAL INFORMATION SYSTEMS

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.

Total: 45 Hours

Reference(s)

1. R.C.Goyal, Hospital Administration and Human Resource Management, PHI -Fourth Edition, 2006.
2. G.D.Kunders,Hospitals Facilities Planning and Management - TMH, New Delhi - Fifth Reprint 2007.
3. Ramani K V, Hospital Management-Text and Cases, Pearson education, New Delhi, 2013.
4. Malhotra A K, Hospital management - An Evaluation , Global India Publications, New Delhi, 2009.
5. Norman Metzger, Handbook of Health Care Human Resources Management, 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.
6. Blane, David, Brunner, Health and SOCIAL Organization: Towards a Health Policy for the 21st Century, Eric Calrendon Press 2002

19BM307 SENSORS AND MEASUREMENTS LABORATORY

0 0 2 1

Course Objectives

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.
- To know the different display and recording devices.

Course Outcomes (COs)

1. Describe the purpose and methods of measurements.
2. Explain the principle of different sensors and its applications.
3. Analyze the characteristics of different transducers.
4. Describe the need and function of various signal conditioning circuits.
5. Explain different display and recording devices for various applications

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	1	2			2	2						2	2	2
2	2	1	1	2	1	2	1						2	1	2
3	2	1	2	2	1	1	2		-				2	2	1
4	2	1	2	1	2	2	1					-	2	1	1
5	2	2	1	1	2	2	2	-					2	2	1

3 Hours

EXPERIMENT 1

Characteristics of various temperature sensors - RTD, Thermistor and Thermocouple

3 Hours

EXPERIMENT 2

Measurement of displacement capacitive transducer, LVDT and Inductive transducer

3 Hours

EXPERIMENT 3

Characteristics of various light sensors - LDR, Photodiode and Phototransistor

3 Hours

EXPERIMENT 4

Characteristics of Piezoelectric Transducer

3 Hours

EXPERIMENT 5
Wheatstone Bridge Bridge for Measurement of Resistance

3 Hours

EXPERIMENT 6
Kelvin's Bridge for Measurement of Resistance

3 Hours

EXPERIMENT 7
Design of Heart sound measurement

3 Hours

EXPERIMENT 8
Design of Heart rate measurement

3 Hours

EXPERIMENT 9
Blood pressure Measurement

3 Hours

EXPERIMENT 10
Design of Hearing Aid

Total: 30 Hours

Reference(s)

1. Doebelin E.O. and Manik D.N., Measurement Systems, Tata McGraw-Hill Education Pvt.Ltd, 7 th Edition, 2019.
2. L.A Geddes and L.E.Baker, Principles of Applied Biomedical Instrumentation, John Wiley and sons, 3rd Edition, Reprint 2008.
3. Albert D.Helfrick and William D.Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, 2015
4. A.K.Sawhney, Electrical & Electronics Measurement and Instrumentation, Dhanpat Rai & Co, New Delhi, 2015.
5. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
6. Leslie Cromwell, Fred J.Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurement, Prentice Hall India Pvt. Ltd, New Delhi, 2nd Edition, Reprint, 2015.

19BM308 ELECTRON DEVICES AND CIRCUITS LABORATORY

0 0 2 1

Course Objectives

- Understand the characteristics of Basic Electronic Devices and their Applications
- Familiarize the Frequency response of amplifiers and amplifier gain.
- Learn and design the instrumentation amplifier, Integrator, Differentiator and Oscillators.

Course Outcomes (COs)

1. Study the characteristics of PN and Diode and their application as a Rectifier.
2. Analyze the characteristics of BJT in CE and CE configuration and JFET.
3. Learn the frequency response of CE and CS FET amplifier
4. Design a Integrator, Differentiator and Instrumentation Amplifier.
5. Design a Audio and Radio Oscillators

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3	2		3								1	1	1	
2	3	1	-	2								1	1	1	
3	2	2		3								1	1	1	
4	3	2		2								1	1		
5	3	2		3									1	1	

3 Hours

EXPERIMENT 1

a) PN Junction diode characteristics (Forward bias and Reverse bias)
b) Zener diode characteristics and voltage regulator

3 Hours

EXPERIMENT 2

a) Half wave Rectifier with and without filter.
b) Full wave Rectifier with and without filter.

3 Hours

EXPERIMENT 3

Measurement of h-parameters of CB and CE configuration

3 Hours

EXPERIMENT 4

Drain and transfer characteristics of JFET

3 Hours

EXPERIMENT 5

a) Frequency response of CE amplifier
b) Frequency response of CS FET amplifier

3 Hours

EXPERIMENT 6

Design and testing of Integrators and differentiators using Op-amps

3 Hours

EXPERIMENT 7

Design of instrumentation amplifier

3 Hours

EXPERIMENT 8

a) Design of audio frequency oscillator
b) Design of radio frequency oscillator

3 Hours

EXPERIMENT 9

Design and testing of RC phase shift oscillator

3 Hours

EXPERIMENT 10

Design and testing of wein bridge oscillator

Total: 30 Hours

Reference(s)

1. David A. Bell, Electronic devices and circuits, Oxford University higher education, 5th edition 2008.
2. Jacob. Millman, Christos C. Halkias and SathyabrataJit, Electronic Devices and Circuits, Tata McGraw Hill, New Delhi, 2011
3. Sedra and smith, Microelectronic circuits,7th Ed., Oxford University Press
4. Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory, Pearson Education, Tenth edition, 2012
5. Theodre F. Boghert, Electronic Devices & Circuits, Pearson Education, Sixth edition, 2011
6. Solid State Circuits, NPTEL - IIT, Chennai, Link: http://nptel.iitm.ac.in/courses.php

18GE301 SOFT SKILLS - VERBAL ABILITY 2 0 0 0

Course Objectives

- To help students gain adequate proficiency in vocabulary
- To help students become proficient in basic writing skills related to workplace communication
- To read and understand unabridged text

Course Outcomes (COs)

1. Take up verbal ability part of the placement tests with confidence
2. Write with confidence in professional and workplace communication
3. Distinguish fact from opinion by reading passages from a text

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1										1					
2										2	2				
3									2	2					

UNIT I **15 Hours**

INTRODUCTION

Synonyms - Antonyms - Word Groups - Verbal Analogies - Etymology - Critical Reasoning - Cloze Test - One Word Substitution - Idioms and Phrases - Text & Paragraph Completion.

UNIT II **15 Hours**

BASICS OF VERBAL APTITUDE

Sentence Formation - Paragraph Formation - Change of Voice - Change of Speech - Reading Comprehension - Sentence Equivalence - Jumbled Sentences - Spotting Errors -Homophones Homonyms - Commonly Mispronounced/Misspelt Words.

Total: 30 Hours

Reference(s)

1. Murphy, Raymond. English Grammar in Use A Self-Study Reference and Practice Book for Intermediate Learners of English. IV Edition. United Kingdom: Cambridge University Press. 2012.
2. Lewis, Norman. Word Power Made Easy. New York: Pocket Books. 1991.
3. Baron"s The Official Guide for New GMAT Review, New Jersey: John Wiley & Sons, Inc. 2015.

19BM401 ENGINEERING MATHEMATICS IV 3 1 0 4

Course Objectives

- To analyze a mathematical problem and determine which numerical technique to use to solve it.
- To understand the methods to solve polynomial equations and implement the mathematical ideas for interpolation numerically.
- To summarize and apply the methodologies involved in solving problems related to ordinary and partial differential equations

Course Outcomes (COs)

1. Compute the errors, apply the numerical methods to solve nonlinear equations and system of equations.
2. Analyze the Finite difference -Forward and backward difference table.
3. Understand numerical differentiation and integration .
4. Determine numerical solutions of ordinary differential equations.
5. Evaluate partial differential equations using numerical techniques.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	1													
2	2	2													
3	2	1													
4	2	2													
5	1	2													

UNIT I **9 Hours**

APPROXIMATION

Approximation in numerical computation: Truncation and rounding errors- fixed and floating-point arithmetic - propagation of errors. Numerical solution of algebraic equations: Bisection method - Regula - Falsi method - Newton-Raphson method. Numerical solution of a system of linear equations: Gauss elimination method - Matrix inversion- LU Factorization method - Gauss-Seidel iterative method

UNIT II **9 Hours**

INTERPOLATION

Interpolation: Newton forward/backward interpolation - Lagranges - Newtons divided difference Interpolation

UNIT III **9 Hours**

NUMERICAL INTEGRATION

Numerical single and double integration: Trapezoidal rule - Simpsons 1/3 rule - Expression for corresponding error terms

UNIT IV **9 Hours**

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION

Numerical solution of ordinary differential equation: Eulers method - Runge-Kutta methods - Milnes Predictor -Corrector methods - Adams Predictor - Corrector methods - Finite Difference method

UNIT V **9 Hours**

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATION

Finite difference solution of parabolic equations by Crank - Nicholson method - elliptic equations by iterative methods - hyperbolic equations by explicit finite difference method

Total: 60 Hours

Reference(s)

1. Sankara Rao. K, Numerical Methods for Scientists and Engineers, Third Edition, Eastern Economy Edition, 2009
2. Grewal B. S, Numerical Methods in Engineering and Science with Programs in C & C++, Ninth Edition, Khanna Publications, 2010.
3. Gerald C.F and Wheatley P.O, Applied Numerical Analysis, Seventh Edition, Pearson Education, New Delhi, 2006
4. Jain M.K, Iyangar S.R.K and Jain R.K Numerical Methods For Scientific and Engineering Computation New Age International (P) Ltd , New Delhi , 2005
5. S.S.Sastry, Introductory Methods of Numerical Analysis, Fifth Edition, PHI Learning Pvt. Ltd, 2012
6. Burden R. L and Douglas Faires J, Numerical Analysis Theory and Applications, Cengage Learning, Ninth Edition, 2005

19BM402 ANALOG AND DIGITAL ELECTRONICS 3 1 0 4

Course Objectives

- To study the application of analog ICs in the designing circuit
- To study various number systems and to simplify the mathematical expressions using Boolean functions
- To study the implementation of digital ICs
- To study the design of various combinational synchronous and asynchronous circuits
- To expose the students to various memory devices

Course Outcomes (COs)

1. Interpret various number systems and simplifications using K-maps
2. Design the combinational and Sequential logic circuits for given real time problems
3. Implement the Explain the application of analog ICs in the designing circuit
4. Apply the Concept of state transition and analyse the design of sequential circuit
5. Analyze the digital system design using PLD and interpret the logic families

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	1	1													
2	2	1	1										2		
3	2	2											1	1	
4	2	1											2		
5	2	2											1	1	

UNIT I **9 Hours**

NUMBER SYSTEM AND LOGIC GATES

Decimal, Binary, Octal and Hexadecimal Numbers -Conversion between these number systems - Complements - subtraction using complements - Encoding numbers and characters using Binary digits. -Binary coded Decimal- Gray code - Binary to Gray code conversion - ASCII Code. Logic gates - Truth tables - NOT, AND, OR, NOR, NAND, XOR, XNOR - Boolean Laws and theorems - Solving Boolean expressions, Truth Tables and Logic circuits , The Karnaugh Map - half adder- full adder, Multiplexers and Demultiplexers - Decoders and encoders

UNIT II **9 Hours**

SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS

Flip flops - SR, JK - MSJK, D and T - Shift Registers - Analysis of synchronous sequential circuits; Design of synchronous sequential circuits - Moore and Melay models - Counters, Timers, state diagram; state reduction; state assignment. Analysis of asynchronous sequential machines - State assignment - Asynchronous design problem - Difference between Synchronous and Asynchronous Sequential Circuits.

UNIT III **9 Hours**

OPERATIONAL AMPLIFIERS

The characteristics of Ideal Operation - slew rate, offset voltage, bias current, CMRR, bandwidth - equivalent circuit of an op-Amp - virtual ground concept - Linear applications of op-amp - inverting and non-inverting amplifier, summing, subtracting, averaging amplifier - voltage to current converter - current to voltage converter - Differential amplifiers - differentiator and integrator. Nonlinear applications - comparator - Schmitt Triggers - Precision Diode Half wave and full wave rectifiers - Average detectors - peak Detector

UNIT IV **9 Hours**

ACTIVE FILTERS AND SIGNAL GENERATOR

Active filters (first and second order) - Low pass, high pass, band pass filters, band reject filters (notch filters). Oscillators - RC Phase shift and Wein-bridge. Waveform generators - Square, triangular and saw tooth

UNIT V **9 Hours**

TIMER, PLL, A/D AND D/A CONVERTERS

555 Timer (internal diagram) and its applications - monostable and astable multivibrator. Phase locked Loop (565 - block diagram approach) and its applications - Frequency multiplication, Frequency translation, voltage to frequency and frequency to voltage converters. DAC - Binary weighted DAC and R-2R DAC. ADC - single slope and dual slope ADCs, successive approximation ADC.

Total: 60 Hours

Reference(s)

1. M.Morris Mano,Digital Logic and Computer design,Prentice Hall,2010
2. Ramakant A.Gayakwad,Op-AMP and Linear Ics,Prince Hall,2015
3. Robert B.Northrop, Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation, CRC Press, second edition,2012
4. SergioFranco, Design with Operational Amplifiers and analog Integrated circuits, McGraw-Hills, Fourth edition, 2014
5. Millman J ,Halkias.C., Integrated Electronics, TMH, Second edition, 2017
6. John.F.Wakerly, Digital Design Principles and Practices, Fourth Edition, Pearson Education, 2008

19BM403 BIOSIGNAL PROCESSING 3 1 0 4

Course Objectives

- To have an understanding on the key theoretical principles of biomedical signal processing
- To be able to apply knowledge of the signal processing techniques on medical signals
- To apply biomedical signal processing concepts to relevant domain

Course Outcomes (COs)

1. Understand different types of biomedical signal and its signal conversion technique
2. Apply the signal averaging techniques and filters for Biosignal processing
3. Analyse the data compression techniques in medical signals.
4. Identify and analyze the ECG data acquisition and processing
5. Identify and analyze the EEG data acquisition and processing

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	2			3	1									
2	1	2		3	2								3	3	
3	2			1	2									3	
4	2		3	3		1								3	2
5	2		3	3		1								3	2

UNIT I **9 Hours**

INTRODUCTION TO BIOMEDICAL SIGNALS

Introduction to Biomedical Signals: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis. Signal Conversion: Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits

UNIT II **9 Hours**

SIGNAL AVERAGING AND FILTERS

Signal Averaging: Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. Filters: Time Domain Filter, Frequency domain filter, optimal filter, adaptive filter, selecting an appropriate filter

UNIT III **9 Hours**

DATA COMPRESSION TECHNIQUES

Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms. Fourier transform, Correlation, Convolution, Power spectrum estimation, Frequency domain analysis of the ECG

UNIT IV **9 Hours**

CARDIOLOGICAL SIGNAL PROCESSING

ECG data acquisition, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Bandpass filtering techniques,

Differentiation techniques, Template matching techniques, QRS detection algorithm, Real time ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor

UNIT V **9 Hours**

NEUROLOGICAL SIGNAL PROCESSING

The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients). Correlation Analysis of EEG channels: Detection of EEG rhythms, Template matching for EEG, spike and wave detection

Total: 60 Hours

Reference(s)

1. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003.
2. D C Reddy, "Biomedical Signal processing - Principals and Techniques", Tata Mc Graw Hill Publications, 2007
3. Rangaraj M.Rangayyan, "Biomedical Signal Analysis - A case study approach", Wiley, Second Edition, 2016.
4. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida,2019.
5. Emmanuel C.Ifeachor, Barrie W.Jervis, "Digital Signal processing - A Practical Approach",Pearson education Ltd.,2004.
6. John L.Semmlow, "Biosignal and Biomedical Image Processing Matlab Based applications", Taylor& Francis Inc, Third edition, 2014.

19BM404 BIOMEDICAL INSTRUMENTATION 3 0 0 3

Course Objectives

- To illustrate origin of bio potentials and its propagations to understand the different types of electrodes and its placement for various recordings.
- To design bio amplifier for various physiological recordings and analyze different measurement techniques for non-physiological parameters
- To Summarize different biochemical measurements

Course Outcomes (COs)

1. Differentiate different bio potentials and its propagations
2. Illustrate different electrode placement for various physiological recordings
3. Design bio amplifier for various physiological recordings
4. Explain various technique for non-electrical physiological measurements
5. Demonstrate different biochemical measurement techniques

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3	2			2								1		
2	3	2			2	1							2	2	
3	2	1	3		2	2							2	2	
4	1		2	3		2							2	3	2
5	1		2	3		2							2	3	2

UNIT I **9 Hours**

BIOPOTENTIAL ELECTRODES

Origin of bio potential and its propagation.Electrode-electrolyte interface, electrode-skin interface, half-cell potential, Contact impedance, polarization effects of electrode-non polarizable electrodes. Types of electrodes surface, needle and micro electrodes and their equivalent circuits. Recording problems-motion artifacts, measurement with two electrodes.

UNIT II **9 Hours**

BIOPOTENTIAL MEASUREMENTS

Bio signals characteristics-frequency and amplitude ranges. ECG-Einthovens triangle, standard 12 lead system, Principles of vectorcardiography. EEG-10-20 electrode system,unipolar, bipolar and average mode. EMG-unipolar and bipolar mode. Recording of ERG, EOG and EGG.

UNIT III **9 Hours**

BIOSIGNAL CONDITIONING

Need for bio-amplifier-single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers-transformer and optical isolation-isolated DC amplifier and AC carrier amplifier, Power line interference, Right leg driven ECG amplifier, Band pass filtering, Artifacts and removal.

UNIT IV **9 Hours**

MEASUREMENT OF NON-ELECTRICAL PARAMETERS

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 **9 Hours**

BIOCHEMICAL MEASUREMENT AND BIOSENSORS

Biochemical sensors- pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET(IMFET), Blood glucose sensors, Blood gas analyzers- colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description)-Biosensors-Principles-amperometric and voltometric techniques, Electrophoretic techniques.

Total: 45 Hours

Reference(s)

1. Leslie Cromwell, Biomedical Instrumentation and measurement, 2nd edition, Prentice Hall of India,New Delhi,2015
2. John G. Webster,Medical Instrumentation Application and Design, 5th edition,Wiley India Pvt Ltd,New Delhi,2020
3. Khandpur R.S,Handbook of Biomedical Instrumentation, 3rd edition, Tata McGraw-Hill New Delhi,2014.
4. Joseph J. Carr and John M. Brown,Introduction to Biomedical Equipment Technology, Pearson Education,2004.
5. Myer Kutz,Standard Handbook of Biomedical Engineering and Design, McGraw Hill Publisher, 2003.

19BM405 BIOCHEMISTRY, PATHOLOGY AND MICROBIOLOGY

3 0 0 3

Course Objectives

- To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids
- Gain knowledge on the structural and functional aspects of living organisms
- Know the etiology and remedy in treating the pathological diseases

Course Outcomes (COs)

1. Understand the fundamentals of biochemistry.
2. Analyze structural and functional aspects of living organisms
3. Understand various fluid and hematological disorders
4. Understand bacterial cultures and techniques involved
5. Describe methods involved in treating the pathological diseases

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3												3	1	
2	3												3	1	
3	3												3	2	
4	3		2						1			1	2	1	1
5	3		1						1			1	3	2	1

UNIT I **9 Hours**

INTRODUCTION TO BIOCHEMISTRY

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson- Hasselbalch equation, physiological buffers, fitness of the aqueous environment for living organism . Principle of viscosity, surface tension, adsorption, diffusion, osmosis and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes

UNIT II **9 Hours**

CELL DEGENERATION, REPAIR AND NEOPLASIA

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, carcinogensis, spread of tumors, autopsy and biopsy

UNIT III **9 Hours**

FLUID AND HEMODYNAMIC DERRANGEMENTS

Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, chronic venous congestion. Hematological disorders- Bleeding disorders, Leukemia, Lymphomas Hemorrhage.

UNIT IV **9 Hours**

MICROBIAL CULTURES

Morphological features and structural organization of bacteria, growth curve, identification of bacteria, culture media and its types , culture techniques and observation of culture.

UNIT V **9 Hours**

IMMUNOPATHOLOGY

Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonization, phagocytosis, 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, immune-electrophoresis, RIA and ELISA, monoclonal antibodies.

Total: 45 Hours

Reference(s)

1. David.W.Martin, Peter.A.Mayes, Victor. W.Rodwell, Harper"s Illustrated Biochemistry, LANGE Medical Publications, 2018
2. Keith Wilson, John Walker, Practical Biochemistry- Principles & Techniques, Oxford University Press,2009
3. Ramzi S Cotran, Vinay Kumar, Stanley L Robbins, Pathologic Basis of diseases, WB Saunders Co. 7th Edition,2005
4. Harsh Mohan, Text book of Pathology, Jaypee Brothers Medical publishers private Limited, 8th Edition,2019

19BM406 PYTHON PROGRAMMING 2 0 2 3

Course Objectives

- To understand the problem-solving techniques using Algorithms, Pseudocode and Flowchart.
- To develop Python programs with conditionals and loops.
- To develop Python programs with lists, tuples, dictionaries, Files and Packages.

Course Outcomes (COs)

1. Develop algorithmic solutions to simple computational problems.
2. Implement python programs using datatypes and operators.
3. Develop python programs using control flow statements, functions and strings.
4. Apply the concepts of list, sets, tuples and dictionaries in python programming.
5. Design applications using functions and files in python.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3	3		3											
2	2	3		3											
3	2	3		3											
4	2	3		3											
5	2	3		3											

UNIT I **9 Hours**

ALGORITHMIC PROBLEM SOLVING

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation(pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi

UNIT II **9 Hours**

DATA, EXPRESSIONS, STATEMENTS

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III **9 Hours**

CONTROL FLOW, FUNCTIONS

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV **9 Hours**

LISTS, TUPLES, DICTIONARIES

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V **9 Hours**

FILES, MODULES, PACKAGES

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

0 Hours

EXPERIMENT 1

Develop Algorithm , flowchart and Pseudocode for computational problems.

0 Hours

EXPERIMENT 2

Program to implement basic operators.

0 Hours

EXPERIMENT 3

Program to implement the concept of function.

0 Hours

EXPERIMENT 4

Develop the program for selection statements.

0 Hours

EXPERIMENT 5

Program to implement looping statements.

0 Hours

EXPERIMENT 6

Program to implement break and continue statements.

0 Hours

EXPERIMENT 7

Develop a program to implement the concept of Recursion.

0 Hours

EXPERIMENT 8

Program to implement string functions.

0 Hours

EXPERIMENT 9

Implement the concept of list.

0 Hours

EXPERIMENT 10
Develop a program to implement tuples.

0 Hours

EXPERIMENT 11
Program to implement set, dictionaries.

0 Hours

EXPERIMENT 12
Program to implement files

0 Hours

EXPERIMENT 13
Program to implement word count

0 Hours

EXPERIMENT 14
Program to implement command line arguments

0 Hours

EXPERIMENT 15
Program to import packages

Total: 45 Hours

Reference(s)

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python - Revised and updated for Python 3.2", Network Theory Ltd., 2014.
3. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus", Wiley India Edition, 2015.
4. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press , 2017

19BM407 BIOSIGNAL PROCESSING LABORATORY

0 0 2 1

Course Objectives

- To have an understanding on the key theoretical principles of biomedical signal processing
- To be able to apply knowledge of the signal processing techniques on medical signals
- To apply biomedical signal processing concepts to relevant domain

Course Outcomes (COs)

1. Understand different types of biomedical signal and its signal conversion technique
2. Apply the signal averaging techniques and filters for Biosignal processing
3. Analyse the data compression techniques in medical signals
4. Identify and analyze the ECG data acquisition and processing
5. Identify and analyze the EEG data acquisition and processing

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	2			3	1									
2	1	2		3	2								3	3	
3	2	2		1	2									3	
4	2		3	3		1								3	2
5	2		3	3		1								3	2

3 Hours

EXPERIMENT 1

Prepare and plot the signals in a Matlab program
a) Convolution b) Peak detection

3 Hours

EXPERIMENT 2

a) Digital IIR Butterworth filter-LPF, HPF
b) Digital IIR chebychev filter-LPF, HPF

3 Hours

EXPERIMENT 3

Design of FIR filter using windowing technique

3 Hours

EXPERIMENT 4

FFT and IFFT of the given sequence using MATLAB

3 Hours

EXPERIMENT 5

Application of Filtering techniques to a noisy biomedical signal and find its following features: Mean, Median, Auto correlation co-efficient

3 Hours

EXPERIMENT 6

Analysis of ECG signal

3 Hours

EXPERIMENT 7

Design a notch filter to remove the artifact and implement it in MATLAB for ECG signal and also plot the frequency response of the filter

3 Hours

EXPERIMENT 8

Filtering of the ECG for the Removal of the 60 Hz Powerline Artifact

3 Hours

EXPERIMENT 9

Analysis of EEG signal

3 Hours

EXPERIMENT 10

Detection of Spike-and-wave Complexes in EEG Signals

Total: 30 Hours

Reference(s)

1. John L.Semmlow, "Biosignal and Biomedical Image Processing Matlab Based applications", Taylor& Francis Inc, Third edition, 2014
2. Arnon Cohen, "Bio-Medical Signal Processing Vol I and Vol II", CRC Press Inc., Boca Rato, Florida,2019
3. Willis J. Tompkins, "Biomedical Digital Signal Processing", Prentice Hall of India, New Delhi, 2003

19BM408 BIOCHEMISTRY AND PHYSIOLOGY LABORATORY **0 0 2 1**

Course Objectives

- To analyse the estimation and quantification of blood cells
- To learn methods for identification of blood group
- TO estimate the heamatological parameters
- To analyse the visual and hearing test
- To Recognize the Classification, structure and properties of Protein and Nucleic acid

Course Outcomes (COs)

1. Identification of enumeration of blood cells
2. Enumeration of haemotoligical parameters
3. Analyse of special sensory organ test
4. Recognize the Classification, structure and properties of Protein and Nucleic acid
5. Analyze the advanced knowledge about organ function test.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	1	1	2		2	2	2	3				3	1	-	
2	1	1	2		2	2	2	3				3	1	-	
3	1	1	1	1	2	2	2	3				3	1		
4	1	1	2	1	2	2	2	3				3	1		
5	1	1	2	1	2	2	2	3	3			3	1		

3 Hours

EXPERIMENT 1

(a) Collection of blood sample and Identification of blood groups.
(b) Bleeding and clotting time

3 Hours

EXPERIMENT 2

Preparation of serum and plasma from blood

3 Hours

EXPERIMENT 3

General tests for Carbohydrates, Proteins and Lipids

3 Hours

EXPERIMENT 4

(a) Estimation of Hemoglobin
(b) Estimation of Blood Glucose

3 Hours

EXPERIMENT 5
(a) Total RBC and WBC count.
(b) PCV, MCH, MCV, MCHC

3 Hours

EXPERIMENT 6
Estimation of Creatinine, Urea and Cholesterol

3 Hours

EXPERIMENT 7
ELISA test

3 Hours

EXPERIMENT 8
Separation of proteins by SDS electrophoresis

3 Hours

EXPERIMENT 9
Separation of amino acids by thin layer chromatography

0 Hours

EXPERIMENT 10
(a)Hearing test- Tuning fork
(b) Visual acuity- Snellens chart

Total: 27 Hours

Reference(s)

1. Biochemistry, U Satyanarayana, Elsevier Health Sciences; Fourth Edition (2014)
2. Textbook of Microbiology, Ananthanarayan and Panikers, Universities Press; Eighth edition (2009).
3. Review in pathology, Nitin chawla , CBS Publishers and Distributors Pvt Ltd (2018).

18HS001 ENVIRONMENTAL SCIENCE 2 0 0 0

Course Objectives

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

Course Outcomes (COs)

1. Examine the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Impact the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Correlate the impacts of population and human activities on environment

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1															
2	1	1													
3															
4	1														
5	2														

UNIT I **6 Hours**

NATURAL RESOURCES

Forest resources: Use - over exploitation - deforestation - case studies. 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 - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, biomagnification). Energy resources: renewable (solar, wind, and hydro).

UNIT II **6 Hours**

ECOSYSTEMS AND BIODIVERSITY

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

UNIT III **6 Hours**

ENVIRONMENTAL POLLUTION

Pollution: Definition - causes - effects - control measures of air pollution - water pollution : (Sewage water treatment by activated sludge and trickling filter process) - noise pollution- thermal pollution. Disaster management: causes - effects - control measures of floods Ã¢?? earthquake

UNIT IV **7 Hours**

SOCIAL ISSUES AND ENVIRONMENT

Sustainable development : Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste.

UNIT V **5 Hours**

HUMAN POPULATION AND ENVIRONMENT

Human population: Population growth - characteristics - variation among nations - population explosion - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

FOR FURTHER READING

Human rights:Biomedical waste -Identification of adulterants in food materials

Total: 30 Hours

Reference(s)

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edtion, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

18GE401 SOFT SKILLS-REASONING 2 0 0 0

Course Objectives

- To acquire command of both the receptive skills (Listening, Reading) and the productive skills (Writing and Speaking) of English language
- To understand and make effective use of English language in business contexts

Course Outcomes (COs)

1. Listen, Read, Speak, and Write Business English at the level of independent users
2. Appear for the Business English Certificate (BEC) Vantage level examination conducted by the Cambridge Assessment English

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2														
2	3														

UNIT I **15 Hours**

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information
Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

UNIT II **15 Hours**

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

15 Hours

LISTENING AND READING

Listening for writing short answers - filling gaps in sentences - identifying topic, context and function - identify different functions of language in business situations - identify prompts -identify paraphrases of required information - Scanning - reading for gist - understanding sentence structure - error identification - identify paraphrases - cohesive words and phrases - understand the importance of analysing the distractors - identify grammatical and semantic relationships

15 Hours

WRITING AND SPEAKING

Business emails - notes - memos to colleagues or friends - giving instructions - explaining a development - asking for comments - requesting information - agreeing to requests - explaining - apologising - reassuring - complaining - describing - summarising - recommending - persuading turn - taking - sustaining interaction - initiating - responding - giving personal information - talking about present circumstances, past experiences and future plans - expressing opinion - speculating - organising a larger unit of discourse - giving information - expressing and justifying opinions - speculating - comparing and contrasting - agreeing and disagreeing

Total: 60 Hours

Reference(s)

1. Whitehead, Russell and Michael Black. Pass Cambridge BEC Vantage Self - study Practice Tests with Key, Heinle - a part of Cengage Learning, Delhi, 2003.

21BM501 BIO CONTROL SYSTEMS 3 1 0 4

Course Objectives

- To Study the principles of system modelling, system analysis and feedback control, and use them to design and evaluate feedback control systems with desired performance.
- Control system modelling: modelling of electric and mechanical systems, using differential equations, transfer functions, block diagrams, and state variables.
- Control system analysis: analysis of properties of control systems, such as stability, controllability, tracking, in time and frequency domains.
- Analyze the frequency domain specifications of the different systems.
- To study the concept of physiological control system

Course Outcomes (COs)

1. Assess the transfer function model of electrical and mechanical systems.
2. Interpret the time response and steady error for the different order systems to various inputs.
3. Analyze stability condition for the given biocontrol systems
4. Analyze performance of the system using frequency response methods.
5. Categorize the model of physiological control systems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	1	2								1	1	1	
2	2	2		2									1	1	
3	1	3		2								1	1	2	
4	1	3		2									1	2	
5	1	2	2	3								1	1	1	

UNIT I **9 Hours**

CONTROL SYSTEM MODELING

Terminology and the basic structure of control system, the 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 the block diagram, and signal flow graph, conversion of the block diagram to signal flow graph. Need for modeling physiological system

UNIT II **9 Hours**

TIME RESPONSE ANALYSIS

Step and impulse responses of the first order and second-order systems, determination of time-domain specifications of first and second-order systems from its output responses, the definition of steady-state error constants, and its computations. Introduction to PI, PD, and PID controllers.

UNIT III **9 Hours**

STABILITY ANALYSIS

Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability, the definition of dominant poles, and relative stability.

UNIT IV **9 Hours**

FREQUENCY RESPONSE ANALYSIS

Frequency response, Nyquist stability criterion, Nyquist plot, and determination of closed-loop stability, the definition of gain margin and phase margin, Bode plot, determination of gain margin and phase margin using Bode plot, use of Nicholas chart to compute frequency and bandwidth

UNIT V **9 Hours**

PHYSIOLOGICAL CONTROL SYSTEM

Example of the physiological control system, the difference between engineering and physiological control systems, generalized system properties, models with the combination of system elements, linear models of physiological systems-Examples, introduction to simulation. Illustration with real-time applications

Total: 60 Hours

Text Book(s)

1. K. Ogatta, Modern Control Engineering, Pearson Education, New Delhi, 2010.

Reference(s)

1. I.J. Nagrath and M. Gopal, Control System Engineering, New Age International Publisher, 2011.
2. Benjamin C. Kuo, Automatic Control Systems, Prentice-Hall of India Pvt. Ltd. 2012
3. M. Gopal, Control System Principles and Design, Tata McGraw-Hill, 2012
4. M. N. Bandyopadhyay, Control Engineering Theory and Practice, Prentice Hall of India, 2009
5. Norman S. Nise, Control Systems Engineering, 4th edition, New York, John Wiley, 2003. (Indian edition)

21BM502 DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS I

3 0 2 4

Course Objectives

- To understand medical equipment used in the measurement of parameters related to cardiology and neurology.
- To apply some of the cardiac assist devices, ECG and EEG machines
- To analyze the principle of bio telemetry and function of various extra corporeal devices

Course Outcomes (COs)

1. Analyze the working and recording setup of all basic cardiac equipment.
2. Analyze the working and recording of all basic neurological equipment.
3. Categorize and analyze various diagnostic and therapeutic equipment related to EMG.
4. Apply appropriate measurement and assistive techniques related to the respiratory system.
5. Analyze the performance of sensory diagnostic equipment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		1				1				1	2	1	1
2	2	3		1				1				1	2	1	1
3	2	2		2				1				1	2	1	1
4	2	2		1				1				1	2	1	1
5	2	3		2				1				1	2	1	1

UNIT I **9 Hours**

CARDIAC EQUIPMENT

Electrocardiograph - Normal and Abnormal Waveforms, Heart rate monitor, Heart rate variability, Holter Monitor, Cardiac Pacemaker- Internal and External Pacemaker, types, Batteries. AC and DC Defibrillator- Internal and External, types, Precautions.

UNIT II **9 Hours**

NEUROLOGICAL EQUIPMENT

Multi-channel EEG recording system Clinical significance of EEG- Sleep patterns, Epilepsy, Evoked Potential Visual Auditory and Somato sensory .EEG Bio Feedback Instrumentation, Psychophysiological Measurements for testing sensory Responses MEG(Magneto Encephalograph)sensing principle and instrumentation

UNIT III **9 Hours**

MUSCULAR EQUIPMENT

EMG - recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators,nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation. EGG (Electro Gastro Graph), MMG (Magneto Myo Graph).

UNIT IV **9 Hours**

PATIENT MONITORING AND BIOTELEMETRY

Patient monitoring systems ICU/CCU Equipment Infusion pumps bedside monitors ,Central monitoring console Architectureof Biotelemetry system, single and multi-channel Biotelemetry, Inductively coupled Biotelemetry Optical Biotelemetry read out formats. -Health2.0 devices disposable hematology sensors.

UNIT V **9 Hours**

EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES

Need for heart lung machine ,Functioning of bubble Disctype and membrane type oxygenators finger pump roller pump Hemodialyser unit Peritoneal dialyser unit Wearable artificial kidney Lithotripsy Cryogenic technique Thermography Recording Principle and clinical application Tonometer Auto Refractometer Audiometer Bekseystype Puretone Speech Galvanic skin resistance(GSR) polygraph.

Total: 45 Hours

Reference(s)

1. Joseph JCarr and John M Brown, "IntroductiontoBiomedical equipment technology" Peaon rsonEducation 4thEditi2014.
2. John GWebster, "Medical Instrumentation Application and Design "John Wiley and Sons NewYork 5thEdition 2020
3. MyerKutz"Biomedical Engineering Design Handbook "Volume2 McGraw-HillPublisher 2ndEdition 2009
4. LAGeddes and LEBaker, "Principles of Applied Biomedical Instrumentation "John Wiley and Sons 3rd Edition Reprint 2008.
5. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, BiomedicalInstrumentationandMeasurementsPearsonEducationIndia2ndEdition2015
6. Antony YK Chan, "Biomedical Device technology Principles and design "Charles Thomas Publisher Ltd Illinois USA 2008

21BM503 BIOMATERIALS AND ARTIFICIAL ORGANS

3 0 0 3

Course Objectives

- To study the characteristics and classification of biomaterials.
- To understand the response of biomaterials in living system.
- To learn about the polymeric materials and composites in tissue replacements.
- To know the compatibility and functioning of artificial organs inside the living system.

Course Outcomes (COs)

1. Understand the structure of bio-materials and its bio-compatibility
2. Apply appropriate metallic and ceramic implant materials in medical field based on their properties.
3. Apply various polymeric implantable materials for replacing natural organs
4. Analyse soft and hard tissue replacement implants in biomedical applications.
5. Analyse the functioning of artificial organs for replacing natural organ functions.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2		1	2			2							1	1
2	1	1	2	2			2						1	2	1
3	1			2									2	1	
4	1			1		2	2						1		
5	1	1	2	2		2	2						2	2	1

UNIT I **9 Hours**

STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY

Definition and classification of bio-materials, mechanical properties, viscoelasticity, wound healing process, body response to implants, blood compatibility, HLA compatibility.

UNIT II **9 Hours**

IMPLANT MATERIALS

Metallic implant materials, stainless steels, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite, glass ceramics, carbons, medical applications

UNIT III **9 Hours**

POLYMERIC IMPLANT MATERIALS

Polymerization, polyamides, Acryrilic polymers, Hydrogels, rubbers, high strength, thermoplastics, medical applications. Bio polymers: collagen and elastin. Medical Textiles: silica, chitosan,P LA, composites, Sutures, wound dressings. Materials for ophthalmology: contact lens, Intra ocular lens. Membranes for plasma separation and blood oxygenation

UNIT IV **9 Hours**

TISSUE REPLACEMENT IMPLANTS

Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft tissue replacements, types of transplant by stem cell, sutures, surgical tapes, Tissue adhesive/glue.

Percutaneous
and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, Pancreas replacement.

UNIT V **9 Hours**

ARTIFICIAL ORGANS

Artificial Blood, Artificial Skin, Artificial Heart, Prosthetic Cardiac valves, Artificial Lung(Oxygenator),Artificial Kidney(Dialyzer Membrane),Dental Implants, Retinal Implants.

Total: 45 Hours

Text Book(s)

1. Sujata V. Bhatt,Biomaterials,Narosa Publishing House,7 th Edition,2005.

Reference(s)

1. Park Joseph D.Bronzino,Biomaterials-Principles and Applications,CRC press,2003.
2. Myer Kutz,Standard Handbook of Biomedical Engineering & Design,McGraw-Hill,2003
3. John Enderle,Joseph D.Bronzino,Susan M.Blanchard, Introduction to Biomedical Engineering,Elsevier,Third edition,2011.
4. BD Ratner,AS Hoffmann,FJ Schoen,JE Lemmons,An introduction to Materials in Medicine,Academic Press,1996.
5. Sreeram Ramakrishna,MuruganRamalingam,T. S. Sampath Kumar, and Winston O. Soboyejo,Biomaterials:A Nano Approac,CRC Press,2013.

21BM504 MICROCONTROLLERS 3 1 0 4

Course Objectives

- To understand the RISC/CISC architecture and Pipelining technique in microcontrollers.
- To apply the architectural features of hardware for interfacing peripheral devices to PIC 16Fxx microcontrollers.
- To structure the design of LPC2148 microcontroller.
- To outline the concepts of ARM Architecture and Thumb Instruction Set.
- To organize the programming concepts of MSP430 architecture.

Course Outcomes (COs)

1. Understand the fundamentals of PIC Microcontroller
2. Apply interrupts and timers concepts of microcontrollers for real time applications
3. Analyze the peripheral interfacing methodology in PIC Microcontroller for a given application
4. Analyse the architectural features of ARM microcontroller.
5. Analyse the functional facilities available in MSP430 microcontroller.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	2	2		2										
2	3	2	1	2											
3	3	2	2	2	2										
4	2	1	3	2											
5	2	2	2	2	2										

UNIT I **9 Hours**

INTRODUCTION TO PIC MICROCONTROLLER

Introduction to PIC microcontrollers, PIC 16FXX architecture, comparison of PIC with other CISC and RISC based systems - Pipelining - Program Memory considerations - Register File Structure - Addressing modes - Simple Operations.

UNIT II **9 Hours**

INTERRUPTS AND TIMER

PIC micro controller Interrupts- External Interrupts-Interrupt Programming - Loop time subroutine - Timers-Timer Programming - Front panel I/O-Soft Keys - key switches- Display of Constant and Variable strings.

UNIT III **9 Hours**

PERIPHERALS AND INTERFACING

I2C Bus for Peripherals Chip Access - Bus operation-Bus subroutines - Serial EEPROM - analog to Digital Converter - UART-Baud rate selection - Data handling circuit - Initialization - LCD and keyboard Interfacing -ADC, DAC, and Sensor Interfacing.

UNIT IV **9 Hours**

INTRODUCTION TO ARM

The ARM architecture - ARM assembly language program - ARM organization and implementation - The ARM Instruction set - The thumb instruction set - ARM CPU cores - GPIO programming, Timer programming, Interrupt programming, Serial port programming, LCD and Keyboard interfacing.

UNIT V **9 Hours**

INTRODUCTION TO MSP430

MSP430 Architecture: Introduction - Functional block diagram - Memory - Central Processing Unit - Memory Mapped Input and Output - - Instruction Set - Introduction to Code Composer Studio (CCS v4) - Understanding how to use CCS for MSP430 microcontrollers-Interrupt programming-Digital I/O-I/O ports programming using C.

Total: 60 Hours

Reference(s)

1. Peatman JB, "Design with PIC Microcontrollers", Pearson Education, 3rd edition, 2004.
2. Mazidi MA, Rollin Mckinlay, Danny Causey, "PIC Microcontroller", Prentice Hall of India, Pearson Education, 1st edition, 2008.
3. Myke Predko, " Programming and Customizing the PIC Microcontroller, TAB Electronics, 3rd edition, 2009.
4. Furber S, "AR System on Chip Architecture", Addison Wesley trade Computer Publication, 2014
5. Technical documents related to MSP-EXP 430G2 and Tiva C Series TM4C123G

21BM507 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY

0 0 2 1

Course Objectives

- Apply various kinds of signal acquiring methods.
- Demonstrate the working of ECG, EMG and Bio telemetry equipments
- Compare the normal waves and the abnormal waves of both ECG and EMG.
- Analyse the bio Signals of heart, muscles and pulse

Course Outcomes (COs)

1. Identify appropriate equipment for the diagnosing heart and muscle related diseases.
2. Implement all the diagnostic techniques for cardiac diseases.
3. Apply Suitable diagnosing techniques for ECG and EMG equipments.
4. Integrate the components of a bio telemetry for monitoring vital parameters of the patient
5. Compare the ECG and EMG bio signals in patient monitoring system

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	2	2	2		1		2	2		1	1	2	
2		2	2	2	2		1		2	2	1	1	1	2	
3		2	2		2		1		2	2		1	1	2	
4		2	1	2	2	-	1		2	2	1	1	1	2	
5		2	2	1	2		1	1		2	1	1	1	2	

3 Hours

EXPERIMENT 1
Recording and analysis of ECG signals

3 Hours

EXPERIMENT 2
Recording and analysis of EEG signals

3 Hours

EXPERIMENT 3
Evoked Potential - Visual

3 Hours

EXPERIMENT 4
ESR and GSR Measurements

3 Hours

EXPERIMENT 5
Working of different Types of Diathermy-Shortwave, ultrasound surgical

3 Hours

EXPERIMENT 6
Respiratory system analysis using Spirometer

3 Hours

EXPERIMENT 7
Real time patient monitoring system

3 Hours

EXPERIMENT 8
Real time monitoring of Echocardiography

3 Hours

EXPERIMENT 9
Heart sound measurement using PCG

3 Hours

EXPERIMENT 10
EMG Biofeedback with Nerve Conduction Velocity

Total: 30 Hours

Reference(s)

1. MyerKutz "Biomedical Engineering Design Handbook "Volume2 McGraw-Hill Publisher 2ndEdition 2009
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, BiomedicalInstrumentationandMeasurementsPearsonEducationIndia2ndEdition2015

21BM508 MICROCONTROLLERS AND IOT LABORATORY **0 0 2 1**

Course Objectives

- To design medical embedded systems using microcontrollers.
- To gain knowledge on Internet of Things.
- To understand the wireless communication protocols.
- To update the knowledge on data analysis.
- To understand the concept of cloud services.

Course Outcomes (COs)

1. Interface peripherals with microcontroller to design an embedded system.
2. Transmit data wirelessly through Internet of Things.
3. Implement communication protocols as per requirement.
4. Perform data analysis on measured values from sensors.
5. Store data in a remote server and access it.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2		2	2				2		1			
2	2	3	2	2	2					2		1			2
3	3	2	2	2	2					2		1	2	1	1
4	3	3	2	2	2					2		1	2		1
5	2	2	2	2	2					2		1			

3 Hours

EXPERIMENT 1
Implementation and interfacing of LCD with PIC16F877a

3 Hours

EXPERIMENT 2
Implementation and interfacing of LM35 Temperature Sensor using PIC microcontroller

3 Hours

EXPERIMENT 3
Generation of PWM pulse to control DC motor using PIC16F877a

3 Hours

EXPERIMENT 4
Interfacing of Relay with ARM LPC2148

3 Hours

EXPERIMENT 5
Analog to Digital Conversion and Interrupts Using MSP430

3 Hours

EXPERIMENT 6
Interfacing with IoT Transceiver using Wi-Fi Device

3 Hours

EXPERIMENT 7
Implementation of working IoT protocols such as MQTT, CoAP

3 Hours

EXPERIMENT 8
Integration of Intelligent Algorithms for Data Analysis

3 Hours

EXPERIMENT 9
Implementation of Biomedical Data analysis in Cloud Service.

3 Hours

EXPERIMENT 10
Monitoring Health Parameter Mobile App Development with IoT application

Total: 30 Hours

18GE501 SOFT SKILLS - APTITUDE I 0 0 2 0

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Course Outcomes (COs)

1. Explain various concepts of number systems and their techniques in solving the percentage, average and age problems.
2. Analyse the profit and loss of real time situations and the relation between ratio, proportion and variation.
3. Apply different techniques to find the distance, speed and time of various moving objects.
4. Understand the concepts of coding, sequences and series, data interpretation and critical reasoning to solve real time logical reasoning problems.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2													
2	2	2													
3	2	2													
4	2	2													

1 **2 Hours**

NUMBER SYSTEMS

Introduction - Definition - Classification on Numbers- Power cycles and remainders - Short cut process- Concept of Highest Common Factor-Concept of Least Common Multiple- Divisibility- Number of zeros in an expression.

2 **2 Hours**

PERCENTAGE

Introduction - Definition and Utility of Percentage - Importance of base/denominator for percentage calculations-Concept of percentage values through additions-Fraction to percentage conversion table.

3 **3 Hours**

AVERAGES AND AGES

Introduction-Average of different groups-Addition or removal of items and change in average-Replacement of some of the items.

4 **3 Hours**

RATIO, PROPORTIONS AND VARIATION

Introduction- Ratio- Properties-Dividing a given number in the given ratio-Comparison of ratios-Proportions-Useful results on proportion- Continued proportion-Relation among the quantities more than two-Variation.

5 **2 Hours**

PROFIT AND LOSS

Gain/Loss and percentage gain or percentage loss-Multiplying equivalents to find sale price-Relation among cost price, sale price, gain/loss and percentage gain or percentage loss-An article sold at two different selling price-Two different articles sold at same selling price-Percentage gain or percentage loss on selling price-Percentage gain or percentage loss on whole property.

6 **2 Hours**

TIME AND WORK

Introduction-Basic concepts-Concepts on working with different efficiencies-Pipes and Cisterns-Work Equivalence (Man Days) -Alternative approach.

7 **2 Hours**

TIME, SPEED AND DISTANCE

Definition-Basics of Time, Speed and Distance - Relative speed-Problems based on Trains-Problems based on Boats and Streams-Problems based on Races-Time taken with two difference modes of transport-Time and distance between two moving bodies.

8 **3 Hours**

CODING AND DECODING

Introduction-Description of Coding method-Coding patterns - Concepts of Coding and Decoding-Problems involving Coding and Decoding methods.

9 **2 Hours**

SEQUENCE AND SERIES

Introduction-Sequences of real numbers - Number and Alphabet series-Description of Number and Alphabet series-Analogy-Odd man out-Power series.

10 **3 Hours**

DATA SUFFICIENCY

Introduction to Data Sufficiency - Overview of the wide variety of Data Sufficiency problems - Basic introduction on how to determine what information is sufficient to solve a given problem - Common pitfalls to avoid.

11 **3 Hours**

DIRECTION

Introduction to Direction - sense test - Overview of the wide variety of Direction problems-Direction-Plotting diagrams.

12 **3 Hours**

CRITICAL REASONING

Introduction-Basic concept of critical reasoning- Weaken the argument-Strengthen the argument-Flaw in the argument-Evaluate the conclusion.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

21BM601 BIOMECHANICS 3 1 0 4

Course Objectives

- To study about the mechanics involved with various physiological systems.
- To gain knowledge in deriving the mathematical models related to blood vessels.

Course Outcomes (COs)

1. Understand the fundamental concepts of biomechanics in engineering and analyze its properties.
2. Apply solid and fluid dynamics in biomechanics.
3. Analyze the mechanical properties of hard and soft tissues.
4. Analyze the biomechanical properties of joints.
5. Design and develop the models specific to orthopaedic applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2		1		1						1	2		2
2	2	2		2		1						1	2		2
3	2	3		2		1						1	2		2
4	2	3		2		1						1	2		2
5	2	2	3	2		1		2				1	2	2	2

UNIT I **9 Hours**

INTRODUCTION

Definition and perspective of biomechanics, Kinematic concept for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human movement, Anthropometry

UNIT II **9 Hours**

BIOMECHANICS OF SOLIDS AND FLUIDS

Constitutive Equation, Stress, strain, viscoelasticity, models of viscoelasticity, Flow properties of blood, dynamics of fluid flow in cardiovascular system, Rheology of blood in microvessels, Bio viscoelastic solids, Lubrication of joints

UNIT III **9 Hours**

BIOMECHANICS OF HARD AND SOFT TISSUES

Bone: structure, composition, mechanical properties, anisotropy, fracture mechanisms - pseudo elasticity, Structure, function, mechanical properties of: skin, ligaments, skeletal muscles and tendons, Constitutive equations for soft tissues

UNIT IV **9 Hours**

BIOMECHANICS OF JOINTS

Kinetics and kinematics of joints, Skeletal joints, mechanics of the elbow, mechanics of shoulder, mechanics of spinal column, mechanics of hip, mechanics of knee, mechanics of ankle

UNIT V **9 Hours**

ORTHOPAEDIC APPLICATIONS

Gait analysis, Qualitative biomechanical analysis to: improve technique, understand injury development, Amputations and prosthetics, prosthetic components, Introduction to 3D printing, Introduction to accelerometer

Total: 60 Hours

Reference(s)

1. Y.C.Fung, Bio-Mechanics, Mechanical Properties of Tissues, Springer-Verilog,1993.
2. C. Ross Ether and Craig A. Simmons, Introductory Biomechanics from cells to organisms, Cambridge University Press, New Delhi, 2007.
3. Susan J Hall, Basics of Biomechanics, McGraw Hill Publishing.co. New York, 8th Edition, 2019.
4. Dhanjoo N. Ghista, Orthopaedic Mechanics, Academic Press, 1990.
5. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, Fourth edition,2015.
6. John Enderle, Susanblanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, Third edition, 2011.

21BM602 IMAGE PROCESSING 3 1 0 4

Course Objectives

- To understand the fundamentals and various techniques of biomedical image processing.
- To understand image processing principles of - CT, MRI, diagnostic and therapeutic devices.
- To develop the algorithms for image analysis and diagnosis in medical imaging.

Course Outcomes (COs)

1. Apply appropriate sampling technique to acquire biomedical images through digital modalities
2. Apply suitable image enhancement techniques to reduce the noise and interference level.
3. Apply morphological image processing techniques for boundary detection applications.
4. Analyse images segmentation for extracting the features from medical images
5. Apply image compression techniques to reduce the size of the image

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	3	3											2	
2	1	2	1											1	3
3	2	1	3										1	3	2
4	1		3										2	3	2
5	2	1	3										1	3	2

UNIT I **9 Hours**

FUNDAMENTALS OF DIGITAL IMAGE

Image formation, visual perception, CCD & CMOS Image sensor, Image sampling: Two dimensional Sampling theory, Nonrectangular grid and Hexagonal sampling, Optimal sampling, Image quantization, Non uniform Quantization, Image formats. Types of pixel Operations, Types of neighbourhoods, adjacency, connectivity, boundaries, regions, 2Dconvolution, Colour models.

UNIT II **9 Hours**

IMAGE ENHANCEMENT IN SPATIAL AND FREQUENCY DOMAIN

Basic gray level transformations, histogram processing, Smoothing operations, Edge Detection-derivative based operation, filtering in frequency domain, 2D-DFT, Smoothing frequency domain filters, Sharpening frequency domain filters, Homomorphic filtering.

UNIT III **9 Hours**

MORPHOLOGICAL IMAGE PROCESSING

Dilation and Erosion, Opening and Closing, Hit-or-Miss transformation, Boundary Extraction, Region filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning.

UNIT IV **9 Hours**

IMAGE SEGMENTATION

Detection of discontinuities, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region Based segmentation, K-Means Clustering.

UNIT V **9 Hours**

IMAGE COMPRESSION

Fundamentals of Image compression models, Lossless compression: variable length coding, LZW coding, Arithmetic coding, Lossy compression: Wavelet and DCT coding, Predictive coding

Total: 60 Hours

Reference(s)

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, Education, Inc., 4th Edition, 2018
2. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson Education, Inc., 1st Edition, 2015.
3. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis and Machine vision, Cengage, 4th Edition, 2017.
4. Alan C. Bovik, Handbook of image and video processing, Elsevier Academic press, 2005.
5. S.Sridhar, Digital Image processing, Oxford University press, 2ndEdition, 2016.

21BM603 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT II

3 0 2 4

Course Objectives

- Understand Biomedical Laser principles and applications.
- Understand different types and uses of diathermy units.
- Know the principles of ultrasound and its use in diagnosis
- Know the importance of patient safety against electrical and laser hazards.

Course Outcomes (COs)

1. Identify and measure respiratory parameters using spirometer and ventilators
2. Understand the concept of lasers for diagnosis and therapeutic applications based on their properties
3. Apply and analyze IR and UV waves for diathermy units in healthcare.
4. Apply ultrasound properties effectively to diagnose pathology related to different organs
5. Analyse the electrical hazards associated with hospitals and protecting patients from them

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1													2	3
2	2													3	
3	2		2										1		1
4	2													3	2
5	1	2												2	2

UNIT I **9 Hours**

RESPIRATORY MEASUREMENT AND ASSIST SYSTEMS

Lung Volume and vital capacity, Spirometer, measurements of residual volume. pneumotachometer, Airway resistance measurement, Whole body plethysmography. Intra Alveolar and Thoracic pressure measurements, Apnea Monitor. Types of Ventilators: Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

UNIT II **9 Hours**

LASER BASED EQUIPMENTS

Lasers in Medicine: Types, Tissue reactions. Lasers in ophthalmology, Flow Cytometry, Endoscopy, Minimally Invasive Laparoscopy, Laser Microirradiation, Laser Doppler Velocimetry, Neurosurgical Laser Techniques.

UNIT III **9 Hours**

DIATHERMY

IR and UV lamp: application. Need for different diathermy units, Short wave diathermy, ultrasonic diathermy, Microwave diathermy. Electrosurgery machine: Current waveforms, Tissue Responses, Electro surgical current level, Hazards and safety procedures.

UNIT IV **9 Hours**

ULTRASOUND EQUIPMENT

Diagnosis: Tissue Reaction, Basic principles of Echo technique, display techniques A, B and M mode, B Scan, Application of ultrasound as diagnostic tool: Echocardiogram, Echoencephalogram, abdomen, obstetrics and gynecology, ophthalmology.

UNIT V **9 Hours**

PATIENT SAFETY

Physiological effects of electricity, important susceptibility parameters, Macro shock, Micro chock hazards, Patient's electrical environment, GFI units, Earthing schemes. Electrical safety codes and standards, Basic approaches to protection against shock, Protection equipment design, Electrical safety analyzer, Testing the electrical safety of medical equipment, Biomedical laser safety

3 Hours

EXPERIMENT 1

Recording and analysis of auditory signals using Audiometer

3 Hours

EXPERIMENT 2

Basic life support training using Defibrillator

3 Hours

EXPERIMENT 3

Simulation of Defibrillator signals

3 Hours

EXPERIMENT 4

Recording and analysis of Pacemaker with simulator

3

EXPERIMENT 5

Analysis of TENS

3 Hours

EXPERIMENT 6

Demonstration of Ultrasound Machine

3 Hours

EXPERIMENT 7

Ventilator assessment in CPAP and BIPAP

3 Hours

EXPERIMENT 8

Conceptual analysis of Heart Lung Training Unit

3 Hours

EXPERIMENT 9

Analysis of Haemodialysis Training Unit

3 Hours

EXPERIMENT 10

Analysis of safety parameters for the given medical device using Electrical safety Analyser

Total: 75 Hours

Reference(s)

1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Pearson Education India; 2nd Edition,2015.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical equipment technology, Pearson Education, 4th Edition,2014.
3. Leon Goldman, The Biomedical Laser: Technology and Clinical applications, Springer VerlagNewyorkInc., 2013
4. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition,2014.
5. L.A Geddes and L.E.Baker, Principles of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and Sons, Reprint 2008.

21BM607 IMAGE PROCESSING LABORATORY 0 0 2 1

Course Objectives

- To understand the fundamentals and various techniques of biomedical image processing.
- To understand image processing principles of - CT, MRI, diagnostic and therapeutic devices.
- To develop the algorithms for image analysis and diagnosis in medical imaging.

Course Outcomes (COs)

1. Implement image fundamentals and acquisition techniques using programming
2. Develop algorithms of image improvement
3. Design algorithms for object localization
4. Analyze Medical images for diagnosis using appropriate image processing software tool
5. Apply suitable compression techniques on medical images.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	3		2							1		2	
2	1	2	1		2			1				1		1	3
3	2	1	3		2			1				1	1	3	2
4	1		3		2			1				1	2	3	2
5	2	1	3		2			1				1	1	3	2

3 Hours

EXPERIMENT 1

To implement basic operations of image processing in MATLAB

3 Hours

EXPERIMENT 2

To implement Basic Image gray level transformations for medical images in spatial domain in MATLAB.

3 Hours

EXPERIMENT 3

To implement piece-wise Linear Transformations functions for medical images in MATLAB.

3 Hours

EXPERIMENT 4

To implement Image histogram processing for medical images in MATLAB.

3 Hours

EXPERIMENT 5

To implement Image enhancement of medical images by using spatial filtering in MATLAB.

3 Hours

EXPERIMENT 6

To implement Image enhancement of medical images in frequency domain in MATLAB.

3 Hours

EXPERIMENT 7

To implement Image segmentation using Thresholding and edge detection technique in MATLAB.

3 Hours

EXPERIMENT 8

To implement Image segmentation by using K-means clustering in MATLAB.

3 Hours

EXPERIMENT 9

To implement DCT Compression technique on medical image in MATLAB.

3 Hours

EXPERIMENT 10

To implement Image compressions and feature extraction by using wavelet transform in MATLAB.

Total: 30 Hours

21BM608 BIOMECHANICS LABORATORY 0 0 2 1

Course Objectives

- To study about the mechanics involved with various physiological systems.
- To gain knowledge in deriving the mathematical models related to blood vessels.

Programme Outcomes (POs)

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

Course Outcomes (COs)

1. Apply mechanics in medicine to analyse motion.
2. Analyse the linear and angular impulse of joints.
3. Implement the biomechanics principles to analyse the total body kinetics.
4. Analyze the musculoskeletal kinetics using mathematical models.
5. Design and develop the models specific to orthopaedic applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	1	1				1	1	1		1	1	1	
2	1	1	2	2				1	2	2		2	1	2	
3	1	2	2	2				2	2	2		2	2	2	
4	2	2	2	2				2	2	2		3	2	3	
5	2	2	2	3				2	2	3		3	3	3	

3 Hours

EXPERIMENT 1

Introduction to Motion Analysis: Linear Kinematics and Total Body Centre of Mass (TBCM)

3 Hours

EXPERIMENT 2

Angular Kinematics

3 Hours

EXPERIMENT 3

Linear impulse and momentum

3 Hours

EXPERIMENT 4

Angular impulse and momentum

3 Hours

EXPERIMENT 5

Total Body Kinetics

3 Hours

EXPERIMENT 6

Joint Kinetics

3 Hours

EXPERIMENT 7

Force measurement using Foot sensors

3 Hours

EXPERIMENT 8

Musculoskeletal modelling

3 Hours

EXPERIMENT 9

Simulation of Musculoskeletal models

3 Hours

EXPERIMENT 10

Gait Analysis

Total: 30 Hours

Reference(s)

1. Y.C.Fung, Bio-Mechanics, Mechanical Properties of Tissues, Springer-Verilog,1993.
2. C. Ross Ether and Craig A. Simmons, Introductory Biomechanics from cells to organisms, Cambridge University Press, New Delhi, 2007.
3. Susan J Hall, Basics of Biomechanics, McGraw Hill Publishing.co. New York, 8th Edition, 2019.
4. Dhanjoo N. Ghista, Orthopaedic Mechanics, Academic Press, 1990.
5. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, Fourth edition,2015.
6. John Enderle, Susanblanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, Third edition, 2011.

18GE601 SOFT SKILLS-APTITUDE II 0 0 2 0

Course Objectives

- Expose the undergraduate students to such methods and practices that help, develop and nurture qualities such as character, effective communication, aptitude and holding ethical values. It will provide a lot of activities and examples for a student to learn and develop these life skills.

Course Outcomes (COs)

1. Apply the concepts of probability, Sets, Permutation and Combinations in estimating data for real time problems.
2. Understand the concept of logarithms, progressions and Simple and Compound interest to solve various practical problems.
3. Analyse objects involving cubes and cuboids in determining the number of sides coloured.
4. Interpret various data from graphs and tables to determine ratio, percentage and averages.
5. Apply the logical reasoning skills for identifying age, relations, visual relations and puzzles.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2													
2	2	2													
3	2	2													
4	2	2													
5	2	2													

1 **2 Hours**

PERMUTATION AND COMBINATION

Definition-Fundamental Rules-Theorems on Permutation-Theorems on Combination.

2 **2 Hours**

PROBABILITY

Concept and Importance of Probability-Underlying factors for real Life estimation of Probability-Basic facts about probability-Some important consideration while defining event.

3 **2 Hours**

SYLLOGISM AND VENN DIAGRAM

Concepts on Syllogisms-Venn Diagram-Interpretation-Venn diagram-solving.

4 **4 Hours**

SIMPLE INTEREST AND COMPOUND INTEREST

Introduction-Definition - Effect of change of P, R, T on simple Interest-Amount-Amount becomes N times the Principle-Repayment of debt in equal Instalments-Rate and time are numerically Equal-

Compound Interest-Conversion Period-Basic Formula-Special cases-To find the principle / Time /Rate-Difference between Compound Interest and Simple Interest-Equal annual instalment to pay the borrowed amount.

5 **2 Hours**

MIXTURES AND ALLIGATION

Definition-Alligation rule-Mean value (cost price) of the mixture-Some typical situations where allegation can be used.

6 **4 Hours**

CUBE AND LOGARITHM

Introduction-Basic Concepts of Cube and Cuboid-Problems involving cubes and cuboids of various dimensions-Problems involving coloured cubes and cuboids - Basic concepts of Logarithm-Laws of Logarithms including change of base-Common logarithm (base 10) - Properties of Logarithms to solve equations involving logarithmic expressions.

7 **2 Hours**

DATA INTERPRETATION

Introduction-Ratio-Percentage-Average-Tables - Graphs and Charts.

8 **2 Hours**

PROGRESSION AND LOGICAL REASONING

Arithmetic progression-Geometric progression-Harmonic progression-Theorems related with progressions.

9 **2 Hours**

PROBLEM ON AGES

Introduction-Basic concept-Usage of Percentage and Averages -Applications.

10 **2 Hours**

ANALYTICAL REASONING

Introduction-Basic concept-Non verbal Analytical Reasoning -Arrangements.

11 **2 Hours**

BLOOD RELATION

Introduction-Basic concept-Kinds of relation-Tree diagram -Relations.

12 **2 Hours**

VISUAL REASONING

Introduction-Basic concepts-Odd man out-Next series-Mirror image and water image

13 **2 Hours**

SIMPLIFICATIONS

Introduction-Basic concepts-Arithmetic operations-Equation solving methods-Puzzles.

Total: 30 Hours

Reference(s)

1. Abhijit Guha, Quantitative Aptitude for Competitive Examinations, Fourth Edition, Mc Graw Hill Publications.
2. U. Mohan Rao, Quantitative Aptitude for Competitive Examinations, Scitech Publications Pvt Ltd, India.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examinations, Third Edition, Pearson Education Pvt Ltd, India, 2016.
4. Dr. R S Aggarwal, A Modern Approach to Verbal and Non Verbal Reasoning, Revised Edition, S Chand Publications.
5. Arun Sharma, How to prepare for Logical Reasoning for CAT & other Management Exams, Fifth Edition, Mc Graw Hill Publications.
6. Jaikishan and Premkishan, How to Crack Test of Reasoning in all Competitive Examinations, Revised Edition, Arihant Publications.

21HS002 HUMAN VALUES AND ETHICS 2 0 0 2

Course Objectives

- Understand the concept of good values and comprehend the importance of value-based living.
- Recognize the culture of peace through education.
- Identify and apply the practices for value development and clarification.

Course Outcomes (COs)

1. Understand the importance of human values and ethics in life.
2. Execute the importance of harmonious living in a diverse society.
3. Analyze the sensitivity to the crying needs of society such as ungodliness, corruption, poverty, and suffering, and play a vital role in eradicating them.
4. Plan intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Execute a correct balance between professional excellence and social commitment.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1								3	2	2				
2								3	2	2				
3								3	2	2				
4								3	2	2				
5								3	2	2				

UNIT I **6 Hours**

COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS

1.Importance of Human Values & Ethics in 21st Century

2.Understanding the theory of basic human values and ethics

Openness to change

Self-enhancement

Conservation

Self-transcendence

3. Schwartz Value Survey: Self-Assessment

UNIT II **6 Hours**

EMBRACING THE COMMON ETIQUETTE

Altruism – Integrity -Freedom -Justice -Honesty -Truthfulness -Responsibility -Compassion

UNIT III **6 Hours**

CONTINUOUS HAPPINESS AND PROSPERITY

An overview on basic Human Aspirations - Understanding and living in harmony at various levels of life -Embracing self-love and wellness -Understanding harmony in the family and society

UNIT IV **6 Hours**

UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS

Reflection on growing global multifold problems: poverty, pollution, hunger, disease, unemployment, caste system, child labour, gender equality, politics and violence.

Understanding the challenges in cultural, personal, social, political, and economic environment

UNIT V **6 Hours**

UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS CO-EXISTENCE

Understanding the harmony in the Nature - Holistic perception of harmony at all levels of existence - Practice Exercises and Case Studies will be taken up in Practice Sessions

Total: 30 Hours

Reference(s)

1. Martin, G. (2011). The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin.
2. Gupta, N. L. (2002). Human Values For The 21St Century. India: Anmol Publications Pvt. Limited.
3. Mishra, A. (2017). Happiness Is All We Want. India: Bloomsbury Publishing.
4. Universal Human Values. (2023). (n.p.): Booksclinic Publishing.
5. A Textbook On Professional Ethics And Human Values. (2007). India: New Age International (P) Limited

21BM702 PATTERN RECOGNITION TECHNIQUES

3 0 0 3

Course Objectives

- To understand different supervised learning techniques
- To understand different unsupervised learning techniques
- To obtain sound knowledge in the recent advancement on pattern recognition techniques.

Course Outcomes (COs)

1. Understand the fundamental concepts of pattern recognition techniques in classification.
2. Apply the unsupervised learning techniques for pattern classification
3. Apply suitable algorithm for structural pattern recognition
4. Apply appropriate technique to extract the feature from image
5. Analyse the advanced neural network structures for pattern recognition

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1													
2	2	3													
3	2	1											2		
4	1	3	1		2										
5	2	2	2										1	1	2

UNIT I **9 Hours**

PATTERN CLASSIFIER

Overview of pattern recognition, Discriminant functions, Supervised learning, Parametric estimation, Maximum likelihood estimation, Bayesian parameter estimation, Perceptron algorithm, LMSE algorithm, Problems with Bayes approach, Pattern classification by distance functions, Minimum distance pattern classifier.

UNIT II **9 Hours**

UNSUPERVISED CLASSIFICATION

Clustering for unsupervised learning and classification, Clustering concept, C-means algorithm - Hierarchical clustering procedures, Graph theoretic approach to pattern clustering, Validity of clustering solutions.

UNIT III **9 Hours**

STRUCTURAL PATTERN RECOGNITION

Elements of formal grammars, String generation as pattern description, Recognition of syntactic description, Parsing, Stochastic grammars and applications.

UNIT IV **9 Hours**

FEATURE EXTRACTION AND SELECTION

Entropy minimization, Karhunen, Loeve transformation, Feature selection through functions approximation, Binary feature selection.

UNIT V **9 Hours**

NEURAL PATTERN RECOGNITION

Neural network structures for Pattern Recognition, Neural network based Pattern associators, Unsupervised learning in neural Pattern Recognition.

Total: 45 Hours

Reference(s)

1. Earl Gose, Richard Johnsonbaugh Steve Jost, Pattern Recognition and Image Analysis, Prentice Hall of India Pvt Ltd., NewDelhi,2015.
2. Freeman J. A., and Skapura B.M, Neural networks, algorithms, applications and programming techniques, Addison Wesley,2003
3. RobertJ.Schalkoff, PatternRecognition: Statistical, Structural and Neural Approaches, JohnWiley&Sons Inc., New York,2007.
4. Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London,1974.
5. Duda R.O., Hart.P.E., and Strok, Pattern Classification, Second Edition Wiley, New York,2012.
6. Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, NewYork, 1993.

21BM707 HOSPITAL TRAINING 0 0 4 2

Course Objectives

- Observe 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

Course Outcomes (COs)

1. Advocate a patient-centered approach in healthcare
2. Communicate with other health professionals in a respectful and responsible manner
3. Recognize the importance of inter-professional collaboration in healthcare
4. Propose a patient-centered inter-professional health improvement plan based upon the patients perceived needs
5. Use the knowledge of ones own role and those of other professions to address the healthcare needs of populations and patients served.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1							1	1	1						
2							2	1	2						
3							1	1	2	-					
4							1	2	3						
5							2	3	3						

60 Hours

Students need to complete training in any leading Multi-specialty hospital for a period of 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 10. The students can give a presentation of the remaining departments during laboratory hours

Departments for visit

1 Cardiology
2 ENT
3 Ophthalmology
4 Orthopedic and Physiotherapy
5 ICU/CCU
6 Operation Theatre
7 Neurology
8 Nephrology
9 Radiology
10 Nuclear Medicine
11 Pulmonology
12 Urology

13 Obstetrics and Gynecology
14 Emergency Medicine
15 Biomedical Engineering Department
16 Histo-Pathology
17 Biochemistry
18 Pediatric/Neonatal
19 Dental
20 Oncology
21 PACS
22 Medical Records and Telemetry

Total: 60 Hours

21BM708 PROJECT WORK I 0 0 6 3

Course Objectives

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present the oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	3	3	1	3	3	3	3	3		2	3	3	3
2	2	2	3	3	1	3	3	3	3	3		2	3	3	3
3	2	2	3	3	3	3	3	3	3	3	3	2	3	3	3
4	2	2	3	3	3	3	3	3	3	3	3	2	3	3	3
5	2	2			2			3	3	3		2	3	3	3

0 0 18 9

21BM804 PROJECT WORK II

Course Objectives

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

Course Outcomes (COs)

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present the oral demonstrations.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	3	3	1	3	3	3	3	3		2	3	3	3
2	2	2	3	3	1	3	3	3	3	3		2	3	3	3
3	2	2	3	3	3	3	3	3	3	3	3	2	3	3	3
4	2	2	3	3	3	3	3	3	3	3	3	2	3	3	3
5	2	2			2			3	3	3		2	3	3	3

21BM001 SPEECH AND AUDIO SIGNAL PROCESSING

3 0 0 3

Course Objectives

- To familiarize the basic mechanism of speech production and the basic concepts of speech analysis and parametric representation of speech
- To impart ideas of Perception of Sound, Psycho-acoustic analysis, Spatial Audio Perception and speech analysis
- To disseminate Audio Compression Schemes

Course Outcomes (COs)

1. Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in real time applications
2. Analyze the speech signal based on its features
3. Implement Signal processing models of sound perception and apply the speech perception models in audio signal processing.
4. Apply suitable audio compression algorithms and standards for real time applications.
5. Analyze the subjective and objective qualities of audio signal.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	3		1								1	1		
2	2	3		2								1	1		
3	2	3		2								1	1		
4	1	2	1	3								1	1		
5	1	3		2								1	1		

UNIT I **9 Hours**

SPEECH PRODUCTION AND MODELLING

Speech Production: Acoustic theory of speech production. Parametric representation of speech: AR Model, ARMA model. LPC Analysis (LPC model, Auto correlation method). Fundamentals of Speech recognition and Text-to-speech conversion. Speech coding, speech enhancement, Speaker Verification, Language Identification

UNIT II **9 Hours**

SPEECH ANALYSIS

Speech Analysis: Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF) Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis, MFCC.

UNIT III **9 Hours**

SIGNAL PROCESSING MODELS OF AUDIO PERCEPTION

Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, Quantization Noise Shaping, MPEG psycho-acoustic model

UNIT IV **9 Hours**

AUDIO COMPRESSION METHODS

Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Transform coding of digital audio: MPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression, Loss less coding methods

UNIT V **9 Hours**

SPATIAL AUDIO PERCEPTION AND RENDERING

The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Audio quality analysis: Objective quality analysis, Subjective quality analysis.

Total: 45 Hours

Reference(s)

1. Ellis, D., Gold, B., Morgan, N. Speech and Audio Signal Processing: Processing and Perception of Speech and Music. Germany: Wiley. 2011
2. Douglas O"Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2/e, 2016
3. Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, July 1999, John Wiley & Sons, ISBN: 0471351547
4. Yu, D., Deng, L. Automatic Speech Recognition: A Deep Learning Approach. United Kingdom: Springer London. 2014
5. Schafer, R. W., Rabiner, L. R. Introduction to Digital Speech Processing. Netherlands: 2007

21BM002 BIOMETRIC SYSTEMS 3 0 0 3

Course Objectives

- To understand the general principles, design of biometric systems and the underlying trade-offs.
- To study the technologies of fingerprint, iris, face and speech recognition
- To study of evaluation of biometrics systems

Course Outcomes (COs)

1. Understand the concepts and characteristics of biometric systems
2. Apply fingerprint recognition technique for a real time application
3. Apply face and hand geometry recognition techniques for feature extraction and classification applications
4. Apply suitable methodology to iris recognition of a person
5. Analyse the features of voice signal and multimodal biometric systems

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	1											3	2	1
2		2	3	1								1	3	2	1
3		2	3	1								1	3	2	1
4		2	3	1								1	3	2	1
5		3	2	1								1	3	2	1

UNIT I **9 Hours**

INTRODUCTION TO BIOMETRICS

Introduction and back ground, biometric technologies, passive biometrics, active biometrics, Biometric characteristics, Biometric applications, Biometric Authentication systems, Taxonomy of Application Environment, Accuracy in Biometric Systems, False match rate, False non match rate, Failure to enroll rate, Derived metrics, Biometrics and Privacy

UNIT II **9 Hours**

FINGERPRINT TECHNOLOGY

History of fingerprint pattern recognition, General description of fingerprints, fingerprint sensors, fingerprint enhancement, Feature Extraction, Ridge orientation, ridge frequency, fingerprint matching techniques- correlation based, Minutiae based, Ridge feature based, fingerprint classification, Applications of fingerprints, Finger scan, strengths and weaknesses, Evaluation of fingerprint verification algorithms

UNIT III **9 Hours**

FACE RECOGNITION AND HAND GEOMETRY

Introduction to face recognition, face recognition using PCA, LDA, face recognition using shape and texture, face detection in color images, 3D model based face recognition in video images, Neural networks for face recognition, Hand geometry, scanning, Feature Extraction, classification

UNIT IV **9 Hours**

IRIS RECOGNITION

Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization, Daugman and Wildes approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions

UNIT V **9 Hours**

VOICE SCAN AND MULTIMODAL BIOMETRICS

Voice scan, speaker features, short term spectral feature extraction, Mel frequency cepstral coefficients, speaker matching, Gaussian mixture model, NIST speaker Recognition Evaluation Program, Introduction to multimodal biometric system, Integration strategies, Architecture, level of fusion, combination strategy, examples of multimodal biometric systems, Securing and trusting a biometric transaction, matching location, local host, authentication server, match on card (MOC)

Total: 45 Hours

Reference(s)

1. James Wayman& Anil Jain, Biometric Systems- Technology Design and Performance Evaluation, SPRINGER (SIE), 1st Edition, 2011.
2. Paul Reid, Biometrics for Network Security, Pearson Education, 2004
3. Nalini K Ratha, Ruud Bolle, Automatic fingerprint recognition system, Springer, 2003
4. L C Jain, I Hayashi, S B Lee, U Halici, Intelligent Biometric Techniques in Fingerprint and Face Recognition, CRC Press, 1st Edition, 1999
5. S.Y. Kung, S.H. Lin, M.W., Biometric Authentication: A Machine Learning Approach, Prentice Hall, 2004

21BM003 BRAIN COMPUTER INTERFACE 3 0 0 3

Course Objectives

- To understand the basics for Brain Computer Interface
- To classify different types of BCI system based on Biosignal acquisition
- To familiarize the medical and non-medical application of BCI

Course Outcomes (COs)

1. Understand the concepts of neuroscience and Brain Computer Interface systems
2. Categorize Brain Computer Interface systems
3. Analyze the Non-Invasive BCIs and categorize it based on its functions
4. Apply stimulation techniques for advanced BCIs
5. Analyse the ethical principles of BCIs for medical and non-medical fields.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	3		1									3	2	2
2	1	2		3									3	2	2
3	1	3		2									3	2	2
4	1	3		2									3	2	2
5	1	3		2				3				1	3	2	2

UNIT I **9 Hours**

INTRODUCTION

Introduction to Neuroscience: Neurons, action potential generation, Recording and simulation of Brain, Review of signal processing techniques applied for EEG signal, building a BCI: Major Types of BCIs, Brain Responses Useful for Building BCIs, Conditioned Responses, Population Activity, Imagined Motor and Cognitive Activity, Stimulus-Evoked Activity

UNIT II **9 Hours**

INVASIVE BCI AND SEMI-INVASIVE BCIS

Two Major Paradigms in Invasive Brain-Computer Interfacing, invasive BCIs in Animals, Invasive BCIs in Humans, Long-Term Use of Invasive BCIs, Semi-Invasive BCIs: Electrocorticographic (ECoG) BCIs, BCIs Based on Peripheral Nerve Signals

UNIT III **9 Hours**

NON-INVASIVE BCIS

Electroencephalographic (EEG) BCIs: Oscillatory Potentials and ER, Slow Cortical Potential, Stimulus-Evoked Potentials, BCIs Based on Cognitive Tasks, Error Potentials in BCI, Co-adaptive BCI, Hierarchical BCIs, Other Non-invasive BCIs: fMRI, MEG, and fNIR, Functional Magnetic Resonance Imaging-Based BCI, Magnetoencephalography-Based BCIs, Functional Near Infrared and Optical BCIs

UNIT IV **9 Hours**

BIDIRECTIONAL, RECURRENT BCI AND STIMULATION

Cursor Control with Direct Cortical Instruction via Stimulation, Active Tactile Exploration Using a BCI and Somatosensory Stimulation, Bidirectional BCI Control of a Mini-Robot, Cortical Control of Muscles via Functional Electrical Stimulation, Establishing New Connections between Brain Region, Sensory Restoration, Restoring Hearing: Cochlear Implants, Restoring Sight: Cortical and Retinal Implants, Motor Restoration, Deep Brain Stimulation (DBS) and Sensory Augmentation

UNIT V **9 Hours**

APPLICATIONS AND ETHICS

Medical Applications : Sensory Restoration ,Ã‚Content , Motor Restoration ,Cognitive Restoration and Rehabilitation, Restoring Communication with Menus, Cursors, and Spellers , Brain-Controlled Wheelchairs ,Nonmedical Applications: Web Browsing and Navigating Virtual Worlds, Robotic Avatars Mnemonic and Cognitive Amplification , Applications in Space , Gaming and Entertainment ,Brain-Controlled Art, Ethics of Brain-Computer Interfacing : Medical, Health, and Safety Issues, Abuse of BCI Technology

Total: 45 Hours

Reference(s)

1. Chang S. Nam, Anton Nijholt, Fabien Lotte, Brain Computer Interfaces Handbook: Technological and Theoretical Advances, CRC Press, UK. 2018
2. Maureen Clerc, Laurent Bougrain, Fabien Lotte, Brain Computer Interfaces 2: Technology and Applications, Wiley Publisher, 2016.
3. Rajesh P. N. Rao, Brain Computer Interfacing: An Introduction, 1st Edition, Cambridge University Press, 2018.
4. Christian Kothe, Introduction to Modern Brain Computer Interface design video lectures, https://sccn.ucsd.edu/wiki/Introduction_To_BrainComputer_Interface_Design.

21BM004 ADVANCED MEDICAL IMAGE ANALYSIS

3 0 0 3

Course Objectives

- To understand the principles of basic imaging modalities and properties of image construction.
- To assess the quality of medical images based on image acquisition process
- To implement advanced medical imaging techniques during the development of image modalities

Course Outcomes (COs)

1. Analyze radiographic imaging techniques based on its nature and properties
2. Apply projection radiography in medical imaging
3. Analyze the computer tomography imaging technique based on image quality
4. Analyse the mechanics of nuclear medical imaging and the effects of image quality
5. Analyse the concept of MRI imaging and reconstruction

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	1	3	2	2		1		1				1	3	2	2
2	1	2	2	2		1		1				1	3	2	2
3	1	3	2	2		1		1				1	3	2	2
4	1	3	2	2		1		1				1	3	2	2
5	1	3	1	2		1		1				1	3	2	2

UNIT I **9 Hours**

RADIOGRAPHIC IMAGING

Basic imaging principles - Image quality - Physics of radiography - Ionization - forms of ionization radiation - nature and properties - Attenuation of electromagnetic radiation - radiation dosimetry

UNIT II **9 Hours**

PROJECTION RADIOGRAPHY

Instrumentation: X-ray tubes, filtration, contrast agents, film screen detectors, image intensifiers, Digital radiography, mammography - Image formation: Geometric effects, blurring effects, film characteristics - Noise and Scattering: Signal to noise ratio, quantum scattering, Compton scattering

UNIT III **9 Hours**

COMPUTED TOMOGRAPHY

CT Instrumentation: Generations, dual energy CT - Image formation: Line integrals, CT numbers, CT reconstruction techniques (fan beam, parallele ray, helical, cone beam) - Image quality: Resolution, noise and artifacts

UNIT IV **9 Hours**

NUCLEAR MEDICINE IMAGING

Physics of nuclear medicine: Radioactive decay, modes of decay, radiotracers - Planar Scintigraphy: Instrumentation, Image capture, Image formation: Event position estimation, Acquisition modes, Anger

camera imaging equation, Image quality: Resolution, noise, Sensitivity, uniformity, energy resolution, factors affecting count rate

UNIT V **9 Hours**

MAGNETIC RESONANCE IMAGING

Instrumentation - MRI data acquisition: slice selection, frequency encoding, gradient echoes, pulse repetition interval - Image reconstruction: rectilinear data, polar data, imaging equations, Image quality: Sampling, resolution, SNR, artifacts - Advanced contrast mechanisms

Total: 45 Hours

Reference(s)

1. Jerry L Prince, Jonathan M Links, Medical Imaging Signals and Systems, Prentice Hall Publications, 2015.
2. Wolfgang Birkfellner, Applied medical Image Processing- A basic course, Second Edition, CRC Press, 2014.
3. Rafael C. Gonzales, Richard E. Woods, Digital Image Processing, Fourth Edition, Pearson Education, 2018.
4. Anil Jain K. Fundamentals of Digital Image Processing, PHI Learning Pvt. Ltd., 2011.
5. William K. Pratt, Introduction to Digital Image Processing, CRC Press, 2013.

21BM005 MACHINE VISION 3 0 0 3

Course Objectives

- To review image processing techniques for machine vision.
- To understand the concept of shape, region and motion analysis.
- To study object recognition techniques.

Course Outcomes (COs)

1. Understand fundamental concepts of machine vision
2. Apply suitable techniques for filtering images to reduce the undesired components
3. Analyze the performance of various edge detection techniques in machine vision
4. Analyze the motion detection process using moving camera
5. Analyze the process of object recognition using patterns and features

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	2		1									2		
2	1	2	3	2									1		
3		3	2	2									1		
4		3	2	2									1		
5		3	2	2									1		

UNIT I **9 Hours**

MACHINE VISION FUNDAMENTALS

Machine Vision- Relationships to Other Fields-Role of Knowledge-Image Geometry-Perspective Projection-Coordinate Systems-Levels of Computation - Thresholding, Geometric Properties, Size, Position, Orientation, Projections, Run-Length Encoding, Binary Algorithms, Morphological Operators, Optical Character Recognition

UNIT II **9 Hours**

REGION AND FILTERING BASED PROCESSING

Regions and Edges - Region Segmentation - Region Representation - Split and Merge - Region Growing - Image Filtering - Histogram Modification - Linear Systems - Linear Filters - Median Filter - Gaussian Smoothing

UNIT III **9 Hours**

EDGE DETECTION

Gradient - Steps in Edge Detection - Comparison- Second Derivative Operators: Laplacian Operator, Second Directional Derivative, Laplacian of Gaussian, Image Approximation - Gaussian Edge Detection, Canny Edge Detector - Subpixel Location Estimation - Edge Detector Performance - Methods for Evaluating Performance - Figure of Merit - Sequential Methods - Line Detection

UNIT IV **9 Hours**

DYNAMIC VISION

Change Detection - Change Detection - Segmentation using Motion - Motion Correspondence - Image flow - Segmentation using a Moving Camera - Tracking - Shape from Motion

UNIT V **9 Hours**

OBJECT RECOGNITION

System Components - Complexity of Object Recognition - Object Representation: Observer-Centered Representations, Object-Centered Representations - Feature Detection - Recognition Strategies: Classification, Matching, Feature Indexing - Verification: Template Matching, Morphological Approach, Symbolic, Analogical Methods

Total: 45 Hours

Reference(s)

1. Ramesh Jain, Ramesh C Jain, Machine Vision, pp., McGraw Hill, 1995.
2. Fabio Solari, Manuela Chessa, Silvio P. Sabatini, Machine vision Applications and Systems, BoD Books on Demand, 2012.
3. J. Shi and C. Tomasi, Good Features to Track. In IEEE Conference on Computer Vision and Pattern Recognition, 1994.
4. D. G. Lowe, Distinctive Image Features from Scale-Invariant Keypoints. In International Journal of Computer Vision, 2004.
5. D. Comaniciu and P.Meer, Robust analysis of feature spaces: Color image segmentation. IEEE Conference on Computer Vision and Pattern Recognition, June 1997, 750-755.

21BM006 DEEP LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- To understand the theoretical foundations, algorithms and methodologies of Machine Learning Algorithms
- To design and develop an application using specific deep learning models
- To provide practical knowledge in handling and analyzing real world applications.

Course Outcomes (COs)

1. Apply the concepts of Machine Learning Algorithms to solve real world problems
2. Apply the Deep Learning Architectures to classify the unstructured data.
3. Analyze the Convolutional Neural Networks and transfer learning models to obtain an optimal solution
4. Build a Recurrent Neural Networks, Recursive Nets models and classify the given inputs with reduced cost and time
5. Design a model using Auto encoders and Generative models for image generation

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	2	3										1		
2	2	2	3										1		
3	2	3	2	1									2		
4	2	1	3	1									2		
5	2	2	3	1									2	1	2

UNIT I **10 Hours**

MACHINE LEARNING BASICS

Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Basic Machine Learning Algorithms: Nave Bayes, Support Vector Machine, Decision Tree, Random Forest, Neural Networks - Multilayer Perceptron, Back-propagation algorithm and its variants stochastic gradient decent, Curse of Dimensionality.

UNIT II **9 Hours**

DEEP LEARNING ARCHITECTURES

Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications.

UNIT III **9 Hours**

CONVOLUTIONAL NEURAL NETWORKS AND TRANSFER LEARNING

Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures ResNet, AlexNet, Applications Transfer Learning Techniques, Variants of CNN DenseNet, PixelNet.

UNIT IV **8 Hours**

SEQUENCE MODELING RECURRENT AND RECURSIVE NETS

Recurrent Neural Networks, Bidirectional RNNs, Encoder decoder sequence to sequence architectures BPTT for training RNN, Long Short Term Memory Networks, Neural style transfer in Keras

UNIT V **9 Hours**

AUTOENCODERS AND DEEP GENERATIVE MODELS

Under complete Auto encoder, Regularized Autoencoder, stochastic Encoders and Decoders, Contractive

Encoders - Deep Belief networks, Boltzmann Machines, Deep Boltzmann Machine, Generative Adversarial Networks.

Total: 45 Hours

Reference(s)

1. Ian Goodfellow, YoshuaBengio and Aaron Courville, Deep Learning, MIT Press, 2017.
2. Josh Patterson, Adam Gibson Deep Learning: A Practitioner"s Approach, O"Reilly Media, 2017
3. Umberto Michelucci Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks Apress, 2018.
4. Kevin P. Murphy Machine Learning: A Probabilistic Perspective, The MIT Press, 2012.
5. EthemAlpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, Third Edition 2014.

21BM007 ASSISTIVE DEVICES 3 0 0 3

Course Objectives

- To understand the theoretical foundations, algorithms and methodologies of Machine Learning Algorithms
- To provide practical knowledge in handling and analyzing real world applications.

Course Outcomes (COs)

1. Outline the principle of cardiac assist devices based on pathophysiology
2. Analyze the functions of hemodialysers to purify the blood through dialysis
3. Apply suitable noise reduction techniques for hearing aids
4. Categorize the models used as assistive devices for limb disabilities
5. Analyse the functions and characteristics of advanced assistive devices

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	3				1		1				1	1		
2	2	3		2		1		1				1	1		
3	2	2	3	2		1		1				1	2		
4	2	1		2		1		1				1	2		
5	2	3		2		1		1				1	2	1	2

UNIT I **9 Hours**

CARDIAC ASSIST DEVICES

Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves.

UNIT II **9 Hours**

HEMODIALYSERS

Artificial kidney, Dialysis action, haemodialysis unit, membrane dialysis, portable dialyser monitoring and functional parameters.

UNIT III **9 Hours**

HEARING AIDS

Common tests audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids principles, drawbacks in the conventional unit, Digital Hearing Aid Enhancement and Noise reduction, Artificial middle ears.

UNIT IV **9 Hours**

PROSTHETIC AND ORTHOTIC DEVICES

Hand and arm replacement , different types of models, externally powered limb prosthesis, feedback in orthotic system, Transcutaneous electrical nerve stimulator, bio feedback

UNIT V **9 Hours**

ADVANCED ASSISTIVE DEVICES

Functional electrical stimulation, sensory assist devices, Tactile stimulation methods for Deaf and/or blind, Role of tactile stimulation in sensory substitutes, Basic characteristics of tactile sense, Tactile aids for deaf and/or blind

Total: 45 Hours

Reference(s)

1. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 12-May-2010
2. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2011.
3. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1
5. Tohru Ifukube, Sound based assistive technology- support to hearing, speaking and seeing, Springer International Publications, 2017

21BM008 BIO MEMS AND NANO TECHNOLOGY 3 0 0 3

Course Objectives

- To introduce various MEMS fabrication techniques.
- To impart knowledge on different types of sensors and actuators and their principles of operation at the micro scale level.
- To discuss the applications of MEMS in different fields of medicine

Course Outcomes (COs)

1. Outline the materials used for MEMS technology and its fabrication process
2. Analyze different types of sensors and actuators and their principles of operation at the micro scale level.
3. Apply MEMS in different field of medicine
4. Categorize Nano sensors for various applications in biomedical field
5. Analyse the performance of various Nano devices used in medical applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1		2			1	1				1	1		
2	2	3		2			1	1				1	1		
3	2	2	3	2			1	1				1	2		
4	2	2		2			1	1				1	2		
5	2	3		2			1	1				1	2	1	2

UNIT I **9 Hours**

MEMS MATERIALS AND FABRICATION

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 **9 Hours**

SENSORS AND ACTUATORS

Mechanics for MEMs design - static bending of thin plates, mechanical vibration, thermo mechanics, 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. Properties of piezoelectric materials, Piezoelectric sensor and actuator - inchworm motor.

UNIT III **9 Hours**

THE PROSPECT OF NANOMEDICINE

Current Medical Practice, The Evolution of Scientific Medicine - Volitional Normative Model of Disease - Treatment Methodology - Evolution of Bedside Practice - The Nano medical Perspective, Nanomedicine and Molecular Nanotechnology -Pathways to Molecular Manufacturing - Molecular Transport and Sortation

UNIT IV **9 Hours**

NANOSENSORS

Nanosensor Technology - Chemical and Molecular Nanosensor - Displacement and Motion Sensors - Force Nanosensor - Thermal Nanosensor - Electric and Magnetic Sensing - Cellular Bio scanning - Macrosensing - intergated nanosensor technologies, genomics & proteomics - real time & in vivo medical monitoring

UNIT V **9 Hours**

NANODEVICES FOR MEDICINE

Nanodevices for Clinical Nanodiagnostics, Nanoendoscopy, Nanobiotechnology and Drug Delivery Devices - Tools for Nanosurgery, Nanoscale Laser Surgery, Nanorobotics for Surgery - Nanotechnology for Detection of Cancer, QDs, Dendrimers for Sensing Cancer Cell Apoptosis, Gold Nanoparticles for Cancer Diagnosis, Nanotubes for Detection of Cancer Proteins, Nanoparticles for the Optical Imaging of Tumours.

Total: 45 Hours

Reference(s)

1. Chang Liu,‟ Foundations of MEMS‟, Pearson Education International, New Jersey, USA, 2nd Edition, 2011
2. Robert .A. Freital.Jr, " Nanomedicine " Landes Bioscience Press 2010.
3. Wanjun Wang, Stephen A.Soper,‖BioMEMs: Technologies and applications‖, CRC Press, New York, 2007.
4. Robert A. Freitas, "Nanomedicine, Volume IIA: Biocompatibility", Landes Bioscience, 2011.
5. Jain.K.K, "Handbook of Nanomedicine" Springer, 2012.

21BM009 VIRTUAL INSTRUMENTATION 3 0 0 3

Course Objectives

- Design basic Virtual Instrumentation Systems using LabVIEW
- Interface DAQ systems with Computer through LabVIEW
- Analyze Signals using Virtual Instrumentation Systems.

Course Outcomes (COs)

1. Analyze the building blocks of a Graphical Programming Tool.
2. Apply the concepts of loops and arrays to design simple GUI based applications using LabVIEW.
3. Apply the concepts of Data Acquisition using DAQ Systems and interfacing it with PC.
4. Design basic virtual instrumentation systems using LabVIEW.
5. Analyze the signals using a Virtual Instrumentation System

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	1	2	2	3	3									3	
2	1	2	3	2	3									3	
3	1	2	2	2	2									3	
4	1	2	3	3	2									3	
5	1	2	3	3	3									3	

UNIT I **9 Hours**

FUNDAMENTALS OF VIRTUAL INSTRUMENTATION

LabVIEW - graphical user interfaces- controls and Indicators - programming - data types - data flow programming - Editing Debugging and Running a Virtual Instrument- Graphical programming palettes and tools - Front panel objects.

UNIT II **9 Hours**

GRAPHICAL PROGRAMMING ENVIRONMENT IN VI

FOR Loops, WHILE loops, Shift Registers, CASE structure, formula nodes-Sequence structures-Arrays and Clusters- Array operations - Bundle, Unbundle - Bundle/Unbundle by name, graphs and charts - string and file I/O - High level and Low level file I/Os.

UNIT III **9 Hours**

INTERFACING DAQ SYSTEM WITH PC

Basics of DAQ Hardware and Software - Concepts of Data Acquisition and terminology - Installing Hardware, Installing drivers -Configuring the Hardware - addressing the hardware in LabVIEW- Digital and Analog I/O function - Buffered I/O.

UNIT IV **9 Hours**

SIMPLE PROGRAMMING IN VI

Simple programs in VI- Advanced concepts in LabVIEW- TCP/IP VIs , Synchronization - other elements of Virtual Instrumentation - Bus extensions - PXI - Computer based instruments.

UNIT V **9 Hours**

ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI

Fourier transform - Power spectrum - Filtering tools - CRO emulation - Audio signal processing using Signal processing toolkit-Virtual instrumentation application in Biomedical, Process Control and Mechatronics.

Total: 45 Hours

Reference(s)

1. Jovitha Jerome, Virtual Instrmentation using LabVIEW, PHI, 2010.
2. Garry M. Johnson, LabVIEW Graphical Programming, Tata McGraw Hill, 1996.
3. Labview Basics I and II Manual, National Instruments.
4. Barry Paton, Sensor, Transducers and LabVIEW, PHI, 2000.
5. Lisa K Wlls, LabVIEW for Everyone,PHI,1996.

21BM010 REHABILITATION AND ROBOTICS ENGINEERING

3 0 0 3

Course Objectives

- To understand the sensory rehabilitation systems.
- To learn the use of the orthopaedic prosthetics and orthotics in rehabilitation.
- To understand rehabilitation medicine and advocacy.

Course Outcomes (COs)

1. Understand the concepts of rehabilitation devices and its design considerations
2. Identify suitable orthotic and prosthetic devices for rehabilitation based on its functional advancements
3. Analyze the features and configurations of wheel mobility and the therapeutic exercise technique in rehabilitation
4. Analyse the role of Robotics for automation in biomedical engineering
5. Analyse the functions of rehabilitation robotics

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	3	2	3		2		1						3	
2	1	2		2		2		1						3	
3	1	3		2		2		1						3	
4	1	3		3										3	
5	1	3		3										3	

UNIT I **9 Hours**

INTRODUCTION TO REHABILITATION

Engineering Concepts in Sensory Rehabilitation, Motor Rehabilitation - Rehabilitation Engineering Technologies: The Conceptual Frameworks - The Provision Process - Education and Quality Assurance - Specific Impairments and Relates Technologies- Future Developments - Design Considerations - Sensory augmentation and substitution- Visual system, Auditory system, Tactual system

UNIT II **9 Hours**

PROSTHETIC AND ORTHOTIC DEVICES

Engineering concepts in motor rehabilitation, Fundamentals - Amputation - Lower extremity prosthetics - Upper limb prosthetics (trans radial), (trans humeral) - Ankle foot orthoses (AFO) - Knee Ankle Foot Orthoses (KAFO) - Truncal and Cervical orthoses - Assistive Devices - Applications

UNIT III **9 Hours**

WHEELED MOBILITY AND THERAPEUTIC EXERCISE TECHNIQUE

Introduction - Categories of Wheelchairs - Wheelchair Prescriptions - Wheelchair Structure and Component Design - Ergonomics of Wheelchair Propulsion - Power Wheelchair Electrical Systems - Personal Transportation - Wheelchair Safety, Standards and Testing. Rehab-Therapy - Co-ordination exercises - Frenkels exercises - Gait Training - Relaxation exercises - Strengthening exercises - Mobilization exercises - Endurance exercises

UNIT IV **9 Hours**

INTRODUCTION OF ROBOTICS

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic Stabilization-Applications of robotics in medicine

UNIT V **9 Hours**

REHABILITATION ROBOTICS

Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume - Precision of movement - End effectors - Sensors. human-robot interaction, Functions of rehabilitation robotics, rehabilitation robotics in recent areas - exoskeletons, Neuroplasticity, robotic therapy

Total: 45 Hours

Reference(s)

1. Robinson C.J," Rehabilitation Engineering", CRC Press, 2006
2. Rory A Cooper, " Rehabilitation Engineering Applied To Mobility And Manipulation", IOP Publishing Ltd 1995.
3. Joseph D Bronzino," The Biomedical Engineering Handbook",2nd edition, CRC Press,2000.
4. John Iovine, "Robots, Android and Animatronics", McGraw-Hill, 2nd Edition, 2012.
5. Robert J. Schilling, "Fundamentals of Robotics- Analysis and Control", Pearson Education, 2006.

21BM011 CRITICAL CARE EQUIPMENT 3 0 0 3

Course Objectives

- To offer clear understanding of various intensive care equipment and their working.
- To understand the necessity of different operation theatre equipment.
- To know about different dialyzers and ventilators.

Course Outcomes (COs)

1. Apply suitable design techniques in new monitoring devices for ICU and assist the medical personnel's during emergency situations
2. Analyze the working of various operation theatre equipment and suggest suitable surgical instruments and operational devices.
3. Compare the various techniques for clinical diagnosis, therapy and surgery, and its recent methods
4. Assess the centralized systems required during critical care environment
5. Analyze the conditions of critical care equipment in the aspect of patient safety.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	3		1		1		1					1	1	1
2	2	3		2		1		1					2	1	1
3	2	2		2		1		1					2	1	1
4	1	2		1		1	1	1					1	1	1
5	1	3		1		2	1	1					2	1	1

UNIT I **9 Hours**

INTENSIVE CARE UNIT EQUIPMENT

Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and large units. ICU ventilators. Automated drug delivery systems, Infusion pumps, components of drug infusion system, closed loop control infusion system, implantable infusion system. BMD Measurements - SXA - DXA -Quantitative ultrasound bone densitometer.

UNIT II **9 Hours**

OPERATION THEATRE EQUIPMENT

Craniotomy, Electrosurgical Machines (ESU), electrosurgical analysers, surgical aspirator, Instruments for operation. Anaesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy - Laparoscopy - Cryogenic Equipment - Anaesthesia gas, Anaesthesia gas monitor - surgical Microscope.

UNIT III **9 Hours**

ASSISTIVE CRITICAL CARE EQUIPMENT

Defibrillators, Haemodialysis Machine, Different types of Dialyzers, Membranes, Machine controls and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.

UNIT IV **9 Hours**

CENTRALISED SYSTEMS

Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting. C Arm.

UNIT V **9 Hours**

PATIENT SAFETY

Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms, ICCU and IMCUs, Opto couplers and Pulse transformers.

Total: 45 Hours

Reference(s)

1. John G. Webster, " Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd, New Delhi, 2015
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012
3. Khandpur. R.S.,"Handbook of Biomedical Instrumentation",Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003
4. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
5. Antony Y.K.Chan, "Biomedical Device Technology, Principles and design",Charles Thomas Publisher Ltd, Illinois, USA, 2008.
6. Leslie Cromwell, "Biomedical Instrumentation and Measurement",Pearson Education, New Delhi, 2007.

21BM012 RADIOLOGICAL EQUIPMENT 3 0 0 3

Course Objectives

- To understand the principle of X-ray, Computed Tomography, MRI and its uses in imaging
- To study the principles of different radio diagnostic equipment in Imaging
- To understand radiation therapy techniques and radiation safety.

Course Outcomes (COs)

1. Understand the working principle of the X-ray machine and its application.
2. Apply the concept of computer tomography for imaging applications.
3. Interpret the technique used for visualizing various sections of the body using magnetic resonance imaging
4. Apply suitable nuclear medicine techniques for disease diagnosis
5. Outline the features of radiation measuring instruments and radiation safety.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	2						1				1	2		
2	1	2		3				1				1	2	2	
3	1	2		3				1				1	2	2	
4	1	2		3				1				1	2	2	
5	1	2		3				1				1	2	2	

UNIT I **9 Hours**

MEDICAL X-RAY EQUIPMENT

Nature of X-rays- X-Ray absorption - Tissue contrast. X- Ray Equipment (Block Diagram)- X-Ray tube, collimator, Bucky Grid, power supply, Cathode and filament currents, Focusing cup, Thermionic emission, Electromagnet induction, Line focus principle and the heel effect, Causes of x-ray tube failure: Electron arcing/ filament burn out, Failure to warm up tube, High temperature due to over exposure, x-ray tube rating charts. X- ray image intensifier tubes - Fluoroscopy - Digital Fluoroscopy - Digital Fluoroscopy. Angiography, Cine Angiography, Digital subtraction Angiography. Mammography and Dental x-ray unit.

UNIT II **9 Hours**

COMPUTED TOMOGRAPHY

Principles of tomography, CT Generations, X- Ray sources- collimation - X- ray detectors- Viewing systems- spiral CT Scanning - Ultra fast CT Scanners. Advantages of computed radiography over film screen radiography: Time, Image quality, Lower patient dose, Differences between conventional imaging equipment and digital imagine equipment: Image plate, Plate readers, Image characteristics, Image reconstruction techniques- back propagation and iterative method. Spiral CT, 3D Imaging and its application.

UNIT III **9 Hours**

MAGNETIC RESONANCE IMAGING

Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave - rotation and precession - Introduction of magnetic resonance signals - bulk

magnetization- Relaxation processes T1 and T2. Block Diagram approach of MRI system- system magnet (Permanent, Electromagnet and super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), and shim coils, Electronic components, fMRI.

UNIT IV **9 Hours**

NUCLEAR MEDICINE TECHNIQUES

Nuclear imaging- Anger scintillation camera- Nuclear tomography- single photon emission computer tomography, positron emission tomography - Recent advances- Radionuclide imaging- Bone imaging, dynamic renal function, myocardial perfusion. Non imaging techniques- haematological measurements, Glomerular filtration rate, volume measurements, clearance measurement, whole-body counting, surface counting.

UNIT V **9 Hours**

RADIATION THERAPY AND RADIATION SAFETY

Radiation therapy- linear accelerator, Telegram 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.

Total: 45 Hours

Reference(s)

1. Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine"- Third edition Springer, 2006.
2. B.H.Brown, PV Lawford, R H Small wood, D R Hose, D C Barber, "Medical physics and Biomedical Engineering", CRC Press, 1999.
3. Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.
4. P. Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine Concepts and Techniques", Paperback - Import, 2007.
5. Steve Webb, "The Physics of Medical Imaging", Adam Hilger, Philadelpia, 1988.
6. R. Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002.

21BM013 CELL BIOLOGY 3 0 0 3

Course Objectives

- To provide a basic understanding of cell, its structure, function, types and about its culture.
- To understand the concepts in Cell Biology.
- To compare cellular processes and regulation
- To carry out the recent trends in cell and molecular research

Course Outcomes (COs)

1. Apply structural information of cells to differentiate Eukaryotic cell and prokaryotic cell
2. Categorize cell organelles based on its types and functions
3. Analyse the transportation of action potential from one cell to another
4. Analyse the cause, and methods of cell signalling and signal transduction.
5. Analyse the cell culture preparation process

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	1	2	2	2									1	1	
2	1	3	2	2									1	1	
3	1	3		2									1	1	
4	1	3		2									1	1	
5	1	3		2									1	1	

UNIT I **9 Hours**

CELL STRUCTURE

Cells - definition, Eukaryotic cell and prokaryotic cell -differences and key organelles, Relationship and evolution of Eukaryotic cell and prokaryotic cell, plant cells and animal cells - differences and general structure - Cellular environment, tissues, various types of cell, Extra cellular matrix, cytoskeletal proteins, Cell Cycle - Mitosis and meiosis.

UNIT II **9 Hours**

CELL ORGANELLES

Cell Organelles and function - Nucleus, Cytoplasm, Endoplasmic reticulum, Golgi complex, lysosomes, cell membranes, chloroplast, mitochondria - structure, importance and function.

UNIT III **9 Hours**

CELLULAR TRANSPORT

Transport across cell membranes - importance, classification - Active and passive, passive transport - movement of water, small lipid across membrane. Active - Na+ K+ ATPase Pump, Lysosomal and Vacuolar pumps. Cotransport - Symport, antiport - examples, Endocytosis and Exocytosis transport across prokaryotic membrane, entry of viruses and toxins.

UNIT IV **9 Hours**

CELL SIGNALING AND SIGNAL TRANSDUCTION

Cell signaling - process importance, various kinds of Receptors and ligands - Examples, Different modes of action of ligands, Qualification and characterization of receptors, different modes of signal transduction and amplification with examples, signaling through G-Proteins (Monomeric and trimeric), signaling for growth factors, second messengers, protein kinases, Ca ions and cAMP molecule in signaling.

UNIT V **9 Hours**

CELL CULTURE

Definition, Media preparation, Propagation of eukaryotic and prokaryotic cell, cell lines, primary cultures, stock cell cultures, maintenance of cell lines in cell culture, explants cultures, differentiation and contamination

Total: 45 Hours

Reference(s)

1. James E Darnell, Harvey F Lodish, David Baltimore, " Molecular Biology of the Cell" , W.H. Freeman publishers, 2012
2. Geoffrey Cooper, "The Cell: A molecular approach", OUP USA; 8th edition, 2019.
3. Vermaand Aggarval," Cytology", S. Chand Publications, 2003.
4. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the cell", fifth edition, Taylor and Francis group, 2012.
5. De Robertis & De Robertis, "Cell Biology", 4th Edition, 2010.
6. Gerald Karp," Cell and Molecular Biology" , John Wiley and sons Inc, 2013.

21BM014 TISSUE ENGINEERING 3 0 0 3

Course Objectives

- To study Cell cycle and differentiation
- To understand the basics about stem cells and its applications
- To familiarize different synthetic and natural biomaterials in tissue replacements

Course Outcomes (COs)

1. Understand the fundamental concepts of Tissue Engineering
2. Apply the concepts of stem cell, gene therapy in healthcare systems
3. Apply Engineering design methods to tissue engineering
4. Apply suitable material for designing artificial organs using tissue engineering
5. Analyse the characteristics of Biomaterials in Tissue engineering

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	2											3		
2	1	2	3			1							2	2	
3	1	2	3			1							2	2	
4	1	2	2			1		1					2	3	
5	1	3	2			1							2	3	

UNIT I **9 Hours**

FUNDAMENTALS OF TISSUE ENGINEERING

Particles, waves, probability amplitudes, Schrodinger equation, wave packets solutions, operators, expectation values, Eigen functions, piecewise constant potentials

UNIT II **9 Hours**

STEM CELLS AND GENE THERAPY

Embryonic stem cells - Liver stem cells - adult epithelial tissue stem cells - mesenchymal stem cells - strategies of gene therapy - Ex vivo Vs in vivo gene therapy, gene transfer vector, cell - specific targeting strategies, combining gene transfer with stem cell strategies, challenges to gene therapy for tissue engineering

UNIT III **9 Hours**

ENGINEERING METHODS AND DESIGN

Soft lithography, self-assembled monolayer, micro fluidic patterning, laminar flow patterning, cells interaction with polymers, cell interaction with three dimensional polymer scaffolds and gels - polymer scaffolds fabrications, electrospinning, freeze drying, microfabrication of cell seeded scaffolds - three dimensional scaffold design and engineering

UNIT IV **9 Hours**

MATERIALS IN TISSUE ENGINEERING

Biological materials, degradable and non-degradable, extra cellular matrix decellularization, Polymers: synthetic and natural, cell interaction with polymers, applications of polymer, Ceramics and Metals.

UNIT V **9 Hours**

APPLICATIONS

Replacement Engineering: Bone, cartilage, skin, blood, pancreas, kidney, heart valve and liver, Regenerative engineering: peripheral Nerve regeneration, cardiac tissue regeneration, muscle regeneration, Tissue Engineered Food. Regulation, Commercialization and Patenting

Total: 45 Hours

Reference(s)

1. Robert P lanza, Robert Langer and Joseph Vacanti, "Principles of tissue engineering", Academic Press, California, 2007
2. W. Mark Saltzman, "Tissue Engineering: Engineering principles for design of replacement organs and tissue", Oxford University Press Inc New York, 2004
3. Gary E. Wnek, Gary L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering" , Marcel Dekker Inc, New York, 2008
4. R. Lanza, Anthony Atala (Eds), "Essential of Stem Cell Biology", Academic Press, USA, 2013
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, "Molecular Biology of the Cell" , Garland Science Publications, New York, 2008

21BM015 GENETIC ENGINEERING 3 0 0 3

Course Objectives

- To understand the concepts of Genetics
- To introduce the practice of recombinant DNA technologies
- To solve genetic engineering problems and design target gene expression with advanced genetic engineering techniques.
- To explore with genetic engineering techniques for cloning target gene or protein expression.

Course Outcomes (COs)

1. Understand the concepts of Genetics
2. Apply Recombinant DNA technology for gene cloning methods for construction of Gene Libraries
3. Apply the polymerase chain reaction in disease diagnosis, forensic science and genetic Engineering
4. Analyse the advancements in genetic Engineering
5. Analyse genetic engineering concepts in drugs and vaccine preparation and its ethical issues.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3	2										1	3		
2	1	2	3			1		1				1	2	2	
3	1	2	3			1		1				1	2	2	
4	1	3	2			1		1				1	2	3	
5	1	3	2			1		3				1	2	3	

UNIT I **9 Hours**

BASICS OF GENETICS

Biomolecules: Carbohydrates, Proteins, Lipid, Amino acid and Nucleic acids. Nucleic acids: Introduction, History, DNA and RNA- genetic material, types, mutation. Chromosome, Gene, Expression of genetic information, Regulation of mRNA stability.

UNIT II **9 Hours**

RECOMBINANT DNA TECHNOLOGY

Gene cloning - concept and basic steps; Restriction modification enzymes used in recombinant DNA technology, endonucleases, ligases and other enzymes useful in gene cloning; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, artificial chromosomes, Ti plasmid, shuttle vectors, expression vectors; DNA delivery methods; Construction of genomic and cDNA libraries; Techniques for selection, screening and characterization of transformants.

UNIT III **9 Hours**

ROLE OF POLYMERASE CHAIN REACTION

Concept of PCR; DNA polymerases; primer designing, linkers, adapters, setting up PCR reactions; Various types of PCR; Applications of PCR in disease diagnostics, forensic sciences and genetic engineering.

UNIT IV **9 Hours**

ADVANCED APPROACHES IN GENETIC ENGINEERING

Gene expression in prokaryotes & eukaryotes, Tissue specific promoter, wound inducible promoters, Strong and regulatable promoters, promoter analysis (EMSA and DNA foot printing), gene expression profiling (real time PCR, SAGE, differential display, Microarray); DNA sequencing methods; Molecular markers: RAPD, RFLP, AFLP, SNP; Site directed mutagenesis, gene silencing techniques.

UNIT V **9 Hours**

APPLICATIONS OF GENETIC ENGINEERING

Genetic engineering and Biotechnology; Creation of recombinant microorganisms, transgenic plants and animals; cloning of sheep (Dolly) & other mammals; applications in conservation; therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning; Gene therapy; DNA drugs and vaccines.

Total: 45 Hours

Reference(s)

1. Patrick Faraday, "Genetic Engineering: Emerging concepts and Technologies", Syrawood Publishers, 2018.
2. "The Biotech Primer: An Insider"s Guide to the Science Driving the Biopharma Industry", The Biotech Primer For Non-Scientists Series, November 15, 2019
3. Sandhya Mitra, "Genetic Engineering", Mcgraw Hill, 2nd edition, 2017.
4. R. W Old," Principles of gene manipulation - An introduction to genetic engineering", Distributors, USA, Publishers" Business Services, 1989.
5. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering", Cambridge University Press, 2023.

21BM016 CANCER BIOLOGY 3 0 0 3

Course Objectives

- To import knowledge on Cancer Biology fundamentals and principles of carcinogenesis.
- To discuss about molecular cancer cell biology and metastasis
- To introduce various therapeutic procedures for treating carcinoma
- To emphasize knowledge of the historical background for the development of the tumor microenvironment

Course Outcomes (COs)

1. Understand the concepts of cancer biology and different forms of cancers
2. Analyse the molecular mechanisms behind carcinogenesis
3. Analyse the processes of Mutation of cancer cell genomes of living cells
4. Analyze the treatment procedures currently available for cancer.
5. Categorize different therapeutic techniques used for cancer

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	3	2			-	1						1	2	1	
2	1	3	3			1						1	2	2	
3	1	3	3			1						1	2	2	
4	1	3	2			1		1				1	2	2	
5	1	3	2			1		1				1	2	2	

UNIT I **9 Hours**

FUNDAMENTALS OF CANCER BIOLOGY

Regulation of cell cycle, Mutations that cause changes in signal molecules, Cancer genes - Tumour suppressor genes, oncogenes and their mutations, Modulation of cell cycle in cancer, Different forms of cancers, Clinical examination, Radiological examination, Biopsy and its type, Prediction of aggressiveness of cancer, tumour markers, Molecular tools for early diagnosis

UNIT II **9 Hours**

PRINCIPLES OF CARC INOGENESIS

Theory of carcinogenesis, Chemical carcinogenesis, Metabolism of carcinogemnesis, Principlkes of physical carcinogenesis, X-ray radiation, Mechanisms of radiation carcinogenesis, Diet and cancer

UNIT III **9 Hours**

PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER

Signal targets and cancer, Actiation of kinases, Oncogens, Identification of oncogens, Retroiruses and Oncogens, Detection of oncogens, Oncogens/Proto oncogen actiity, Growth factors related to transformation, Tewlomerases.

UNIT IV **9 Hours**

PRINCIPLES OF CANCER METASTASIS

Clinical significances of inasion, Heterogenity of metastatic phenotype, metastatic cascade, Basement description, Proteinases and tumour cell inasion

UNIT V **9 Hours**

NEW MOLECULES FOR CANCER THERAPY

Different forms of therapy, Chemotherapy, Radiation therapy, Detection of cancers, Use of signal targets towardsa therapy of cancer, Gene therapy, Cancer resistance to chemotherapy, Adancement in cancer therapy, Nano systems for drug deliery, Enzyme inhibitors in relation to cancer therapy

Total: 45 Hours

Reference(s)

1. David Kerr, Francesco Pezzella, Mahvash Tavassoli, Cancer Biology, Oxford University Press, 2019.
2. Aysha Divan, Janice Royds, Cancer Biology and Treatment, Oxford University Press, 2020.
3. Momna Hejmadi, Introduction to Cancer Biology, bonbooks, 2023
4. Carsten Carlberg, Eunike Velleuer, Cancer Biology: How Science Works, Springer International Publishing 2021.
5. Walter M. Stadler , Cancer Biology Review A Case-Based Approach, Demos Medical Publishing, 2013

21BM017 BIO COMPUTATIONAL TECHNIQUES 3 0 0 3

Course Objectives

- To introduce the biocomputational techniques
- To familiarize the protein structure, modelling and simulation
- To introduce advanced computational techniques in Biology

Course Outcomes (COs)

1. Apply the concept of sequencing in physiology
2. Apply distance and character based methods for phylogenetic tree construction
3. Apply modelling and simulation concept to study protein structure
4. Develop suitable machine learning approaches for system engineering and modelling procedures
5. Apply perl programming for biological data analytics

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	1	2										2		2
2	2	2	3										2		2
3	2	2	3		2								2		2
4	2	1	3		2								2		2
5	2	2	3		2								2		2

UNIT I **9 Hours**

INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

UNIT II **9 Hours**

PHYLOGENETICS

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

UNIT III **9 Hours**

PROTEIN STRUCTURE, MODELLING AND SIMULATIONS

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modelling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

UNIT IV **9 Hours**

MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED TOPICS

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA computing.

UNIT V **9 Hours**

PERL FOR BIOINFORMATICS

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Total: 45 Hours

Reference(s)

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press. 2019
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
4. Tisdall, James, Beginning PERL for Bioinformatics, O Reilley Publications, 2001
5. Andrew R. Leach, Molecular Modelling Principles And Applications, Second Edition, Prentice Hall 2009

21BM018 NEUROSCIENCE 3 0 0 3

Course Objectives

- To understand the basics of nervous systems and its functions
- To characterize neuronal cells
- To identify the effect of neuronal functions and the neural disorders
- To select suitable testing methods for analysing neural behaviour

Course Outcomes (COs)

1. Apply the concept of action potential propagation to understand neuron Synaptic potentials and Receptor potentials
2. Analyse the characteristics of neuronal cells based on its characterisation
3. Analyse the effect of neuronal function based on the neurotransmission models
4. Analyse the different types of neurological disorders and its causes
5. Analyse the neuronal behavioural using appropriate testing methods

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	2	3									1	1	1	1
2	2	3	2									1	1	1	1
3	2	3	2									1	2	1	1
4	2	3	2									1	2	1	1
5	2	3	2									1	2	1	2

UNIT I **9 Hours**

INTRODUCTION TO NERVOUS SYSTEM

Nervous system: Introduction, Central and peripheral nervous system, Signalling molecules, First growth factor, First Neuro transmitters in brain, functional organization, Synaptic potentials and Receptor potentials.

UNIT II **9 Hours**

NEURO ANATOMY

Structures and functions of neurons, Synapse: function, signals produced by neurons, Sensors function, Glial cells, molecular and cellular organization of neuronal differentiation, characterization of neuronal cells.

UNIT III **9 Hours**

NEUROPHYSIOLOGY AND NEUROPHARMACOLOGY

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission. Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function.

UNIT IV **9 Hours**

NEUROLOGICAL DISORDERS

Pathogenesis, Genetic basis of neurological disorders, Psychiatric Disorders: Psychiatric epidemiology, Unipolar depression, Bipolar depression, Seasonal affective disorder, Panic disorder, Autism, Stroke, Huntington disease

UNIT V **9 Hours**

BEHAVIOUR SCIENCE

Neuronal mechanism of behaviour, Animal behaviour, Behaviour in various environments, Behavioural and cognitive neuroscience, Behavioural studies using animal model, Testing motor functions, Grip Strength Test, Testing Cognitive Functions, Learning and memory related test

Total: 45 Hours

Reference(s)

1. Georg Goldenberg, Bruce L. Miller - Neuropsychology and Behavioral Neurology_ Handbook of Clinical Neurology, Elsevier - libgen.lc., 2008
2. Michael J. Aminoff, Handbook of Clinical Neurology, Elsevier, London, 2012
3. Mason P., Medical Neurobiology, Oxford University Press, 2011
4. Mathews G.G. Neurobiology, 2nd edition, Blackwell Science, UK, 2000
5. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University Press, USA, 1994

21BM019 CARDIOVASCULAR ENGINEERING 3 0 0 3

Course Objectives

- To understand the basics of cardiovascular system
- To analyse events of cardiac cycle
- To learn hemodynamic of cardiac systems

Course Outcomes (COs)

1. Understand the concepts and controls of cardiovascular system.
2. Analyse the mechanical events related to human cardiac cycle
3. Analyse the cardiac excitation and contraction process
4. Assess the cardiac output for the specific events using suitable methods
5. Analyse Hemodynamic with respect to cardiovascular system

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	2	2									1			
2	1	3	2	2								1	2	1	
3	1	3	2	2								1	2	2	
4	1	3	2	2								1	2	1	
5	1	3	2	2								1	2	1	

UNIT I **9 Hours**

OVERVIEW OF THE CARDIOVASCULAR SYSTEM

Functions of the cardiovascular system, Circulation of blood, Central control of the cardiovascular system

UNIT II **9 Hours**

CARDIAC CYCLE

Mechanical events, Arterial cycle and central venous pressure cycle, Clinical aspects of human cardiac cycle

UNIT III **9 Hours**

CARDIAC EXCITATION AND CONTRACTION

Mechanism of contraction, Sinoatrial node function, cardiac conduction system, Atrioventricular node function, Autonomic regulation of the heart rate

UNIT IV **9 Hours**

ASSESSMENT OF CARDIAC OUTPUT

Fick principle, Thermodilution and indicator dilution methods, Pulse Doppler methods, miscellaneous methods

UNIT V **9 Hours**

HEMODYNAMICS

Relationship between pressure, flow and resistance, Frank-Starling law, Preload, afterload and contractility, Control of stroke volume and cardiac output

Total: 45 Hours

Reference(s)

1. Anne Waugh, Allison Grant, Ross and Wilson Anatomy and Physiology, Elsevier, edition 14. 2018.
2. George A Stouffer, J Larry Klein, Cardiovascular Hemodynamics for the clinician, First edition, John Willey & Sons, 2017
3. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, 2006
4. John Enderle, Susan blanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, 2005.
5. Michel R Labrosse, Cardiovascular Mechanics, First edition, CRC press, Taylor and Francis Group, 2019

21BM020 PHYSIOLOGICAL MODELLING 3 0 0 3

Course Objectives

- To introduce system concept to physiology
- To introduce relationship between engineering control system and physiological control system
- To familiarize lumped and distributed parametric modelling techniques for understanding physiology
- To model dynamically varying physiological system

Course Outcomes (COs)

1. Apply Engineering system concept for human physiological systems.
2. Analyze system transfer function and the feedback approach to derive mathematical model of a Physiological system
3. Analyze the vital homeostatic mechanisms as closed loop control system
4. Develop suitable models for analysing Cardiopulmonary System
5. Analyse Respiratory physiology using mathematical model and its simulation

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	2	3	2								1	3	2	1
2	2	3	2	2								1	3	2	1
3	2	3	2	2								1	3	2	1
4	2	2	3	2								1	3	2	1
5	2	3	2	2								1	3	2	1

UNIT I **9 Hours**

SYSTEM CONCEPT

Purpose of physiological modelling and signal analysis, Characterization of simple physiological system, System properties: Resistance, linear resistance analysis, static and dynamic resistance, Storage, system with volume storage, electrical analog of compliance, combined hollow elastic element, cylindrical elements, storage in thermal systems, storage in mechanical systems Distributed Vs lumped parametric model, unmyelinated nerve fiber model simulation

UNIT II **9 Hours**

SYSTEM ANALYSIS AND FEEDBACK

Review: transfer function, First and second order system transfer function and step response transfer function, sinusoidal analysis of second order system. Difference between engineering and physiological control systems. Muscle reflux system Open vs closed loop system. Positive and negative feedback system

UNIT III **9 Hours**

PHYSIOLOGICAL CONTROL SYSTEMS AND ANALYSIS

Homeostasis: Body temperature, Glucose regulation, Blood pressure regulation, Fight-Flight response, Body fluid, pH regulation, electrolyte regulation, Transient and steady state response - Steady state operating point- the steady-state characteristics

UNIT IV **9 Hours**

MODELLING OF CARDIOPULMONARY SYSTEM AND OTHER MODELS

Review of cardiovascular anatomy and physiology, two-element and three element Windkessel model, cardiac muscle model, Model of Isovolumic ventricle and ejection effect Simplified model of heart with heart valves- Baroreflex Model- simplified circulatory model.

UNIT V **9 Hours**

RESPIRATORY SYSTEM AND OTHER MODELS

Review of Respiratory system anatomy and physiology, Lung modelling, Pressure Model, Linear lung model with sinusoidal airway dynamics, Gas model, chemical regulation of ventilation, Cheyne-Stoke breathing, biot breathing, Hodgin-Huxley model, Thermal system

Total: 45 Hours

Reference(s)

1. Benjamin C Kuo, Automatic control systems, Tenth Edition, McGraw-Hill Education, 2017
2. Michel C Khoo, Physiological Control Systems -Analysis, simulation and estimation, Prentice Hall of India, 2001
3. Marmarelis, Nonlinear Dynamic Modeling of Physiological Systems, Wiley-IEEE Press,2004
4. Bernhard Graimann, Brendan Allison, GertPfurtscheller, Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction, Springer, 2010
5. David T Westwick, Robert E. Kearney, Identification of Nonlinear Physiological Systems, Wiley-IEEE Press, 2003

21BM021 PROSTHETIC AND ORTHOTIC DEVICES 3 0 0 3

Course Objectives

- To introduce appropriate assist device suitable for specific disorder
- To Develop new assist devices for the needy
- Understand orthopaedic prosthetics and orthotics in rehabilitation

Course Outcomes (COs)

1. Apply suitable assistive technology (AT) for human mobility
2. Analyse sensory impairment of vision and hearing and suggest suitable aiding device
3. Analyze the recent advancements in assistive technology for Vital organs
4. Model an assistive device for a given organ impairment
5. Evaluate the performance of an implant design based on its performance parameters

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	3	2		1		1				1	2	3	2
2		2	2	3		1		1				1	2	3	2
3		2	2	3		1		1				1	2	3	2
4		1	3	2		1		1				1	2	3	2
5		2	2	3		1		1				1	2	3	2

UNIT I **9 Hours**

ASSISTIVE TECHNOLOGY FOR MOBILITY

Basic assessment and evaluation for mobility, Control systems, navigation in virtual space by wheelchairs, Wheel chair seating and pressure ulcers, Fuzzy logic expert system for automatic tuning of myoelectric prostheses, Intelligent prosthesis

UNIT II **9 Hours**

ASSISTIVE TECHNOLOGY AND SENSORY IMPAIRMENTS

Visual and auditory impairment, assessment methods, Libraille, GRAB, mathematical Braille, Augmentative and alternative methods for hearing impairment, Use of multimedia technology to help hard of hearing children, Haptic as a substitute for vision

UNIT III **9 Hours**

ASSIST DEVICES FOR VITAL ORGANS AND ADVANCEMENTS IN TECHNOLOGY

Cardiac assist devices, Intra-Aortic Balloon Pump (IABP), auxiliary ventricles, Dialysis for kidneys, Intermittent positive pressure breathing (IPPB) type assistance for lungs, Latest use of assistive technology for chronic heart diseases and healthcare, Information technology, telecommunications, new media in assisting healthcare, Future trends in assistive technology, virtual reality based training system for disabled children

UNIT IV **9 Hours**

PRINCIPLES OF IMPLANT DESIGN

Principles of implant design, cardiac implants, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration

UNIT V **9 Hours**

IMPLANT DESIGN PARAMETERS AND ITS SOLUTION

Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration, dental and otologic implants

Total: 45 Hours

Reference(s)

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010
2. Kenneth J. Turner, Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 201
3. Gerr, M. Craddock, Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003
4. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 2010

21BM022 REGENERATIVE MEDICINE AND ERGONOMICS

3 0 0 3

Course Objectives

- To familiarize nature and significance of stem cells and its applications
- To Explain the Molecular therapy for regeneration
- To outline the basics of Biomechanical, physiological and anthropometric background.

Course Outcomes (COs)

1. Understand the concept of regenerative medicine and its applications
2. Analyze the usage of stem cells in various clinical applications and injuries
3. Apply suitable biomaterials for designing regenerative medicine
4. Analyse the Anthropometric design principles utilization in regenerative medicine
5. Analyse the ergonomic impacts in Human physiology

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2			1		1		1		1		1	1	1	1
2		3	1	2		1		1		1		1	1	3	2
3		1	3	2		1		1		1		1	1	2	2
4		3	1	2		1		1		1		1	1	3	2
5		3	1	2		1		1		1		1	1	3	2

UNIT I **9 Hours**

REGENERATIVE MEDICINE

Regenerative Therapy, Introduction-Large scale manufacturing of cells, tissues and organs, Artificial organs, Gene therapy Applications-Engineered Tissues and Regenerative Medicine, Molecular therapy for regeneration, Personalized therapies in Regenerative Medicine, Applications of Regenerative Medicine

UNIT II **9 Hours**

STEM CELL BIOLOGY

Introduction, Types & sources of stem cell with characteristics: hematopoietic differentiation pathway, Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, cancer stem cells, induced pluripotent stem cells.

UNIT III **9 Hours**

BIOMATERIALS AND HUMAN- ENVIRONMENT INTERACTION

Biomaterials: Properties of Biomaterials, Surface, bulk, mechanical and biological properties, Biomechanical, Physiological, Anthropometric background, Posture, Sitting, Standing, Change of posture, Hand and arm postures, Movement, Lifting, carrying, pulling and pushing.

UNIT IV **9 Hours**

ANTHROPOMETRY

Anthropometric design principles, work space envelope, factors in design of work space surfaces, principles of seat design, principles of control panel, reducing accidents by altering behaviour.

UNIT V **9 Hours**

HUMAN FACTORS AND ERGONOMICS

Standards, Applications in healthcare, Neuro-ergonomics in human-system interaction, Case Study Biomedical Application, Design optimization of Medical Equipment.

Total: 45 Hours

Reference(s)

1. HosseinBaharvand (Editor), Nasser Aghdami (Editor). Regenerative Medicine and Cell Therapy (Stem Cell Biology and Regenerative Medicine). Humana Press; 2013 edition
2. Pascale Carayon, Handbook of Human Factors and Engineering, Second Edition, CRC Press, 2011
3. Raphael G., Richard S., Stem Cell-Based Tissue Repair, Cambridge RSC Publishing, 1st Edition, 2011
4. Lanza R., Gearhart J. et al. Essential of Stem Cell Biology, Elsevier Academic, 1st Edition, 2006.
5. Gavriel Salvendy, Handbook of Human Factors and Ergonomics, John Wiley & Sons, Fourth Edition 2012.
6. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, Third Edition, 2016

21BM023 FINITE ELEMENT ANALYSIS 3 0 0 3

Course Objectives

- To introduce the concepts of finite element methods for biomechanical analysis
- To familiarize beam elements and scalar problem in two dimension
- To explain analysis approach to field problems

Course Outcomes (COs)

1. Understand the concept of modelling in deriving one dimensional and two dimensional equations for Finite Element Modelling(FEM) techniques
2. Apply the beam element and scalar problem in two dimensional FEM approaches
3. Apply the finite element analysis in biomechanical research
4. Analyse the characteristics of non-linear real time problems with FEM
5. Analyse the impact of physiological model for the given force using FEM

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	2	1	2								1	1	1	
2		2	1	2								1	2	1	
3		2	1	2								1	2	1	
4		3	1	2								1	2	2	
5		3	1	2								1	2	2	

UNIT I **9 Hours**

INTRODUCTION TO MODELLING

Historical Background, Mathematical Modelling of field problems in Engineering, Governing Equations, Natural and Essential Boundary conditions - Basic concepts of the Finite Element Method. One Dimensional Second Order Equations, Discretization, element types- Linear and Higher order Elements Derivation of Shape functions and Stiffness matrices and force vectors.

UNIT II **9 Hours**

BEAM ELEMENTS AND SCALAR PROBLEM IN TWO DIMENTION

Fourth Order Beam Equation Transverse deflections, Natural frequencies of beams and longitudinal vibration. Second Order 2D Equations involving Scalar Variable Variation Formulation Finite Element Formulation Triangular Elements Shape functions and element matrices and vectors. Application to Field Problems in Bio mechanics, Quadrilateral elements.

UNIT III **9 Hours**

APPLICATIONS TO FIELD PROBLEMS

Higher order elements. Natural co-ordinate systems Isoparametric elements Shape functions for isoparametric elements One, two and three dimensions Serendipity Elements Numerical integration and application to plane stress problems transformation in coordinates- Jacobian of transformation order of convergence- numerical integration example problems- shape functions in natural coordinates- rectangular elements- Lagrange family.

UNIT IV **9 Hours**

NON-LINEAR ANALYSIS

Introduction to Nonlinear problems, some solution methods, computational procedure, simple material nonlinearity, stress stiffening, contact interfaces, problems of gaps and contact, geometric nonlinearity, modelling considerations.

UNIT V **9 Hours**

IMPACT ANALYSIS

Mechanical properties of biological and commonly used biomedical engineering materials, Critical reviews of finite element analysis in biomechanical research. Modelling and force analysis of musculoskeletal systems Stress calculations

Total: 45 Hours

Reference(s)

1. King-Hay Yang, Basic Finite Element Method as Applied to Injury Biomechanics, Elsevier Academic Press. 2017
2. Connie McGuire, Finite Element Analysis: Biomedical Aspects, NY Research press, 2015
3. Moratal D., Finite Element Analysis from Biomedical Applications to Industrial Developments, InTech Publisher, 2014
4. J N Reddy, Finite element methods, Tata McGrawHill, 2003
5. Seshu, Text Book of finite element analysis, Prentice Hall, New Delhi, 2003

21BM024 HAPTICS 3 0 0 3

Course Objectives

- To introduce Haptic concepts
- To familiarize different classifications of Haptics and its applications
- To Explain building technology of Haptics

Course Outcomes (COs)

1. Apply suitable display devices for Haptic device based on their performances
2. Apply Human perceptual parameters in Haptics technology
3. Apply appropriate haptic sensors for Machine Haptics
4. Analyse the design of computer haptics
5. Evaluate the role of haptic systems in medical and nonmedical fields

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	3		1						1	1	2	
2	1	2	3	2		1						1	1	2	
3	1	2	1	3		1						1	1	2	
4	1	3	2	2		1						1	1	2	
5	1	2	1	3		1		1				1	2	2	2

UNIT I **9 Hours**

INTRODUCTION

Touch, Sense of Touch, Perception of world through touch, Haptics, Tactile system, Tactile receptors, Sensory and Motor specialization of Hand, Haptic perception, Haptic Illusion, Tactile and Haptic Displays, Haptic exploration, Concepts and terminologies

UNIT II **9 Hours**

HUMAN HAPTIC PERCEPTION

Introduction, Touch and cognition, Human Haptic system: Mechanical structure of Arm, Hand haptics system, Human sensory system, The motor system, Haptic cognition, Haptic exploration, Concept of Illusion, Human perceptual parameters for Haptics: Interface development, Perception Thresholds

UNIT III **9 Hours**

MACHINE HAPTICS

Introduction, Haptic Interfaces: Robotic perspective, Haptic interface system, HAVE sensor: Electromechanic sensors, Optical sensors, Capacitive sensor, Resistive sensor, Force sensors, strain gauge sensors, Magnetic sensor, HAVE actuators: Magnetic Levitation Devices, Nonholonomic devices, Magnetic sensors and parallel mechanisms, performance specifications: physical attributes, special attributes and temporal attributes

UNIT IV **9 Hours**

COMPUTER HAPTICS

Introduction, Haptic rendering subsystems, Polygon, based representation and scene graph, collision detection techniques and bounding volumes, control methods for Haptic systems: Impedance control

architecture, Feed, forward impedance control architecture, positive feedback Impedance control architecture, Hybrid compensation Impedance control architecture, Admittance control architecture

UNIT V **9 Hours**

HAPTICS APPLICATIONS

Introduction , Haptics for Medical Applications: Surgical simulation, stoke based rehablilitation, support of the visually impaired, Tele, surgery, Media: Haptic broadcosting. E, commerce, Video games , other application: Mobile Haptics, Haptics and VR, Introduction to Wearable Haptic devices

Total: 45 Hours

Reference(s)

1. Lynette Jones , Haptics , The MIT Press, 2018
2. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics Technologies: Bringing Touch to Multimedia, Springer Science & Business Media, 2011
3. Tom Bruno , Wearable Technology: Smart Watches to Google Glass for Libraries, Rowman & Littlefield Publishers, Lanham, Maryland, 2015.
4. Hiroyuki Kajimoto, Masashi Konyo, Shoichi Hasegawa, Takuya Nojima, Ki-Uk Kyung, Haptic Interaction: Science, Engineering and Design. (2017). Switzerland: Springer Nature Singapore.
5. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics TechnologiesBringing Touch to Multimedia, Springer, 2011

21BM025 MEDICAL TEXTILES 3 0 0 3

Course Objectives

- To learn about different types of Biomaterials
- To understand the Biomedical application of different textile structures
- To analyze the Functional requirements of textile structures for specific end use
- To understand the Selection and characterization of textile materials used for biomedical applications

Course Outcomes (COs)

1. Categorize medical textiles based on the material used and its usage in medical field
2. Apply material properties of biopolymers suitable for implantable, non, implantable and drug delivery textiles
3. Apply textile technology to implantable and drug delivery systems
4. Apply appropriate textile technology to wound care and dressing applications
5. Analyse the components of smart textile and ethical issues of textile technology

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		2		1							2	1	
2	2	2		2		1							2	1	
3	2	2		2		1							2	1	
4	1	2		2		1							2	1	
5	1	3		2		1		2					2	1	

UNIT I **9 Hours**

INTRODUCTION

Medical textiles, classification, current market scenario in international and national level, government initiatives; antimicrobial fibres and finishes; Nano fibrous materials and films; super absorbent polymers; operating room garments; personal health care and hygiene products and their testing methods; applications of non, wovens in medicine; textiles in infection prevention control.

UNIT II **9 Hours**

BIOPOLYMERS

Biopolymers: classification and their properties, requirements, and applications, testing methods; In vitro tests, direct contact, agar diffusion & elution methods, in vivo assessment of tissue compatibility. Tissue engineering: properties and materials of scaffolds, relationship between textile architecture and cell behavior, applications of textile scaffolds in tissue engineering.

UNIT III **9 Hours**

IMPLANTABLES, NON, IMPLANTABLES AND DRUG DELIVERY

Bandages, types, properties and applications; compression garments, types, properties and applications; sutures: types and properties; implantable textiles: hernia mesh, vascular prostheses, stents; Extra corporeal materials: Cartilage nerves, liver ligaments, kidney, tendons, cornea; Drug delivery textiles: classification, mechanism various fabrication methods, characterization, applications.

UNIT IV **9 Hours**

WOUND CARE AND REUSABLE MEDICAL TEXTILES

Wound: types and healing mechanism, textile materials for wound dressing, bio active dressing, anti-microbial textiles dressing, composite dressing, testing of wound care materials; Wound 97 compression textiles; Reusable medical textiles: types, advantages, physical properties and performance , , reusable processing methods.

UNIT V **9 Hours**

SMART MEDICAL TEXTILES AND LEGAL ISSUES

Smart textiles, types, characteristics, smart textiles in wound care; applications of phase change and shape memory materials, monitoring pregnancy, children and cardio patients, mobile health monitoring; electronics in medical textiles; Smart textiles in rehabilitation and applications; textile sensors for healthcare; legal and ethical values involved in the medical textile materials

Total: 45 Hours

Reference(s)

1. Joon B. Park., and Joseph D. Bronzino., Biomaterials , Principles and Applications , CRCPress, Boca Raton London, New York, Washington, D.C. 2002.
2. Anand S.C., Kennedy J.F.,Miraftab M., and Rajendran S., Medical Textiles and Biomaterials for Health Care , Wood head Publishing Ltd., 2006
3. Horrocks A R, Anand S C , Handbook of Technical Textiles, Woodhead Publishing and Textile Institute, USA, 2000.
4. Adanur S., Wellington Sears Handbook of Industrial Textiles , Technomic Publishing Co. Inc., Lancaster Pennylvania, 1995, ISBN 1, 56676, 340, 1 4
5. Michael Szycher and Steven James Lee, Modern Wound Dressing: A Systematic Approach to Wound Healing , Journal of Biomaterials Applications, 1992

21BM026 WEARABLE SYSTEMS AND BODY AREA NETWORKS

3 0 0 3

Course Objectives

- To provide an overview of the technical background of Body Area Networks (BAN) and its application in health care using mobile technology
- To explain the hardware requirement of BAN
- To familiarize the communication and security aspects in the BAN

Course Outcomes (COs)

1. Analyse the performance and challenges of Body Area Networks (BAN) for healthcare
2. Analyse the suitability of selected hardware for BAN
3. Analyse the wearable sensors and standards for BAN
4. Apply mobile devices for healthcare monitoring
5. Analyze the mobile health technology used for various healthcare applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3		2		1		1					2	1	
2	1	3		2		1		1					2	1	
3	1	3		2		1		1					2	1	
4	1	2		2		1		1					2	1	
5	1	3		2		1		1					2	1	

UNIT I **9 Hours**

BODY AREA NETWORKS

BAN and healthcare, Technical challenges, sensor design, Biocompatibility, energy supply, energy scavenging methods, optimal node placement, number of nodes, networks for BAN, System security and reliability, standards. BAN Architecture

UNIT II **9 Hours**

HARDWARE FOR BAN

Processor, Low Power MCUs, mobile computing MCUs, Integrated processor with radio transceiver, memory types and ranges, Antenna types, PCB antenna, wire antenna, ceramic antenna, external antenna, Sensor interface, power sources, batteries and fuel cells for sensor nodes.

UNIT III **9 Hours**

WEARABLE SENSORS AND STANDARDS FOR BAN

Wearables fundamentals and role of wearable sensors, Attributes of wearable, flexible electronics, meta, wearable, Future of wearable, research road map, Wireless personal area network technologies, Zigbee, coexistence issues with BAN.

UNIT IV **9 Hours**

MOBILE DEVICES FOR HEALTHCARE

Wearable system for ECG Monitoring, Evaluation of night time performance, smart phone based health care monitoring system , Phone based fall risk prediction , RFID based personal mobile medical assistance, Secure medical sensor network

UNIT V **9 Hours**

MOBILE HEALTH TECHNOLOGIES AND APPLICATIONS

Mobile nutrition tracking , case study , Accessing existing virtual electronic patient record, mobile personal health records , Monitoring hospital patients, sensing vital signs and transmission using wireless networks , Context aware healthcare applications with case study

Total: 45 Hours

Reference(s)

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
3. Canjun Yang , G.S.Virk, Huayong yang , Wearable sensors and Robots , Proceeding of international conference on wearable sensors and robots, 2017
4. Zhang, Yuan, Ting, Wearable Medical Sensors and Systems, Springer, 2013
5. Guang, ZhongYang(Ed.),Body Sensor Networks, Springer, 2006.
6. Mehmet R. Yuce, Jamil Y.Khan, Wireless Body Area Networks Technology, Implementation, and Application, Pan Stanford Publishing Pte. Ltd., Singapore, 2012

21BM027 TELEMEDICINE AND IOT 3 0 0 3

Course Objectives

- To understand the principles, practices and areas of application in Hospital management.
- To understand the telemedicine in different sectors
- To introduce the relevance of Telemedicine to the existing technology through demonstrations, case studies, simulations in the field of Telemedicine and IoT

Course Outcomes (COs)

1. Understand the concepts and multimedia principles used in telemedicine
2. Outline telemedicine standards and regulations in device design
3. Apply mobile technology in Tele healthcare
4. Apply appropriate peripherals and communication protocol of IOT in Tele medicine
5. Apply suitable technology in tele medicine for real time scenario

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1		2			1						1			
2	1		2	2		1		2				1	2		
3	1	2	3	2		1						1	2		
4	1	2	3	2		1						1	2		
5	1	2	3	2		1						1	2		

UNIT I **9 Hours**

TELEMEDICAL TECHNOLOGY

Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Telehealth, Tele care, Organs of telemedicine, Principles of Multimedia, PSTN, POTS, ANT, ISDN, Internet, Air wireless communications, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www). Clinical data, local and centralized

UNIT II **9 Hours**

TELEMEDICAL STANDARDS

Data Security and Standards, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO:OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Real, time Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentially of medical records and access control, Cyber laws related to telemedicine

UNIT III **9 Hours**

MOBILE TELEMEDICINE

Tele radiology: Definition, Basic parts of tele radiology system, Tele pathology, multimedia databases, color images of sufficient resolution, Dynamic range, spatial resolution, compression methods, Interactive control of color, Medical information storage and management for telemedicine, patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system, Doctors, paramedics, facilities available. Pharmaceutical information system

UNIT IV **9 Hours**

INTRODUCTION TO IOT

Introduction to Internet of Things (IoT). Review of CC3200 core and its architecture, Introduction to advanced ARM Cortex M4 architecture, Peripherals overview, User API, Power challenges with IoT, CC3200 Simple link applications, starting with Code Composer Studio V6. Various wireless protocols and its applications: ZigBee, Bluetooth Low Energy, 6LowPAN, Wi, Fi

UNIT V **9 Hours**

APPLICATIONS

Telemedicine access to health care services, health education and self, care. Introduction to robotics surgery, tele surgery. Tele cardiology, Tele oncology, Telemedicine in neurosciences, Electronic Documentation, e, health services security and interoperability, Telemedicine access to health care services. Introduction to WLAN, WLAN parameters, AP/STATION modes and its Security types, Socket connection, WLAN AP and WLAN STATION configuration settings.

Total: 45 Hours

Reference(s)

1. R.S.Khandpur Telemedicine Technology and Applications (mhealth, Telehealth and ehealth), PHI Learning Pvt.Ltd, Delhi, 2017
2. Wootton, R., Craig, J., Patterson, V., Introduction to Telemedicine, Royal Society of Medicine Press Ltd, Taylor & Francis 2006
3. Latifi, R. Current Principles and Practices of Telemedicine and e, Health, IOHS Press, Washington DC, 2008
4. Bashshur, R.L., Shannon G.W., History of Telemedicine, New Rochelle NY: Mary Ann Liebert Publishers, 2009
5. Victor Lyuboslavsky, Telemedicine and Telehealth 2.0: A Practical Guide for Medical Providers and Patients, CreateSpace Independent Publishing Platform, 1st edition, 2015

21BM028 BIOINFORMATICS 3 0 0 3

Course Objectives

- To understand the evolving field of bioinformatics.
- To analyse large biological data sets
- To formulate the usage of biological tools effectively

Course Outcomes (COs)

1. Implement Bioinformatics in data generation
2. Identify appropriate biological data base for various analysis
3. Apply suitable analytical techniques to Biological data for research.
4. Implement the concepts of genomic technology in bioinformatics
5. Analyse genetic variability of clinical data

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	2	3								1	1	2	
2		2	3	2								1	1	2	
3		2	3	2								1	1	2	
4		2	3	2								1	1	2	
5		2	1	3				1				1	1	2	

UNIT I **9 Hours**

INTRODUCTION TO BIOINFORMATICS AND DATA GENERATION

Bioinformatics and its relation with molecular biology. Examples of tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, PubMed, PDB), Data generation; Generation of large scale molecular biology data, Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X, Ray Diffraction, and microarray, Applications of Bioinformatics

UNIT II **9 Hours**

BIOLOGICAL DATABASE AND ITS TYPES

General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDB sum).

UNIT III **9 Hours**

STRUCTURAL BIOINFORMATICS

Fundamentals of X, ray diffraction, NMR spectroscopy of macromolecules, Protein Structure: Primary, Secondary, Super Secondary, Domains, Tertiary, Quaternary, Structural features of RNA: Primary, Secondary, Tertiary, Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and Analysis tools.

UNIT IV **9 Hours**

DIFFERENT TYPES AND METABOLIC PATHWAYS

Genomics: Genome Annotation, Genome Assembly, Structural and Functional Genomics. Comparative Genomics, Metagenomics: Introduction, metagenome, shotgun metagenomics (pyrosequencing), Metabolic pathway database (KEGG pathway database), Concept of metabolome and metabolomics

UNIT V **9 Hours**

GENE EXPRESSION AND REPRESENTATION OF PATTERNS AND RELATIONSHIP

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

Total: 45 Hours

Reference(s)

1. Introduction to Bioinformatics Algorithms by Neil Jones and Pavel Pevzner. 2015.
2. Bioinformatics by David Mount, 2016.
3. Bioinformatics: Principles and Applications by Zhumur Ghosh and BibekanandMallick, 2010.
4. Bioinformatics: Sequence and Genome Analysis by Mount and David W, 2005.

21BM029 VIRTUAL AND AUGMENTED REALITY IN HEALTHCARE

3 0 0 3

Course Objectives

- To introduce the relevance of this course to the existing technology through demonstrations, case studies and applications with a futuristic vision along with socio, economic impact and issues
- To understand virtual reality, augmented reality and using them to build Biomedical engineering applications.
- To know the intricacies of these platform to develop PDA applications with better optimality

Course Outcomes (COs)

1. Assess the principle and functions of Virtual Reality (VR)
2. Apply modelling procedures to develop VR applications
3. Design and configure Haptic model in regard to human parameters
4. Assess the principle and components of Augmented Reality (AR)
5. Analyse utility of computer vision and techniques in Augmented Reality (AR)

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		2									2	2	
2	2	2	3	2									2	2	
3	2	2	3	2									2	2	
4	2	2	3	2									2	2	
5	2	3	2	2									2	2	

UNIT I **9 Hours**

INTRODUCTION TO VIRTUAL REALITY

Definition of Virtual Reality (VR), Principles of VR, Main components, the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture Interfaces-Output Devices: Graphics displays-sound displays & haptic feedback, Physiological data recording, Position and movement measuring systems, Problems in VR.

UNIT II **9 Hours**

VR DEVELOPMENT PROCESS & CONTENT CREATION CONSIDERATIONS

Geometric modelling - kinematics modelling- physical modelling - behaviour modelling - model Management. Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

UNIT III **9 Hours**

VR ON THE WEB & VR ON THE MOBILE

JS-pros and cons-building blocks (WebVR, WebGL, Three.js, device orientation events)- frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters-device development and drivers-Design Haptics.

UNIT IV **9 Hours**

INTRODUCTION TO AUGMENTED REALITY WITH AR HARDWARE

Defining augmented reality, history of augmented reality, Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.

UNIT V **9 Hours**

COMPUTER VISION FOR AR & AR TECHNIQUES

Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application, AR Techniques – Marker based and Marker Less approach.

Total: 45 Hours

Reference(s)

1. Jason Jerald. 2015. The VR Book: Human, Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.
2. C. Burdea & Philippe Coiffet, Virtual Reality Technology, Second Edition, Gregory, John Wiley & Sons, Inc.,2008.
3. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison, Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575.
4. Wadee Alhalabi, Virtual Reality Implementation in Healthcare Settings, Medical Information Science Reference, 2017.
5. James Roland, Virtual Reality and Medicine , Reference Point Press, Incorporated, 2018.

21BM030 MEDICAL OPTICS 3 0 0 3

Course Objectives

- To introduce the basic instrumentation related to photonics
- To familiarize the practical applications of optics related to medicine
- To analyze the diagnostic and therapeutic applications in medical optics

Course Outcomes (COs)

1. Identify suitable and essential instruments used in medical optics.
2. Analyze the optical properties of tissues for visualizing its structure
3. Apply appropriate Laser for surgical applications
4. Apply optics concept for Non, thermal diagnostic applications
5. Apply optics in therapeutic applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		2				1					2	2	
2	2	2	3	2				1					2	2	
3	2	2	2	2				1					2	2	
4	1	2	3	2				1					2	2	
5	1	2	3	2				1					2	2	

UNIT I **9 Hours**

INSTRUMENTATION IN PHOTONICS

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

UNIT II **9 Hours**

OPTICAL PROPERTIES OF THE TISSUES

Light transport inside the tissue, optical properties of tissue. Laser Characteristics as applied to medicine and biology, Laser tissue Interaction, Chemical, Thermal, and Electromechanical. Photo ablative processes.

UNIT III **9 Hours**

SURGICAL APPLICATIONS OF LASERS

Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Laser Tissue welding, Case study.

UNIT IV **9 Hours**

NON THERMAL DIAGNOSTIC APPLICATIONS

Phototherapy, Photodynamic therapy (PDT), Principle and mechanism, Oncological and non, oncological applications of PDT, Bio stimulation effect, applications, Laser Safety Procedures.

UNIT V **9 Hours**

THERAPEUTIC APPLICATIONS

Pulsed Laser use in Cardiology, Dentistry and oral surgery, Ophthalmology, Optical Tweezers, Vascular welding, Cosmetic Surgery, Soft tissue treatment, Dermatology Fetal surgery.

Total: 45 Hours

Reference(s)

1. Tuan VoDinh , Biomedical photonics Handbook, CRC Press LLC, 2014
2. MarkolfH Niemz, Laser Tissue Interaction Fundamentals and Applications , Springer, 2007
3. Paras N. Prasad, Introduction to Bio photonics, A John Wiley and sons, Inc. Publications, 2003
4. Mark E Brezinski, Optical Coherence Tomography Principles and Applications, Academic Press, 2006
5. R Splinter and B A Hooper, An Introduction to Biomedical Optics, Taylor and Francis, 2007

21BM031 / 21BMH01 MEDICAL WASTE MANAGEMENT

3 0 0 3

Course Objectives

- To introduce the healthcare hazard control and accidents
- To familiarize biomedical waste management
- To explain facility guidelines, infection control and patient safety

Course Outcomes (COs)

1. Categorize the consequences of medical hazard in environment
2. Implement the Legal guidelines on Waste Disposals
3. Apply appropriate procedure for generation and segregation of medical waste
4. Apply proper guidelines for medical waste transportation, treatment and disposal
5. Analyse the effective practices to minimize the medical waste and financial commitment

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2				1		2			2	1	2		1
2		2				3		2			2	1	1	1	2
3		3	2			1		1			2	1	2	1	1
4		3	2			1		2			2	1	2	1	2
5		3	2			1		1			3	1	2	2	1

UNIT I **9 Hours**

INTRODUCTION

Introduction, Need for disposal of biomedical Waste, Definition, general and hazardous health care waste, infectious waste, genotoxic waste, waste sharps, biomedical waste, categories, composition of biomedical waste, specification of materials, sources, hospitals, health care establishments, others.

UNIT II **9 Hours**

IMPACTS AND LEGISLATION POLICIES

Health impacts, direct and indirect hazards, potential hazards, infection, infection agents, legislation and policies, biomedical waste handling, rules, CPCB guidelines, BARC guidelines, radioactive waste disposal, WHO guidelines, management in developing countries

UNIT III **9 Hours**

GENERATION AND SEGREGATION

Colour coding, yellow, red, blue, white, contents of waste bag, label, biomedical waste, minimize, collection and handling, infection control system, needle sticks injury, hospital policy, segregation, decontaminating, disinfection unit, autoclaving, sharp waste containers, shredding, incrimination, biomedical symbol, microwave, hydro, pulping, plasma torch.

UNIT IV **9 Hours**

TRANSPORTATION, TREATMENT AND DISPOSAL

Central storage, Onsite pre, treatment, mechanical treatment, chemical disinfection, offsite transportation, offsite and onsite, treatment, common treatment, liquid waste treatment, Conventional treatment, wet thermal technology, incineration, alternative treatment technology, microwave technology, rotaclave system, hydroclave, ETP, process electron beam treatment, plasma pyrolysis , gastification systems, non, infectious waste, treatment, composting, rotating jumbling system, French composting, vermin composting, disposal, sharp disposal, deep burial, secured landfill.

UNIT V **9 Hours**

MANAGEMENT ISSUES

Waste minimization, recycling, reuse, health and safety practices, protective equipment usage, occupational health programmers, safety, emergency practices, management, non clinical support devices, Quality improvement tools and strategies, budget allocation, maintenance, records, annual reports

Total: 45 Hours

Reference(s)

1. D.B. Acharya, Meeta Singh, "The Book of Hospital Management", Minerva Press, 2003
2. Mohd Faisal Khan, "Hospital Waste Management: Principle and Guidelines", Kanishka Publishers, 2010
3. Madhuri Sharma, "Hospital Waste Management and its Monitoring", Jaypee Brothers Medical Publishers, 2007
4. Mohammad Mohsin, "Hospital: Waste Management", VDM Publishing, 2010
5. Domiel A Vallero, "Biomedical Ethics for Engineers", Elsevier Publications, 1st Edition, 2007

21BM032 / 21BMH02 MEDICAL ETHICS 3 0 0 3

Course Objectives

- To introduce the legal and ethical principles in health care settings
- To familiarize the professional ethics to be followed by Biomedical Engineers
- To explore the patient safety and regulatory aspects followed in hospitals

Course Outcomes (COs)

1. Implement legal and professional guidelines for the health professions
2. Apply regulatory codes of ethics in healthcare systems
3. Implement medical device safety aspects based on quality systems requirement
4. Analyze success and failure aspects of bioethics
5. Analyze the need of sustainable bioethics

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1		2	2	2				3			2	2		1	
2		2	2	2				3			2	2		1	
3		2	2	2				3			2	2		1	
4		3	2	2				3			2	2		1	
5		3	2	2				3			2	2		1	

UNIT I **9 Hours**

INTRODUCTION TO MEDICAL ETHICS

Definition of Medical ethics, Scope of ethics in medicine, International code of Ethics for occupational health professionals, Ethical Theories, Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Role of ethics in Healthcare workplace, Autonomy, Non Malfeasance, Beneficence, Veracity, Justice, OSHA, Decision Model for Healthcare Dilemmas, Applications of Plus decision making model.

UNIT II **9 Hours**

CODE OF ETHICS FOR BIOMEDICAL ENGINEERS

Bioethics-The principle of Double effect, Code of Hammurabi, Engineering Competence, Ethical Issues in biomedical research Cloning and stem cell research, Neuro ethics, Organ Transplantation, Hypothetico deductive method, Research Conflict of Interest.

UNIT III **9 Hours**

MEDICAL DEVICE SAFETY

Shared Responsibility for Medical device safety. WHO International Health Regulations (IHR), Stages of regulatory control of medical devices, Ethics committee, its members and functions, Global Harmonization Task Force (GHTF). Quality systems requirement, ISO, Voluntary and mandatory standards, Collateral Standards EMC radiation protection & programmable medical device system, Particular Standards-type of medical device.

UNIT IV **9 Hours**

BIOETHICAL SUCCESS AND FAILURE

Measurements of success and Failure, Technological Success and failure, Risk as a bioethical concept, Safety, risk and reliability in design, Reliability An ethics metric, reducing risk, risk as an ethical concept, risk based ethics. Medical device failure, Five failure types, Bio-terrorism.

UNIT V **9 Hours**

SUSTAINABLE BIOETHICS

Introduction to Sustainable Bioethics Rational ethics, Life cycles and Concurrent Engineering, Bioethics of Combustion, Systematic Bioethics Seveso Plant disaster, Poverty and Pollution, Interdependence, Macro ethics and Micro ethics, The Humble Engineer.

Total: 45 Hours

Reference(s)

1. William Charney, Handbook of Modern Hospital Safety, CRC Press, 2nd Edition, 2009.
2. AlmiraBadnjevic, Mario Cifrek, RatkoMagjarevic, ZijadDzemic, Inspection of Medical Devices: For Regulatory Purposes, Springer Nature, 2018.
3. Daniel A Vallero, Biomedical Ethics for Engineers, Elsevier Publications, 1st Edition, 2007.
4. Eileen E. Morrison, Ethics in Health Administration: A Practical Approach for Decision Makers, Jonnes and Bartletts Publication, 2nd Edition, 2011.
5. Robert M Veatch, Basics of Bio Ethics, Prentice Hall, Inc., 2nd Edition, 2003

21BM033 PATIENT SAFETY AND STANDARDS

3 0 0 3

Course Objectives

- To introduce the safety procedures in healthcare organizations
- To familiarize the Health care organization structure and responsibilities
- To explore the safety standard to be followed in hospitals

Course Outcomes (COs)

1. Apply safety procedures in healthcare organizations
2. Apply safety norms in different departments in healthcare sector according to their working environments
3. Analyze the Health care organization structure and the responsibilities of different levels to implement safety
4. Analyze the regulatory standards for medical device maintenance
5. Outline the accreditation protocols for a hospital and its safety standards

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1		2	2	2		1		2				1		2	
2		2	2	2		1		2				1		2	
3		3	2	2		1		2				1		2	
4		3	2	2		1		2				1		2	
5		2	2	2		1		2				1		2	

UNIT I **9 Hours**

INTRODUCTION

Guidelines and safety practices for improving patient safety, Human error and patient safety, safer care, patients for patient safety, Human factors, patient safety from the perspective of medical residents, patient safety in the world, Infection prevention and control, Adverse event investigation and Risk assessment.

UNIT II **9 Hours**

PATIENT SAFETY IN DIFFERENT HEALTHCARE DEPARTMENTS

Patient safety in Intensive care and Anaesthesiology, Safe surgery, Emergency department clinical risk, obstetric safety patient, patient safety in internal medicine, risks in oncology and radiation therapy, patient safety in orthopaedics and Traumatology, patient safety in paediatrics, patient safety in paediatrics and ophthalmology.

UNIT III **9 Hours**

HEALTH ORGANIZATION

Community and Primary Care, Complexity Science as a Frame for Understanding the Management and Delivery of High Quality and Safer Care, Measuring Clinical Workflow to Improve Quality and Safety, shift work Organization, Non-technical Skills in Healthcare, Medication Safety, Digital Technology and Usability, Coping with the COVID-19 Pandemic: Roles and Responsibilities for Preparedness.

UNIT IV **9 Hours**

REGULATORY STANDARDS FOR MEDICAL DEVICE MAINTENANCE

International Standards, Medical Device Directive 93/42/EEC, Medical Electrical Equipment ISO 60601, Safety Testing of Medical Devices ISO 62353, Medical Device Inspection ISO17020. Indian Standards, National Health Mission, Biomedical Equipment Management and Maintenance Program (BMMP), ISO 9001-2008, AERB Compliance, Radiation protection.AE(RP)R-2004, Safety Code AE/RF-MED/SC-3.

UNIT V **9 Hours**

HOSPITAL ACCREDITATION AND SAFETY STANDARDS

Accreditation, JCI Accreditation & its Policies. Life Safety Standards- Protecting Occupants, Protecting the Hospital and Individuals from Fire, Smoke, and Heat. Managing Hazardous Medical Material and Waste, Laboratory and Radiation safety, Health and safety hazards of shift work. Patient Safety, Human factors, Reliability, Evidence based Medicine, Root cause Analysis.

Total: 45 Hours

Reference(s)

1. Donaldson L, Ricciardi W, Sheridan S, Tartaglia R, editors. Textbook of Patient Safety and Clinical Risk Management [Internet].
2. Cham (CH): Springer; 2021. PMID: 36315660.
3. William Charney, Handbook of Modern Hospital Safety, CRC Press, 2nd Edition, 2009.
4. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, Inspection of Medical Devices: For Regulatory Purposes, Springer Nature, 2018

21BM034 MEDICAL DEVICE REGULATIONS 3 0 0 3

Course Objectives

- To introduce the regulations in medical device design
- To discuss the regulations of medical device design in various medical industries

Course Outcomes (COs)

1. Understand the basic concepts of medical device regulations
2. Apply the global policies on medical device regulations
3. Analyze implications of the regulations
4. Analyze the Standards and Regulations used for medical devices
5. Analyze the software and Quality system regulation in medical device design

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1		2		2		1	1	2				1	1	2	
2		2		2		1	1	2				1	1	2	
3		3		2		1	1	2				1	1	2	
4		3		2		1	1	2				1	1	2	
5		3		2		1	1	2				1	1	2	

UNIT I **9 Hours**

INTRODUCTION

Defining the device, Overview of quality function deployment, Business proposal Reliability: Definition, Quality Vs Reliability Vs Unreliability, Types of Reliability, Optimizing reliability, Reliability's effects on medical devices. Concept of Failure: Causes of Failure, Practical aspects of failure, Failure rates, Hardware failure, Software Failure. Safety and Risk Management: Medical device safety and risk management, Effectiveness/performance of medical devices, Phases in the life span of a medical device

UNIT II **9 Hours**

DRUG MANUFACTURING PRACTICES

Global Harmonization Task Force (GHTF): Objectives, Scope of the four GHTF study groups, Benefits of the GHTF, Global Medical Device Nomenclature (GMDN) The Food and Drug Administration: Device classification, Registration and listing, The 510 (k) Process, Declaration of conformity, The PMA application, Investigational Device Exemptions (IDEs), Good Manufacturing Practices(GMPs).

UNIT III **9 Hours**

MEDICAL DEVICE DIRECTIVES

The European Union: European Directives, European Standardization Bodies, European Standards Development Process, Other European Standards Considerations, Conformity Assessment and Testing, European Organization for Testing and Certification. The Medical Devices Directives: Process, Choosing the appropriate directive, Identifying the applicable essential requirements

UNIT IV **9 Hours**

STANDARDS AND REGULATIONS

Standards and Regulation: Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of Standards

UNIT V **9 Hours**

SOFTWARES AND QUALITY SYSTEM REGULATIONS

Software and Quality system regulation: Software as a Technology, Domestic and International Software Regulations and Standards. Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, Corrective and preventive action

Total: 45 Hours

Reference(s)

1. Michael Cheng, Medical Device Regulations Global Overview and Guiding Principles, World Health Organization, 2003.

2. Des O'Brien , Medical Device Regulations Roadmap A Beginners Guide, Create Space Independent Publishing Platform, 2017.

3. Aakash Deep, Medical Device Regulations A Complete Guide, Elsevier Science, 2022.

4. Jack Wong, Raymond Tong, Jenny Stanford Publishing Handbook of Medical Device Regulatory Affairs in Asia, Second Edition, 2018.

5. G.R Higson, Medical Device Safety, The Regulation of Medical Devices for Public Health and Safety, 2001.

21BM035/ 21BMH05 FORENSIC SCIENCE IN HEALTHCARE

3 0 0 3

Course Objectives

- To explain the basic principles of forensic science, crime and criminal justice system, police organization, the role of investigator and tools and techniques used in crime science
- To emphasize the importance of scientific methods in crime identification and detection.
- To deal with the modus operandi and role of modus operandi bureau in crime investigation

Course Outcomes (COs)

1. Understand the principles and laws of Forensic Science in Forensic Examination
2. Apply the scientific tools and techniques to the investigation of crimes
3. Outline the Criminal Justice System and Police organization in India
4. Analyse the forensic evidences in crime scene and the role of investigator in sketching and examination of crime scene
5. Analyse and examine the modus operandi and role of modus operandi bureau in crime investigation

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1		2		1		2		3				1			
2		2		2		2		3				1			
3		2		2		2		3				1			
4		3		2		2		3				1			
5		3		2		2		3				1			

UNIT I **9 Hours**

INTRODUCTION TO FORENSIC SCIENCE

Introduction, Definition, Principles, Laws of Forensic Science, Historical Background of Forensic Science in India, Need of Forensic Science in present scenario, Organizational set up of Forensic Science Laboratories at state and central level, their types and Divisions, Forensic Examination.

UNIT II **9 Hours**

TOOLS AND TECHNIQUES IN FORENSIC SCIENCE

Branches of Forensic Science, Forensic science in international perspectives, including set up of INTERPOL and FBI, Duties of Forensic Scientists, Code of conduct for Forensic Scientists, Qualifications of Forensic Scientists, Data depiction, Report writing

UNIT III **9 Hours**

CRIME AND POLICE ORGANIZATION

Definition, types of crime, causes of crime, prevention of crime, Difference in blue and white collar crime, Introduction of Cyber crime, Criminal Justice System, Organizational set up of Police at central and state level, Functions of Police, Functions of Police in analyzing a crime scene, Different paramilitary forces in India

UNIT IV **9 Hours**

CRIME SCENE

Introduction, Significance Role of Investigator, Evaluation of crime scene, protection of crime scene, Photography of Crime scene, Tools and techniques, Significance of Photography and Videography, Introduction of Sketching, Purpose of Sketching, Making of Sketches

UNIT V **9 Hours**

FORENSIC EVIDENCES AND ANALYSIS AND MODUS OPERANDI

Hair analysis, Fiber analysis, Ballistics & Tool marks: Soil, Glass and Paint, Footprints and tyre impressions, Bite Marks, Finger prints, Blood Spatter Analysis, DNA analysis, Forensic Anthropology and Entomology, Investigation & examination procedure of various types of cases, Murder, Burglary, Railway & Air Crashes, Road Accidents etc.

Total: 45 Hours

Reference(s)

1. W.J. Tilstone, M.L. Hastrup and C. Hald, Fishers, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
2. Saferstein, Richard. Criminalistics An Introduction to Forensic Science, 11th ed. Prentice Hall, Saddle River, NJ. 2011
3. H.B. Baldwin and C.P. May in, Encyclopedia in Forensic Science, Volume 1, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).
4. V.J. Geberth, Practical Homicide Investigation, CRC Press, Boca Raton (2006).
5. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).

21BM036 / 21BMH06 CLINICAL ENGINEERING 3 0 0 3

Course Objectives

- To provide a basic understanding of the clinical engineering profession, qualifications, roles, activities, and expectations
- To practice medical equipment and analyze challenges with their healthcare technology
- To explore the Health Technology Management systems with medical devices and supportive services with advanced application.

Course Outcomes (COs)

1. Assess the roles and responsibilities of Clinical Engineering in healthcare
2. Apply Engineering knowledge to in medical technology management practices
3. Analyse the impact of health care technology package (EHTP) in healthcare
4. Analyse clinical engineering program indicators
5. Outline the advances technologies implementation for patient safety

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	3	2	2				1				1	1	1	1
2	2	2	3	2				1				1	1	1	1
3	2	3	2	2				1				1	2	1	1
4	2	3	2	2				1				1	2	1	1
5	2	2	2	2				1				1	2	1	2

UNIT I **9 Hours**

INTRODUCTION

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System, Enhancing patient safety.

UNIT II **9 Hours**

MEDICAL TECHNOLOGY MANAGEMENT PRACTICES

Strategic Medical Technology Planning, Scope , Clinical necessity operational support, strategic planning process Technology assessment: Technology audit, Budget strategies, Prerequisite for medical technology assessment, Management Practice for Medical Equipment, Device evaluation, Risk reduction, Asset management, ESHTA

UNIT III **9 Hours**

ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP)

Introduction, Health care technology management, Package development: Methodology, Logical framework, Implementation, Information promotion and dissemination, EHTP Justification, EHTP matrix, EHTP advantages, Impact Analysis

UNIT IV **9 Hours**

CLINICAL ENGINEERING PROGRAM INDICATOR

Clinical engineering: program services, Program database, Clinical Engineering Program management, Program indicator, Managing clinical engineering performance using program indicators, Indicator management process

UNIT V **9 Hours**

ADVANCED TECHNOLOGY FOR PATIENT SAFETY

Factors Contributing to Medical Errors: Heath Care Reimbursement, Health Care Failure Mode and Effect Analysis (HFMEA), Patient Safety Best Practices Model Bar coding, Computerized Physician Order Entry (CPOE), and Clinical data repositories, Process analysis, Methodology. Computerized medical equipment management systems.

Total: 45 Hours

Reference(s)

1. Ernesto Iadanza, Joseph Dyro, Clinical Engineering Handbook, Elsevier Academic Press, 2014
2. Robert Miniati, Clinical Engineering from Devices to Systems, Academic Press, 23-Dec-2015 - Technology & Engineering
3. Ernesto Iadanza, Clinical Engineering Handbook, 2nd Edition, Elsevier, Academic Press, November 2019, ISBN 9780128134672
4. Jacobson B and Webster J G Medical and Clinical Engineering Prentice Hall of India New Delhi 1999
5. Cesar A. Cacere& Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersy, 1979.

21BM037/21BMH03 MEDICAL DEVICE DESIGN 3 0 0 3

Course Objectives

- Students will be able to know about the Medical product design and development
- Patient safety and regulatory aspects followed in hospitals
- Professional ethics to be followed by Biomedical Engineers

Course Outcomes (COs)

1. Implement Good Design Practice in medical product design
2. Apply appropriate methodologies for Product development
3. Analyse important regulatory schemes to be followed in medical device design
4. Apply testing, validation and market analysis for developed product
5. Analyse challenges in converting innovation into product in Healthcare sector

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1		3	2	1				1				2		2	
2		2	2	2				1				2		2	
3		3	2	2				1				2		2	
4		3	2	2				1				2		2	
5		2	2	2				1				2		2	

UNIT I **9 Hours**

INTRODUCTION TO MEDICAL PRODUCT DESIGN

Definition, History and Modern Practice, Designs; Design and Product Life Cycle, Design Process, Understanding the innovation cycle, Good Design Practice. Understanding, analysing and validating user needs, Screening Needs, Technical Requirements, Concept Generation, Innovation Survey Questionnaire, Morphological Matrix, QFD, Concept Analysis and validation, Concept Modelling, Concept Screening & Validation.

UNIT II **9 Hours**

PRODUCT DEVELOPMENT

Breakthrough Products, Platform Products, Front End of Innovations, Fuzzy Front End, Generic Product Development Process, Variants of Development Processes, Good Documentation Practice, and Prototyping Specifications, Prototyping, Medical Device standards, Quality management systems (ISO 13485), Medical Device Classification, Design of Clinical Trials.

UNIT III **9 Hours**

REGULATORY SCHEMES

Design Control & Regulatory Requirements, Documentation in Medical Devices, Regulatory pathways, Biomedical Evaluation of Medical Devices, ISO Medical Devices, Applications of Risk Management to Medical Devices (ISO 14971), Electrical Safety Standard, IEC60601-1, IEC60601-2, IEC60601-6, Protection of Electrical and Electronic Parts, Assemblies and Equipments (ESD S20.20-2014).

UNIT IV **9 Hours**

SCALABLE PRODUCT DEVELOPMENT

Design for manufacturing, Design for assembly, Design for Serviceability, Design for usability, Medical Device Verification & Validation, Product Testing & Regulatory compliance, Clinical trial & validation, Device Certification.

UNIT V **9 Hours**

PRACTICAL CHALLENGES ON MEDICAL DEVICE DEVELOPMENT

Product life cycle, challenges in Practicing International Regulatory Requirements, Risk Management: Integration of Risk Management into the supporting QMS, Use of Codes to Identify Medical Devices, Application of Risk Management throughout product life cycle.

Total: 45 Hours

Reference(s)

1. John G. Webster, Medical Instrumentation: Application and Design, 5th Edition, June 2020
2. Peter J. Ogrodnik, Medical Device Design: Innovation from Concept to Market, Academic Press is an imprint of Elsevier, 1st edition 2013
3. Paul H. King, Richard C. Fries, Arthur T. Johnson, Design of Biomedical Devices and Systems, CRC Press, Tailor and Francis Group, 3rd Edition, 2015
4. Andres D. Lantada, Handbook on Advanced Design and Manufacturing Technologies for Biomedical Devices, Springer London 2013
5. Paul G. Yock, StefanosZenios, Joshua Makower, Todd J. Brinton, Uday N. Kumar, F. T. Jay Watkins, Lyn Denend, Thomas M. Krummel, Christine Kurihara, Biodesign: The Process of Innovating Medical Technologies, Cambridge University Press; 2nd edition, 2 February 2015

21BM038 /21BMH04 MEDICAL EQUIPMENT MAINTENANCE AND TROUBLESHOOTING

3 0 0 3

Course Objectives

- To troubleshoot and quality control in medical equipment for biomedical engineering students
- To provide knowledge about the troubleshooting of various equipment used in hospitals and quality standard of medical equipment

Course Outcomes (COs)

1. Apply the common troubleshooting procedures in testing electronic equipment
2. Analyze and identify the fault in given analog and digital circuits using appropriate procedures
3. Apply troubleshooting procedures to find faults in medical equipment
4. Asses the quality of medical devices by applying suitable procedures
5. Analyse medical device regulation procedure in device design

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1		2		3									1	2	
2		3		3									1	2	
3		2		3									1	2	
4		3		3				2					1	2	
5		2		3				2					1	2	

UNIT I **9 Hours**

FUNDAMENTAL TROUBLESHOOTING TESTING PROCEDURES

Equipment failure and its causes, Functional block diagram of a troubleshooting system, troubleshooting process & fault finding aids, troubleshooting techniques and their correction action, Testing of active and passive components: resistor, capacitor, inductor, BJT, JFET, & MOSFET

UNIT II **9 Hours**

FAULT DIAGNOSIS IN INTEGRATED CIRCUITS

Characteristics of ideal op amps, typical op amp based medical circuits, Fault diagnosis in op amp circuits, Digital troubleshooting methods, Digital IC Trouble shooters, logic clip, logic probe, logic pulser, logic current tracer, logic comparator, Circuit board Troubleshooting.

UNIT III **9 Hours**

BIOMEDICAL EQUIPMENT TROUBLESHOOTING

Troubleshooting- ECG Machine, EEG Machine, defibrillator, electrosurgical unit, anaesthesia machine, autoclaves & sterilizers, endoscope, incubators, nebulizer, oxygen concentrators, sphygmomanometers, suction machine, X ray machine.

UNIT IV **9 Hours**

MEDICAL DEVICE DESIGN QUALITY

Definition of quality, essence of quality, Quality operating system and the device life cycle, Evolution of quality, Business excellence: a value proposition, Health care quality.

UNIT V **9 Hours**

DESIGN FOR SIX SIGMA AND MEDICAL DEVICE REGULATION

Global Perspective on medical device regulations, medical device classification (USA, Europe & GHTF). Medical device safety, medical device quality management systems requirements, Medical device regulation throughout the product development life cycle, Purpose of ISO 9001:2001&ISO 13485.

Total: 45 Hours

Reference(s)

1. Khandpur R S, Troubleshooting Electronic Equipment- Includes Repair & Maintenance, Tata McGrawHill, 2nd edition, 2009.
2. Basem S EL-Haik& Khalid S Mekki, Medical Device Design for Six Sigma: A Road Map for Safety and Effectiveness, John Wiley & Sons, 1st edition, 2008
3. Nicholas Cram & Selby Holder, Basic Electronic Troubleshooting for Biomedical Technicians, TSTC Publishing, 2nd edition, 2010.
4. Dan Tomal& Neal Widmer, Electronic Troubleshooting, McGraw Hill, 3rd edition, 2004.
5. World Health Organisation, Maintenance & Repair of Laboratory, Diagnostic imaging & Hospital Equipment, Geneva, 1994.

21BM039 ADVANCED BIOSENSORS 3 0 0 3

Course Objectives

- To familiarize with the concepts of biosensors
- To Study the operating principle of transducers for measurement of physical quantities
- To Study the operating principle of optical sensors

Course Outcomes (COs)

1. Assess the static, dynamic characteristics and errors associated with given sensor/Transducer
2. Apply suitable sensor to measure physical industrial quantities
3. Assess the working principle of a given biosensor
4. Apply suitable biosensors in healthcare applications
5. Integrate advanced sensing technologies for improved sensing accuracy

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	3	2										2	2	
2	2	2	2	2									2	2	
3	1	3	2										2	2	
4	1	2	2	2		2							2	2	
5	1	3	2	3									2	2	

UNIT I **9 Hours**

INTRODUCTION

Transducer Introduction, Definition, Classification and Characteristics of transducers, Selection criteria, Static Characteristics, Dynamic Characteristics, Standards, Calibration, types, Need for Calibration.

UNIT II **9 Hours**

TRANSDUCERS FOR MEASUREMENT OF PHYSICAL QUANTITIES

Strain Gauge: Principle, Classification, Gauge factor, Derivation, Load cell: Principle, Construction and Operation, LVDT: Principle, Construction and Operation, Piezoelectric Sensor: Principle, Construction and Operation, Medical applications of Piezoelectric sensors, Flex sensors: Principle, Construction and Operation, Hall effect transducer: Principle, Construction and Operation and Applications.

UNIT III **9 Hours**

PRINCIPLES OF BIOSENSORS

Biosensors: Definition, Block diagram, Genesis of Biosensors, Classification of Biosensors, Types, Immobilization of Bio receptor, Enzyme immobilization, Biocatalysts based biosensors: Introduction, principle, Glucose biosensor: Principle, Construction and Operation, Bioaffinity based sensor: Principle, Microbe biosensor: Principle, Construction and Operation.

UNIT IV **9 Hours**

APPLICATIONS OF BIOSENSORS

Electrochemical biosensor: Principle, Construction and Operation, Biosensors for pathogen detection, Biosensors for cancer detection, Saliva based biosensors, DNA Biosensors, Biochips, Biosensors for environmental monitoring, Biosensors for disaster management, Futuristic approach of Biosensors.

UNIT V **9 Hours**

ADVANCE IN SENSING TECHNOLOGIES

Smart Sensors: Introduction, Need, Architecture, Salient features, Lab on Chip (LoC): Architecture, e-Nose: System description, OFC: Introduction, Total Internal reflection, Concepts of SPR, SPR sensors, Evanescence Sensor: Concepts, Grating sensors: principle and applications.

Total: 45 Hours

Reference(s)

1. Sawhney A.K, A Course in electrical and electronic measurements and instrumentation, Dhanpat Rai & Co (P) Ltd, Educational and Technical Publishers, 19th Revised edition 2011, Reprint 2014.
2. Patranabis D, Sensors and transducers, PHI, 2nd edition, 2004
3. Murty DVS, Transducer and instrumentation, PHI, 2nd edition, 2010.
4. U.A. Bakshi, A.V. Bakshi, Measurements and instrumentation, Technical Publications, 3rd revised edition, 2010
5. Paras N, Prasad, Introduction to biophotonics, John Wiley & Sons, 1st edition, 2003

21BM040 DRUG DELIVERY SYSTEM 3 0 0 3

Course Objectives

- To explain the basic principles for development of novel drug delivery systems.
- To emphasize the importance of various drug delivery systems and their usage in hospitals.
- To deal with the formulation and evaluation of Novel drug delivery systems

Course Outcomes (COs)

1. Apply Ficks laws for controlled drug delivery systems
2. Design and analyze the technology based CR systems
3. Apply biomaterial knowledge to design implantable therapeutic systems
4. Analyse transdermal drug delivery evaluation and implementation process
5. Analyse the modern technology to facilitate targeted drug delivery

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1		2	2			1						1	2	2	
2		2	3	2		1						1	2	2	
3		2	2	2		1						1	2	2	
4		3	2	2		1						1	2	2	
5		3	2	3		1						1	2	2	

UNIT I **9 Hours**

CONTROLLED DRUG DELIVERY

Fundamentals of Controlled Release (CR) Drug Delivery, Rationale of sustained/controlled drug delivery, Physicochemical and biological factors influencing design and performance of CR products, therapeutic status of CDDS. Theory of mass transfer, Ficks first and second laws and their applications in drug release and permeation. Pharmacokinetic and pharmacodynamic basis of controlled drug delivery, bioavailibility assessment of CR systems.

UNIT II **9 Hours**

DESIGN AND FABRICATION OF TECHNOLOGY BASED CR SYSTEMS

Strategies and design of oral controlled release delivery systems, oral systems based on dissolution, diffusion and dissolution, Ion exchange resins, Ph independent formulations, altered density formulations, Bucco/mucoadhesive systems. Osmotic controlled oral drug delivery, Feedback regulated Drug Delivery Systems

UNIT III **9 Hours**

PARENTERAL SYSTEM

Parenteral systems, biopharmaceutic considerations, design and development, polymeric microspheres, dispersed drug delivery, Implantable therapeutic systems, Biocompatibility of polymers and carriers, Intrauterine devices and intravaginal devices

UNIT IV **9 Hours**

TRANSDERMAL DRUG DELIVERY SYSTEM

Transdermal therapeutic systems (TTS) Drug absorption through skin, permeation enhancers, basic components of TTS, Approaches to development and kinetic evaluation, Testing of transdermal patches, pressure sensitive adhesives, Iontophoresis, Sonophoresis and electroporation. Formulation and evaluation of TTS

UNIT V **9 Hours**

TARGETED DRUG DELIVERY

History concept, Types and key elements, ideal carrier system and approach with special reference to organ targeting (e.g. brain, tumor, lung, liver and lymphatics), Basics of temperature, pH and magnetically induced targeting tactics. Vaccine delivery systems

Total: 45 Hours

Reference(s)

1. Tozer T N, Rowland M, Introduction of Pharmacokinetics and Pharmacodynamics The Quantitative Basis of Drug Therapy, Williams & Wilkins, 2006.
2. Howard C. Ansel, NIcholos G. Popvich, lyold V. Allen , Pharmaceutical dosage forms and Drug Delivery system, 1st edition, 2014.
3. Jain N.K and Sharma S.N. A text book of professional pharmacy, 1st edition 1995.
4. Samuel Harder and GlennV. Buskirk. Pilot Plant Scale-Up Techniques. In The Theory and Practice of Industrial Pharmacy. 3rd edition., 1991
5. Remington, The Science and Practice of pharmacy, 20 th Edn, vol.I, pg.no.903- 913.

21BM041 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

3 0 0 3

Course Objectives

- To instil knowledge on the EMI coupling mechanism and its mitigation techniques
- To impart comprehensive insight about the current EMC standards
- To acquire knowledge on various measurement techniques for EMI mechanisms

Course Outcomes (COs)

1. Assess the impact of electromagnetic interference and its effects in human
2. Apply the suitable coupling mechanisms to reduce electromagnetic interference and compatibility
3. Apply appropriate methods to assess the electromagnetic interferences
4. Analyse the standards and regulations to be followed in electromagnetic interference generating systems
5. Apply instrumentation knowledge to test electromagnetic interferences

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	3	2	2				1				1	1	3	
2	1	2	2	2				1				1	1	2	
3	1	2	2	2				1				1	1	3	
4	1	3	2	2				1				1	1	3	
5	1	2	2	2				1				1	1	2	

UNIT I **9 Hours**

BASIC CONCEPTS

Definition of EMI and EMC, Intra and Inter system EMI, Sources and victims of EMI, Conducted and Radiated EMI emission and susceptibility, Transient & ESD, Case Histories, Radiation Hazards to humans.

UNIT II **9 Hours**

COUPLING MECHANISM

Common made coupling, Differential mode coupling, Common impedance coupling, Ground loop coupling, Field to cable coupling, Cable to cable coupling, Power mains and Power supply coupling.

UNIT III **9 Hours**

EMI MITIGATION TECHNIQUES

Shielding - principle, choice of materials for H, E and free space fields, and thickness, EMI gaskets, Bonding, Grounding circuits, system and cable grounding, Filtering, Transient EMI control devices and applications, PCB Zoning, Component selection, mounting, trace routing.

UNIT IV **9 Hours**

STANDARDS AND REGULATION

Units of EMI; National and International EMI Standardizing Organizations - IEC, ANSI, FCC, CISPR, BIS, CENELEC; FCC standards; EN Emission and Susceptibility standards and specifications; MIL461E Standards.

UNIT V **9 Hours**

EMI TEST METHODS AND INSTRUMENTATION

EMI test sites - Open area site; TEM cell; Shielded chamber; Shielded Anechoic chamber; EMI test receivers; Spectrum Analyzer; Transient EMI Test wave Simulators; EMI coupling Networks - Line impedance Stabilization Networks; Feed through capacitors; Antennas and factors; Current probes and calibration factor; MIL-STD test methods; Civilian STD Test methods, Government policies.

Total: 45 Hours

Reference(s)

1. V.P. Kodali, Engineering EMC Principles, Measurements and Technologies, IEEE Press, Network, 2nd Edition, 2010.
2. Henry W.Ott., Noise Reduction Techniques in Electronic Systems, A Wiley Inter Science Publications, John Wiley and Sons, Network, 2009.
3. layton Paul, Introduction to Electromagnetic Compatibility, Wiley Interscience, 2006.
4. Daryl Gerke and William Kimmel, EDNs Designers Guide to Electromagnetic Compatibility, Elsevier Science and Technology Books, 2002.
5. Dr Kenneth L Kaiser, The Electromagnetic Compatibility Handbook, CRC Press 2005.

21BM042 INTERVENTIONAL AND DIAGNOSTIC RADIOLOGY

3 0 0 3

Course Objectives

- To impart knowledge on the radiation techniques
- To impart comprehensive insight about the interventional radiology in different medical field
- To acquire knowledge on various practices in diagnostic radiology

Course Outcomes (COs)

1. Assess the interaction of radiation with tissue
2. Apply radiology role in various diagnosis procedures
3. Apply radiology in vascular and gastrointestinal track
4. Apply radiology in traumatology
5. Analyze radiology in other organ system diagnosis and treatment

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	2				1				1	3	2	
2	1	2	2	2				1				1	3	2	
3	1	2	2	2				1				1	3	2	
4	1	2	2	2				1				1	3	2	
5	1	3	2	2				1				1	3	2	

UNIT I **9 Hours**

INTRODUCTION

Introduction – Physical basics: Types of radiation, structure of matter and radioactive decay, interaction of radiation and matter, measurement of radiation, The effect of radiation on biological tissue: phases of radiation, radiation damage to the cell, the acute effect of radiation on human body, the chronic effect of radiation, carcinogenesis, the dangers of X-Rays

UNIT II **9 Hours**

RADIOLOGICAL DIAGNOSTIC PROCEDURES

Review of conventional diagnostic radiography: CT, MRI, Angiography and interventions, Ultrasound, contrast agent, Introduction to Neuroradiology: The brain and spinal cord, Mammography imaging and interventional diagnosis of the mammary gland using X-Ray mammography, Breast Sonography and MR mammography.

UNIT III **9 Hours**

INTERVENTIONAL RADIOLOGY IN VASCULAR AND GASTROINTESTINAL TRACK

Vascular diagnostics and interventional techniques, vascular interventional therapy, arterial access of angiography and intervention, arterial thrombolysis and mechanical thrombectomy, Angioplasty and stenting, stent grafting, Gastrointestinal track: Liver, gallbladder and biliary tree, Pancreas, spleen and gastrointestinal system radiological interventions.

UNIT IV **9 Hours**

INTERVENTIONAL RADIOLOGY IN TRAUMATOLOGY

Traumatology: The basics Traumatology- interventional diagnosis: site specific trauma-inflammatory bone diseases, primary and secondary bone tumours, tumour like lesions and systemic skeletal diseases, Diseases of the joints.

UNIT V **9 Hours**

INTERVENTIONAL RADIOLOGY IN OTHER ORGAN SYSTEMS

Interventional uro-radiology, haemodialysis fistula, Hepatobiliary interventions, Interventional radiology in gynaecology, salivary and lacrimal duct interventions, interventions in chest and interventional radiology in transplantation

Total: 45 Hours

Reference(s)

1. Raman Uberoi, Interventional radiology, Oxford University Press, 2009
2. John A Koufman, Michael J Lee, Vascular and Interventional radiology, Elsevier, 2014
3. Debra A. Gervais, Tarun Sabharwal Diagnostic and Interventional Radiology, Springer ,2016
4. Kieran Murphy, Fergus Robertson, Kieran Murphy, Fergus Robertson, Vascular Springer 2013
5. Interventional Radiology: Fundamentals of Clinical Practice Bradley B. Pua, Anne M. Covey, David C. Madoff, Oxford University Press, 2019

21OCE01 ENERGY CONSERVATION AND MANAGEMENT

3 0 0 3

Course Objectives

- To develop an understanding and analyze the energy data of industries
- To carryout energy accounting and balancing
- To conduct energy audit and suggest methodologies for energy savings and
- To utilize the available resources in optimal ways

Course Outcomes (COs)

1. Classify and characterize the various energy utilization techniques.
2. Identify suitable technique to provide an energy efficient system.
3. Identify the need for thermal systems with latest technologies.
4. Choose suitable techniques doe conserving energy with respect to emerging trends.
5. Assess the impact economics on the conservation of energy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	1										1	3
2	1	3									1	3
3	1	3									2	3
4	1	3	2								3	3
5	1	2	2								1	3

UNIT I **9 Hours**

INTRODUCTION

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

UNIT II **9 Hours**

ELECTRICAL SYSTEMS

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

UNIT III **9 Hours**

THERMAL SYSTEMS

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and Encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

UNIT IV **9 Hours**

ENERGY CONSERVATION IN MAJOR UTILITIES

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

UNIT V **9 Hours**

ECONIMICS

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept .

Total: 45 Hours

Reference(s)

1. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com,a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
3. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
4. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
5. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
6. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987.

3 0 0 3

21OCS01 OBJECT ORIENTED PROGRAMMING

Course Objectives

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

Course Outcomes (COs)

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
5. Design applications using templates and apply exception handling mechanisms

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2			3									
2	1	2	3		3									
3	1	2	2		3									
4	1	2	3		3									
5	1	2	3		3									

UNIT I **8 Hours**

INTRODUCTION

Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading.(sona)

UNIT II **8 Hours**

OBJECTS AND CLASSES

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

UNIT III **9 Hours**

OPERATOR OVERLOADING AND INHERITANCE

Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

UNIT IV **10 Hours**

POLYMORPHISM AND FILE STREAMS

Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer-Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

UNIT V **10 Hours**

TEMPLATES AND EXCEPTION HANDLING

Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

Total: 45 Hours

Reference(s)

1. Deitel & Deitel, C++ How to program, Prentice Hall,2005
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing.

21OCS02 JAVA FUNDAMENTALS 3 0 0 3

Course Objectives

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

Course Outcomes (COs)

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2		2									
2	2	3	2		2									
3	3	3	3		3									
4	2	2	2		2									
5	2	2	2		2									

UNIT I **9 Hours**

BASICS OF JAVA

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

UNIT II **9 Hours**

INHERITANCE, PACKAGES AND EXCEPTIONS

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

UNIT III **9 Hours**

EXPLORING JAVA I/O

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

UNIT IV **9 Hours**

JAVA STRINGS

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

UNIT V **9 Hours**

GUI WITH JAVA

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

Total: 45 Hours

Reference(s)

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

21OCS03 KNOWLEDGE DISCOVERY IN DATABASES

3 0 0 3

Course Objectives

- Introduce the basic concepts of data warehousing.
- Impart knowledge about the data mining functionalities.
- Assess the strengths and weaknesses of association mining and cluster analysis.

Course Outcomes (COs)

1. Explain the concepts of Data Warehousing architecture and business analysis process.
2. Illustrate the process of Data Mining and preprocessing techniques for data cleansing.
3. Apply the association rules for mining the various kinds of data
4. Analyze Classification and Clustering algorithms for various problems with high dimensional data.
5. Illustrate the various data mining techniques on complex data objects

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2													
2	2	3	2											
3	2	2	2											
4	3	2	2	2										
5	2	2	2	2										

UNIT I **9 Hours**

DATA WAREHOUSING AND BUSINESS ANALYSIS

Data warehousing Components -Building a Data warehouse -Data Warehouse and DBMS- Metadata-Multidimensional data model - Data Extraction, Cleanup and Transformation Tools - Reporting, Query tools and Applications - OLAP vs OLTP - OLAP operations - Data Warehouse Schemas: Stars, Snowflakes and Fact constellations.

UNIT II **8 Hours**

INTRODUCTION TO DATA MINING

Introduction - Steps in knowledge discovery from databases process - Architecture of a Typical Data Mining Systems - Data Mining Functionalities - Classification of Data Mining Systems - Data mining on different kinds of data - Different kinds of pattern - Task Primitives - Integration of a Data Mining System with a Data Warehouse - Major issues in Data mining.

UNIT III **9 Hours**

ASSOCIATION RULE MINING

Market Basket Analysis- Frequent Item Set Mining methods: Apriori algorithm - Generating Association Rules - A Pattern Growth Approach- Pattern mining in multilevel and multidimensional space - Mining Various Kinds Of Association Rules - Association Analysis to Correlation Analysis - Constraint Based Association Mining.

UNIT IV **9 Hours**

CLASSIFICATION AND CLUSTERING

Decision Tree Induction - Bayesian Classification - Rule Based Classification - Classification by Back propagation - Support Vector Machines - Clustering: Types of data - Partitioning methods: k-means, k- medoid - Hierarchical Methods: distance based agglomerative and divisible clustering, BIRCH – Density Based Method: DBSCAN - Grid Based Method: STING.

UNIT V **10 Hours**

DATA MINING APPLICATIONS

Mining complex data objects - Text Mining - Graph mining - Web mining - Spatial Data mining -Application and trends in data mining - Social impacts of Data mining.

Total: 45 Hours

Reference(s)

1 Jiawei Han, Micheline Kamber and Jian Pai , Data Mining: Concepts and Techniques, Morgan Kauffman, 3rd Edition, 2013.
2 Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Tata Mcgraw- Hill, 1997.
3 David Hand, Heikki Manila, Padhraic Symth, Principles of Data Mining, MIT Press, 2001.
4 Margaret H.Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2003.

21OCS04 E-LEARNING TECHNIQUES 3 0 0 3

Course Objectives

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

Course Outcomes (COs)

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in e-learning environment.
5. Assess the various applications of e-learning.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2												
2	2	2	3											
3	3	3	3											
4	2	2	2											
5	2	2	2											

UNIT I **9 Hours**

INTRODUCTION

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

UNIT II **9 Hours**

TECHNOLOGIES

Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

UNIT III **9 Hours**

MANAGEMENT

Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

UNIT IV **9 Hours**

TEACHING-LEARNING PROCESS

Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

UNIT V **9 Hours**

APPLICATIONS

Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

Total: 45 Hours

Reference(s)

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.

3 0 0 3

21OCS05 SOCIAL TEXT AND MEDIA ANALYTICS

Course Objectives

- Understand the basic ideas of Text mining.
- Analyze the methods and approaches used in analytics.
- Gain knowledge on various types of analytics like web, social network, and social media

Course Outcomes (COs)

1. Demonstrate the concepts and applications of text mining
2. Explain Content analysis and Sentiment analysis
3. Illustrate web analytics with a suitable model
4. Illustrate social network analytics with suitable example.
5. Illustrate social media analytics with suitable example.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3		2	3									
2	2	3		2	2									
3	2	3		3	3									
4	2	2	2	3	2									
5	2	3		2	3									

UNIT I **7 Hours**

TEXT MINING

Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications.

UNIT II **9 Hours**

METHODS

Content Analysis-Natural Language Processing-Clustering & Topic Detection-Simple Predictive Modeling-Sentiment Analysis; Sentiment Prediction.

UNIT III **9 Hours**

WEB ANALYTICS

Web analytics tools-Clickstream analysis-A/B testing, online surveys-Web search and retrieval-Search engine optimization-Web crawling and Indexing-Ranking algorithms-Web traffic models.

UNIT IV **10 Hours**

SOCIAL NETWORK ANALYTICS

Social contexts: Affiliation and identity - Social network analysis - Social network and web data and methods. Graphs and Matrices - Basic measures for individuals and networks

UNIT V **10 Hours**

SOCIAL MEDIA ANALYTICS

Information visualization - Making connections: Link analysis - Random graphs and network evolution.

Total: 45 Hours

Reference(s)

1. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
2. Hansen, Derek, Ben Sheiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
3. Avinash Kaushik. Web Analytics 2.0: The Art of Online Accountability, 2009.
4. Hanneman, Robert and Mark Riddle. Introduction to Social Network Method, 2005.
5. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.
6. Monge, P. R. & Contractor, N. S. Theories of communication networks. New York: Oxford University, 2003

21OEC04 PRINCIPLES OF COMPUTER COMMUNICATION AND NETWORKS

3 0 0 3

Course Objectives

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

Course Outcomes (COs)

1. Classify the types of computer networks and analyze the seven layers of OSI model.
2. Analyze the basic operations of Routing Algorithms and Routing devices
3. Analyze the local and wide area networking technologies.
4. Apply the ISDN and ATM interface connections in broadband networks.
5. Analyze the security and management techniques related with networks.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	1	2	1	1								
2	1	2	2	3								
3	1	1	2	3								
4	1	1	3									
5	1	2	3	3								

UNIT I **9 Hours**

NETWORK FUNDAMENTALS

Types of Computer Networks: by Area, by Topology; Communication Services: Serial and Parallel, Synchronous and Asynchrounous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

UNIT II **9 Hours**

INTERNETWORKING AND COMPONENTS

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch, Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

UNIT III **9 Hours**

LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

UNIT IV **9 Hours**

BROADBAND NETWORKS

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

UNIT V **9 Hours**

NETWORK SECURITY AND MANAGEMENT

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

Total: 45 Hours

Reference(s)

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schafer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

21OEI01 PROGRAMMABLE LOGIC CONTROLLERS 3 0 0 3

Course Objectives

- To impart knowledge about automation and architecture of PLC
- To understand the PLC programming using timers, counters and advanced PLC functions
- To familiarize the student with PLC based applications

Course Outcomes (COs)

1. Outline the fundamental Concepts of Automation
2. Conclude the architecture, interfacing and communication techniques of PLC
3. Execute the suitable PLC Programming languages
4. Attribute the various functions and instruction sets of PLC
5. Generate a suitable logical programming for given applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1		2	2		3							
2	2	1		2	2		3							
3	2	1		2	2		3							
4	2	1		2	2		3							
5	2	1		2	2		3							

UNIT I **10 Hours**

INTRODUCTION TO AUTOMATION

Evolution of automation -Types of automation - Fixed, flexible and programmable automation - Batch process and continuous process - open loop system and closed loop system - Function of sensors - Proximity sensors: Capacitive and Inductive - Infrared and Laser Push-buttons and toggle switches - Actuators: Solenoid valve - servo motor - electromagnetic relays.

UNIT II **9 Hours**

ARCHITECTURE OF PLC

Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485, Ethernet - Selection criteria for PLC.

UNIT III **8 Hours**

PLC PROGRAMMING

Programming languages - Ladder logic components: User and bit Instructions, branch instructions, internal relay instruction Boolean logic using ladder logic programming, Latching -Timers: On Delay timer, OFF Delay timer and Retentive timer - Counters: Up Counter and Down Counter.

UNIT IV **10 Hours**

ADVANCED PLC FUNCTONS

Instructions in PLC: Program Control Instructions, Math Instructions, Data Manipulation Instructions: Data compare operations, Data transfer operations - Sequencer and Shift register instructions- Analog Instructions: PID Controller - Scaling Instructions.

UNIT V **8 Hours**

APPLICATIONS OF PLC

Case Studies: Bottle filling system - Pick and place robot - Car Parking - Traffic light control (4 ways with pedestrian signal) -Elevators - Pneumatic stamping system - alarm annunciator system.

Total: 45 Hours

Reference(s)

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2015.
2. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, New Delhi, 2014.
3. John Park, Steve Mackay, Edwin Wright, Practical data communications for instrumentation and control, Newnes, Elsevier, 2015.
4. K. L.S. Sharma, Overview of Industrial Process Automation, Elsevier, 2014.
5. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

21OME01 DIGITAL MANUFACTURING 3 0 0 3

Course Objectives

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

Course Outcomes (COs)

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Select appropriate liquid or solid materials based AM process to the respective application
5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	2	2		2								1	2	
2	2	2	2		2								1	2	
3	2	2	2		2								1	2	
4	2	2	2		2								1	3	
5	2	2	2		2								1	2	

UNIT I **9 Hours**

CAD MODELING

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

UNIT II **10 Hours**

AUTOMATION AND CNC MACHINES

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

UNIT III **7 Hours**

ADDITIVE MANUFACTURING

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

UNIT IV **8 Hours**

LIQUID AND SOLID MATERIAL BASED SYSTEMS

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

UNIT V **11 Hours**

POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

Total: 45 Hours

Reference(s)

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015 http://www.springer.com/978-1-4939-2112-6
6. www.grabcad.com, www.all3dp.com

21OME02 INDUSTRIAL PROCESS ENGINEERING 3 0 0 3

Course Objectives

- To impart the knowledge on production planning methodologies and layout design
- To learn about production planning and its control methods
- To provide the knowledge of work study, process charts and ergonomic condition
- To impart the knowledge on inventory control and material handling
- To learn about system analysis and different types of maintenance processes

Course Outcomes (COs)

1. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth operations.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2	3	1		1									2	
2	3	3	1		2						2			2	
3	1	3	3		2									2	
4	2	3	1		2									2	
5	2	3	1		2									2	

UNIT I **9 Hours**

INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer-Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

UNIT II **10 Hours**

PROCESS PLANNING AND PRODUCTION CONTROL

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet.Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

UNIT III **8 Hours**

WORK STUDY AND ERGONOMICS

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles

of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches- seating arrangement, Industrial physiology.

UNIT IV **10 Hours**

INVENTORY MANAGEMENT

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models,ABC analysis, Material Requirement Planning(MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

UNIT V **8 Hours**

SYSTEM ANALYSIS AND MAINTENANCE

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

Total: 45 Hours

Reference(s)

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006
4. Ravi Shankar, Industrial Engineering and Management, Golgotia Publications Pvt. Ltd., New Delhi, 2009

21OME03 MAINTENANCE ENGINEERING 3 0 0 3

Course Objectives

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

Course Outcomes (COs)

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
1	2	2												2	
2	2	2												2	
3					2	2	1							2	
4	1	2	1		2	2	2							2	
5	2	2	2		1	1	1							2	

UNIT I **9 Hours**

PRINCIPLES OF MAINTENANCE PLANNING

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

UNIT II **9 Hours**

MAINTENANCE CATEGORIES AND LUBRICATION

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

UNIT III **9 Hours**

CONDITION MONITORING

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

UNIT IV **9 Hours**

FAILURE ANALYSIS AND REPAIR METHODS

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

UNIT V **9 Hours**

COMPUTER AIDED MAINTENANCE MANAGEMENT

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

FURTHER READING

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

Total: 45 Hours

Reference(s)

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

21OBT01 BIOFUELS 3 0 0 3

Course Objectives

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainabledevelopment
- To give way to the bolster green technology and incline towards more ecofriendly options.

Course Outcomes (COs)

1. Apply thee bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio- refinery

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1		2				3								1
2	2						1								3
3	1						3								2
4	2						3								3
5	1						1								

UNIT I **9 Hours**

CLASSIFICATION AND RESOURCES

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feed stocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

UNIT II **9 Hours**

BIODIESEL

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Trans esterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

UNIT III **9 Hours**

QUALITY BIODIESEL AND ENVIRONMENT

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative andthermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties.

UNIT IV **9 Hours**

BIOETHANOL AND BIOGASES

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, purification - wet and dry milling processes, saccharification-chemical and enzymatic. Production of bio methane and bio hydrogen.

UNIT V **9 Hours**

BIOREFINERIES

Definition and types of bio-refineries, co-products of bio-refineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of bio-refineries.

Total: 45 Hours

Reference(s)

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology,McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer,2007

21OFD01 TRADITIONAL FOODS 3 0 0 3

Course Objectives

- Understand the importance of traditional foods and food habits
- Know the traditional processing of snack, sweet and dairy food products
- Infer the wide diversity and common features of traditional Indian foods and meal patterns.

Course Outcomes (COs)

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1													
2		1												
3	2	1	1											
4								2						
5								2						

UNIT I **9 Hours**

TRADITIONAL METHODS OF FOOD PROCESSING

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

UNIT II **9 Hours**

TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:-Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

UNIT III **9 Hours**

TRADITIONAL FERMENTED FOOD PRODUCTS

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

UNIT IV **10 Hours**

COMMERCIAL PRODUCTION OF TRADITIONAL FOODS

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods -types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

UNIT V **8 Hours**

HEALTH ASPECTS OF TRADIONAL FOODS

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

Total: 45 Hours

Reference(s)

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan,and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.

3 0 0 3

21OFD02 FOOD LAWS AND REGULATIONS

Course Objectives

- Introduce the concept of food hygiene, importance of safe food and laws governing it
- Learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- Understand food inspection procedures employed in maintaining food quality

Course Outcomes (COs)

1. Analyse the food safety strategies and nutritional quality of the food
2. Check the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Understand and apply the voluntary regulatory standards
5. Assess the implementation of food safety for a food processing industry

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1											
2		1				1	2	1						
3		1												
4	1	2												
5	1	2												

UNIT I **10 Hours**

INTRODUCTION

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic resides - inorganic residues and contaminants.

UNIT II **10 Hours**

FOOD LAWS

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

UNIT III **10 Hours**

REGULATIONS

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claims.

UNIT IV **10 Hours**

STANDARDS

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

UNIT V **5 Hours**

IMPLEMENTATION AND RISK ASSESSMENT

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

Total: 45 Hours

Reference(s)

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

21OFD03 POST HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES **3 0 0 3**

Course Objectives

- To understand the importance and different methods of post harvest handling and storage of fruits and vegetables.
- To gain knowledge on different preservation methods of fruits and vegetables
- To familiarize with the value added products from fruits and vegetables

Course Outcomes (COs)

1. Implement the different post harvest handling practices for the storage of fruits and vegetables
2. Analyze the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Evaluate the requirement of low temperature and irradiation methods to preserve specific fruits and vegetables
4. Apply the concentration and fermentation methods to preserve fruits and vegetables
5. Implement the canning method to preserve fruits and vegetables

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2	1			1							
2	1	1												
3	1	2												
4	1		1											
5	2	1	1											

UNIT I **9 Hours**

POST-HARVEST PRACTICES AND PROCESSING

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

UNIT II **9 Hours**

PRESERVATION AND VALUE ADDITION

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

UNIT III **9 Hours**

PRESERVATION BY LOW TEMPERATURE AND IRRADIATION

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

UNIT IV **9 Hours**

PRESERVATION BY DRYING

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

UNIT V **9 Hours**

PRESERVATION BY CANNING

Canning: principles, Types of cans, packing of canned products-preparation of canned products - general considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit- spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations.

Total: 45 Hours

Reference(s)

1. S.Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

21OFD04 CEREAL, PULSES AND OILSEED TECHNOLOGY

3 0 0 3

Course Objectives

- Understand the application of scientific principles in the processing technologies specific to the materials
- Understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- Develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

Course Outcomes (COs)

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2		2		2								
2	1	2		2		1								
3	2	2		1		2								
4	2	3		2		2								2
5	2	2		2		3								

UNIT I **9 Hours**

CEREALS

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut,rolled oats, quick cooking; Traditional and Fermented cereal products.

UNIT II **9 Hours**

OTHER CEREALS AND MILLETS

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

UNIT III **9 Hours**

PULSES AND LEGUMES

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

UNIT IV **9 Hours**

OIL SEEDS AND NUTS

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

UNIT V **9 Hours**

STORAGE AND HANDLING

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

Total: 45 Hours

Reference(s)

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hoseney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

21OFT01 FASHION CRAFTSMANSHIP 3 0 0 3

Course Objectives

- To impart theoretical and practical knowledge about various handi-craft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

Course Outcomes (COs)

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	3				2		2	2		2	2	
2	3	2	3				1		2	3		2	2	
3	3	2	3				2		2	3		2	2	
4	3	2	3				2		2	3		2	2	
5	3	2	3				2		2	3		2	2	

UNIT I **9 Hours**

TECHNIQUES OF HANDICRAFT MATERIALS

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

UNIT II **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - INTERIORS

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

UNIT III **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

UNIT IV **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - ORNAMENTS

Designing and Construction procedures for following various decorative and appealing products: Stone necklace using Macrame Technique, Tribal Jewellery using woollen threads, Floral Jewellery using Resin Technique, Fabric Jewellery using Tie and Dye Technique.

UNIT V **9 Hours**

DECORATIVE AND APPEALING PRODUCTS - FANCY ITEMS

Designing and Construction procedures for following various decorative and appealing products: Jewellery Box, Utility Holder, Gift items. Lampshade decors from cardboard, Driftwood Frames for pictures and Mirrors.

Total: 45 Hours

Reference(s)

1. Handmade in India: A Geographic Encyclopaedia of India Handicrafts. Abbeville press; 1 edition (October 20,2009)
2. Encyclopaedia of Card making Techniques (Crafts), Search Press Ltd, illustrated edition, 2007
3. All about Techniques in Illustration, Barron Educational Series, 2001
4. Printing by Hand: A Modern Guide to printing with Handmade stamps, Stencils and Silk Screens, STC Craft/A Melanie Falick Book, 2008
5. Materials & Techniques in the Decorative Arts: An Illustrated Dictionary, University of Chicago Press, 2000
6. https://www.marthastewart.com/274411/fashion-crafts

21OFT02 INTERIOR DESIGN IN FASHION 3 0 0 3

Course Objectives

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

Course Outcomes (COs)

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	3		-	1							2	
2	3	2	3		2	3		2					3	
3	3	3	3		2	2		2					2	
4	3	3	3		2	3		2					2	
5	3	2			2			3					3	

UNIT I **9 Hours**

INTRODUCTION

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design -Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

UNIT II **9 Hours**

GRAPHICAL PRESENTATIONS

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

UNIT III **9 Hours**

SPACE PLANNING

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

UNIT IV **9 Hours**

INTERIOR COMPONENTS

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

UNIT V **9 Hours**

ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

Total: 45 Hours

Reference(s)

1. Joanna Gaines, Homebody: A guide to creating spaces you never want to leave, Harper design, 2018.
2. Erin gates, Elements of Style: Designing a Home and a life, Simon and Schuster, 2014.
3. Simon Dodsworth, The Fundamentals of Interior Design, AVA publishing, 2009.
4. V. Mary. Knackstedt, The Interior Design Business Handbook: A Complete Guide to Profitability, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, Building Drawing with an Integrated Approach to Build Environment, Tata McGraw Hill, 2002.
6. Https://eclectictrends.com

21OFT03 SURFACE ORNAMENTATION 3 0 0 3

Course Objectives

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

Course Outcomes (COs)

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2					1						
2	2	3	2						2				2	2
3	2	3	2		3								2	2
4	2	2	2						2				2	2
5	2	2	2						2					2

UNIT I **9 Hours**

INTRODUCTION TO SURFACE ORNAMENTATION

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

UNIT II **9 Hours**

HAND EMBROIDERY

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

UNIT III **9 Hours**

MACHINE EMBROIDERY

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

UNIT IV **9 Hours**

EMBELLISHMENT TECHNIQUES

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

UNIT V **9 Hours**

TRADITIONAL EMBROIDERIES OF INDIA AND CARE

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

Total: 45 Hours

Reference(s)

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations,2014
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. http://www.needlenthread.com/tag/hand-embroidery-stitches

21OPH05 PHYSICS OF SOFT MATTER 3 0 0 3

Course Objectives

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supramolecules
- To summarize the soft matter proprties of structures and components of life

Course Outcomes (COs)

1. Identify the salient features of soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Illustrate the structure and properties of liquid crystals
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2	1												
3	2	2												
4	2	2												
5	2	2												

UNIT I **9 Hours**

CONDENSED MATTER

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

UNIT II **9 Hours**

COLLOIDAL DISPERSIONS & GELS

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids.Physical and chemical gels-classical theory of gelation-elasticity of gels

UNIT III **9 Hours**

LIQUID CRYSTALS

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

UNIT IV **9 Hours**

SUPRAMOLECULAR SELF ASSEMBLY

Aggregation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

UNIT V **9 Hours**

SOFT MATTER IN NATURE

Components and structures of life-Nucleic acids-proteins-interaction between proteins-polysaccharides-membranes

Total: 45 Hours

REFERENCES

1. Richard A L Jones, Soft Condensd Matter, Oxford University Press, UK, 2002
2. Masao Doi, Soft Matter Physics,Oxford University Press, UK, 2013.
3. Ian W. Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007
4. A. Fernandez-Nieves, A M Puertas, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016
5. Maurice Kleman, Oleg D. Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

21OCH01 CORROSION SCIENCE AND ENGINEERING

3 0 0 3

Course Objectives

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

Course Outcomes (COs)

1. Explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Calculate the rate of corrosion on metals using electrochemical methods of testing
5. Propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2						1							
3	1	3												
4	2	2												
5	3	3					1							

UNIT I **9 Hours**

CORROSION

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix digrams of Mg, Al and Fe and their advantages and disadvantages

UNIT II **7 Hours**

TYPES OF CORROSION

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

UNIT III **9 Hours**

MECHANISM OF CORROSION

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

UNIT IV **10 Hours**

CORROSION RATE AND ITS ESTIMATION

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

UNIT V **10 Hours**

CORROSION CONTROL METHODS

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control

Total: 45 Hours

Reference(s)

1. Mouafak A. Zaher, "Introduction to Corrosion Engineering", CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, "Introduction to Corrosion Science", Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, "Corrosion Engineering", Tata McGraw Hill, Singapore, 2008
5. David E.J. Talbot (Author), James D.R. Talbot, "Corrosion Science and Technology", Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. http://corrosion-doctors.org/Corrosion-History/Eight.html

21OCH02 POLYMER SCIENCE 3 0 0 3

Course Objectives

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers
- Identify suitable polymers for various industrial applications

Course Outcomes (COs)

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Identify the structure, thermal, and mechanical properties of polymers for different applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	1	2												
3	2	2												
4	1	1	2											
5	1	3	2											

UNIT I **10 Hours**

POLYMERS AND ELASTOMERS

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) -ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene -butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

UNIT II **8 Hours**

POLYMERIZATION TECHNIQUES

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

UNIT III **8 Hours**

CHARACTERIZATION AND TESTING

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

UNIT IV **9 Hours**

POLYMER PROCESSING

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

UNIT V **10 Hours**

SPECIALITY POLYMERS

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

Total: 45 Hours

Reference(s)

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, "Polymer Science", New Age International (P) Ltd., New Delhi, 2021
2. Joel R. Fried, "Polymer Science and Technology", Prentice Hall of India (P). Ltd., 2014
3. F. W. Billmeyer,"Text Book of Polymer Science", John Wiley & Sons, New York, 2008
4. Barbara H. Stuart, "Polymer Analysis", John Wiley & Sons, New York, 2008
5. George Odian , "Principles of Polymerization", John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, "Introduction to Polymers", CRC Press, New York, 2011
7. Common Biocompatible Polymeric Materials for Tissue Engineering and Regenerative Medicine (2019), Materials Chemistry and Physics https://doi.org/10.1016/j.

21OCH03 ENERGY STORING DEVICES 3 0 0 3

Course Objectives

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

Course Outcomes (COs)

1. Find the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Differentiate fuel cells based on its construction, production of current and applications.
4. Compare different methods of storing hydrogen fuel and its environmental applications.
5. Classify the solar cell based on the materials used in it.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1												
2	2	3					1							
3	3	1												
4	2	2					1							
5	3	3					1							

UNIT I **6 Hours**

BASICS OF CELLS AND BATTERIES

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

UNIT II **10 Hours**

BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES

Primary batteries: zinc-carbon - magnesium,and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

UNIT III **10 Hours**

TYPES OF FUEL CELLS

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

UNIT IV **10 Hours**

HYDROGEN AS A FUEL

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

UNIT V **9 Hours**

ENERGY AND ENVIRONMENT

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

Total: 45 Hours

Reference(s)

1. N. Eliaz, E. Gileadi, Physical Electrochemistry, Fundamentals, Techniques and Applications, Wiley, 2019.
2. J. Garche, K. Brandt, Electrochemical Power sources: Fundamentals Systems and Applications, Elsevier, 2018
3. S.P. Jiang, Q. Li, Introduction to Fuel Cells, Springer, 2021.
4. A. Iulianelli, A. Basile, Advances in Hydrogen Production, Storage and Distribution, Elsevier, 2016.
5. M.M. Eboch, The Future of Energy, From Solar Cells to Flying Wind Farms, Capstone, 2020.

21OMA01 GRAPH THEORY AND COMBINATORICS

3 0 0 3

Course Objectives

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

Programme Outcomes (POs)

- Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. Recognize the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	1	2													
2	1	3													
3	2	3													
4	2	3													
5	3	3													

UNIT I **9 Hours**

INTRODUCTION

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

UNIT II **9 Hours**

TREES, CONNECTIVITY

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

UNIT III **9 Hours**

MATRICES, COLOURING AND DIRECTED GRAPH

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

UNIT IV **9 Hours**

PERMUTATIONS

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

UNIT V **9 Hours**

GENERATING FUNCTIONS

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

Total: 45 Hours

Reference(s)

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

21OGE01 PRINCIPLES OF MANAGEMENT 3 0 0 3

Course Objectives

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

Course Outcomes (COs)

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1									2		3				
2									2		2				
3									2		2				
4									3		2				
5									2		2				

UNIT I **9 Hours**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

UNIT II **9 Hours**

PLANNING

Nature and purpose of planning - Planning process - Types of planning – Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

UNIT III **9 Hours**

ORGANISING

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority - Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource - Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

UNIT IV **9 Hours**

DIRECTING

Foundations of individual and group behaviour - Motivation-Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership-types and theories of leadership - Communication-Process of communication - Barrier in communication Effective communication-Communication and IT.

UNIT V **9 Hours**

CONTROLLING

System and process of controlling - Budgetary and non-Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

Total: 45 Hours

Reference(s)

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.

21OGE02 ENTREPRENEURSHIP DEVELOPMENT I 3 0 0 3

Course Objectives

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

Course Outcomes (COs)

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyze the different modes of operation management.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1						1	2		2						
2						1	2		2						
3						1	2		2						
4						1	2		2						
5						1	2		2						

UNIT I **9 Hours**

BASICS OF ENTREPRENEURSHIP

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

UNIT II **9 Hours**

GENERATION OF IDEAS

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

UNIT III **9 Hours**

LEGAL ASPECTS OF BUSINESS

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

UNIT IV **9 Hours**

BUSINESS FINANCE

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

UNIT V **9 Hours**

OPERATIONS MANAGEMENT

Importance – functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

21OGE03 ENTREPRENEURSHIP DEVELOPMENT II **3 0 0 3**

Course Objectives

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

Course Outcomes (COs)

1. Examine the strategies and plans in marketing management.
2. Analyze the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1						1	2		2						
2						1	2		2						
3						1	2		2						
4						1	2		2						
5						1	2		2						

UNIT I **9 Hours**

MARKETING MANAGEMENT

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

UNIT II **9 Hours**

HUMAN RESOURCE MANAGEMENT

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

UNIT III **9 Hours**

BUSINESS TAXATION

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases

UNIT IV **9 Hours**

GOVERNMENT SUPPORT

Industrial policy of Central and State Government, National Institute - NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

UNIT V **9 Hours**

BUSINESS PLAN PREPARATION

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

Total: 45 Hours

Reference(s)

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. http://niesbud.nic.in/agencies.html

21OGE04 NATION BUILDING, LEADERSHIP AND SOCIAL RESPONSIBILITY

3 0 0 3

Course Objectives

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

Course Outcomes (COs)

1. Understand religo-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Acquire a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Acquire awareness about the various types of weapon systems in the Armed Forces.

Articulation Matrix

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	2		1				1					3			
2	2		2				2					2			
3	2		1				1					2			
4	2		3				3					3			
5	2		1				1					2			

UNIT I **9 Hours**

NATIONAL INTEGRATION

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation. Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

UNIT II **9 Hours**

PERSONALITY DEVELOPMENT AND LEADERSHIP

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – copping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

UNIT III **9 Hours**

SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.

Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

UNIT IV **9 Hours**

HEALTH, HYGIENE AND COMMUNICATION

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga-Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.

Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.

COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

UNIT V **9 Hours**

ARMED FORCES AND NCC GENERAL

Introduction to Digital Signal Processors- Basic Classification-Features TMS320C6713 Architecture-Functional Unit-Pipelining- Addressing Modes -Instruction set Simple Assembly Language Program.

Total: 45 Hours

Reference(s)

1. Director General NCC Website: https://indiancc.nic.in/ncc-general-elective-subject-course-design/
2. Grooming Tomorrow's Leaders, published by DG, NCC. https://indiancc.nic.in/
3. Youth in Action, published by DG, NCC. https://indiancc.nic.in/
4. The Cadet, Annual Journal of the NCC. https://indiancc.nic.in/
5. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material. https://indiancc.nic.in/

19BM0XA 3D PRINTING 1 0 0 1

Course Objectives

- Understand the basics of 3D printing in engineering fields.
- Explain the concepts of 3D printing in the field of Biomedical Engineering
- Professional ethics to be followed by Biomedical Engineers.

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. 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.
m. Apply science, technology, engineering and mathematical knowledge for solving problems in health care
n. Identify appropriate design principles to provide solutions for biomedical needs.
o. Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

Course Outcomes (COs)

1. Represent the 3D printing technologies and its basics.
2. Analyse various types of softwares and operating procedures of 3D printing.
3. Implement different methods of 3D printing in applications of Biomedical Engineering.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	2	1	2		2							1	2	2	1
2	1	2	2		2							1	2		
3	2	2	1		2							1	2	2	1

UNIT I **15 Hours**

SYLLABUS

Introduction to additive manufacturing, rapid prototyping, Introduction to 3D printing and various 3D printing technologies - Illustration of FDM/FFF 3D printers, Hands-on with open source 3D modelling software and tools for 3D printing - Hands-on with 3D slicing software, Operating procedures of 3D printers - Language features, Classes, Object and methods, Subclassing and dynamic binding, Multithreading, Overview of class library, Object method serialisation, Remote method invocation, Java script - Hands-on with converting and processing medical DICOM images for 3D printing, Applications of 3D printing DICOM images - Case studies 3D printed robots, Applications of 3D printed robotics.

Total: 15 Hours

Reference(s)

1. Christopher Barnatt, 3D Printing: The Next Industrial Revolution, Create Space Independent Publishing Platform, 2013.
2. Ian M. Hutchings, Graham D. Martin, Inkjet Technology for Digital Fabrication, John Wiley & Sons, 2013.
3. Joan Horvath, Mastering 3D Printing, A Press, 2014
4. Ibrahim Zeid, Mastering CAD CAM, Tata McGraw-Hill Publishing Co., 2007
5. Chua, C.K., Leong K.F. and Lim C.S., Rapid prototyping: Principles and applications, second edition, World Scientific Publishers, 2010

19BM0XB BIOMIMETICS 1 0 0 1

Course Objectives

- Understand the principles of biomimetics and biomineralization
- Increase awareness of how biology can help in enriching other fields of engineering and vice versa
- Interpret the examples of biomimetic applications and how they work

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. 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.
h. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
m. Apply science, technology, engineering and mathematical knowledge for solving problems in health care
n. Identify appropriate design principles to provide solutions for biomedical needs.

Course Outcomes (COs)

1. Understand the theory and methods behind biomimicry
2. Explain diverse examples of biomimetic applications and how they work
3. Apply biomimetic approaches to solve engineering problems

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	1										2	2	
2	1		2										2	2	
3	2	2						-					1	2	

UNIT I **15 Hours**

SYLLABUS

Introduction to biomimetics Inventions inspired by nature for biomedical applications Biomimicry at the cell-material interface Moth inspired Cultured carbon nano tube Mosquito inspired Painless syringe needles Biocompatible medical bandage Nacre inspired materials Gecko inspired biodegradable and biocompatible adhesive Sensory-aid devices Plant inspired super hydrophobic surfaces.

Total: 15 Hours

Reference(s)

1. Conrado Aparicio Maria Pau Ginebra, Biomineralization and Biomaterials: Fundamentals and Applications, Woodhead Publishing , Series in Biomaterials, 2015.
2. Akhlesh Lakhtakia (Editor),Raafal Josafa Martafan-Palma (Editor), Engineered Biomimicry, Elsevier , 1st Edition, 2013.

19BM0XC MEDICAL EQUIPMENTS TROUBLESHOOTING AND CALIBRATION

1 0 0 1

Course Objectives

- Understand the basics of Trouble shooting in Medical equipments
- Apply the concepts of calibration in the field of Biomedical Engineering

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. 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.
n. Identify appropriate design principles to provide solutions for biomedical needs.
o. Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

Course Outcomes (COs)

1. students will be able to Integrate on clinical and technical application of critical care products, anesthesia.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
1	2	2	1											2	2

UNIT I

PATIENT MONITORING SYSTEMS **4 Hours**

Application of ECG, SPO2, NIBP, IBP, Temperature, Respiration, Cardiac Output etco2, BIS Function if each modules used in the patient monitors. ECG methods & Lead wire systems, Different Arrhythmia Cardiac output methods, Spo2 technology etco2(Main stream, side stream, Micro stream) measurement and types.

ICU VENTILATOR & ANESTHESIA WORKSTATION OVERVIEW **3Hours**

Respiratory breathing System, Different Blocks of Ventilator, Modes of ventilation (Pressure & Volume), Simulation demonstration on Ventilator on all modes, Purpose of ICU ventilator & Anesthesia workstation.

CRITICAL CARE EQUIPMENTS TECHNICAL & APPLICATION 7Hours

SYRINGE & INFUSION PUMP: Different blocks - modes of syringe pump - bolus - purge Volume, Time & Flow - Internal Parts of Syringe pump.

DIATHERMY: Basics blocks of Diathermy Monopolar & Bi-polar modes - Internal blocks of Diathermy.

CPAP & BIPAP: Basic Blocks of CPAP & its purpose Internal parts of CPAP

ROLE OF BIOMEDICAL ENGINEERS IN CRITICAL CARE 1 Hour

Know the technology Easy Handling Troubleshooting Maintenance Calibration MIS.

Total: 15 Hours

Reference(s)

1. Joseph J Carr. John M Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, New Delhi, 2011.
2. Fred A MettlerJr, Milton J Guiberteau, "Essentials of Nuclear Medicine Imaging", Elsevier, 5th Edition, 2006
3. Rafadiger Kramme, Klaus-Peter Hoffmann, Robert S. Pozos (Eds.), "Handbook of Medical Technology". Springer, 2011

19BM0XD INTRODUCTION TO HEALTHCARE SYSTEMS ENGINEERING

1 0 0 1

Course Objectives

- Understand the basics of Health care system
- Explain the concepts of Healthcare system delivery
- Professional ethics to be followed by Healthcare professionals

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. 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.
f. 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.
n. Identify appropriate design principles to provide solutions for biomedical needs.

Course Outcomes (COs)

1. Represent the Healthcare systems & services
2. Analyze various types of system design in Healthcare Systems.
3. Implement different Healthcare Concepts and Architectures.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2													2	
2		2												1	
3	2														

UNIT I **15 Hours**

SYLLABUS

Healthcare System and Healthcare Delivery-Delivery of Healthcare Services-Healthcare Delivery Markets and System Drivers Systems Engineering for Health care System Types Health care Concepts Exploration and Architectures Applying Functions and Requirements in Healthcare Systems Deriving Requirements and Allocating in Systems Design Healthcare Systems Interfaces and Integration Risks of Integration and Healthcare Systems Testing & Evaluation Healthcare Systems Production & Deployment, In-Service Monitoring & Updates "ilities" of In-Service Monitoring & Updates and Course Wrap-Up.

Total: 15 Hours

Reference(s)

1. Paul M. Griffin, Harriet B. Nembhard, Christopher J. DeFlitch Nathaniel D. Bastian Hyojung Kang David A. Munoz Healthcare Systems Engineering Wiley Publications 2016.
2. Yuehwern Yih Handbook of Healthcare Delivery Systems CRC Press 2011
3. Alexander Kossiakoff, William N. Sweet , Samuel J. Seymour , Steven M. Biemer Systems Engineering Principles and Practice Wiley publications 2011.
4. Susan Houston & Lisa Anne Bove Project Management for Healthcare Informatics Springer, 2010.

19BM0XE HEALTH INFORMATICS & MEDICAL TECHNOLOGY

Course Objectives

- Understand the basics of health informatics
- Explain the concepts in health informatics analysis relevant to medical technology
- Analyze the importance of health informatics and technology improvement

Programme Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
d. 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.
f. 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.
n. Identify appropriate design principles to provide solutions for biomedical needs.

Course Outcomes (COs)

1. Understand current trends in healthcare data management.
2. Analyze various types of technology advancement in health informatics.
3. Assess the healthcare therapeutic improvements based on health informatics.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2													2	
2		2												1	
3	2														

UNIT I 15 Hours

RECENT TRENDS IN MEDICAL TECHNOLOGY 2 Hours

Remote Patient Monitoring and Wearables - AI technology – Blockchain - Cloud computing – Telehealth - Digital Therapeutics - Technology in Mental Health - Internet of Medical Things(IoMT) - Virtual Reality (VR) and Augmented Reality (AR) - Healthcare interoperability solutions.

HEALTHCARE DATA RESOURCES 4 Hours

Electronic Health Records - Administrative Data - Claims Data - Patient / Disease Registries - Health Surveys - Clinical Trials Data

HEALTHCARE SOFTWARE SYSTEM 3 Hours

Medical Practice Management System - Primary Healthcare Management System – Secondary Healthcare Management System – E-Prescribing Software - Medical Billing Software - Urgent Care

Applications - Patient Portal - Master Patient Index (MPI)

HEALTH DATA STANDARDS & HEALTH DATA STORAGE 4 Hours

Data Standards in Healthcare - Terminology Standards - Content Standards - Data Exchange or Transport Standards - Privacy and Security Standards - Database management types in Healthcare - On-premise - Public Cloud - Hybrid Cloud

JOB OPPURTUNITIES IN HEALTHCARE IT 2 Hour

Medical coding – Regulatory Affair - IT jobs in healthcare - Skills required for Healthcare IT -Top EHR Vendors

Total: 15 Hours

Reference(s)

1. Health Science library, University of Washington, 'Data Resources in the Health Sciences'.
A Practical Guide to Clinical Data Warehousing Association for Clinical Data Management (ACDM)
2. An International Handbook for Medical Devices and Healthcare Products, Edited by Jack Wong, Raymond K. Y. Tong, Copyright Year 2022
3. Elizabeth D. Moyer Ph.D., in Alternative Careers in Science (Second Edition), 2006
4. I Haggle, Å Holmgren, in Drug Discovery and Development (Second Edition), 2013

19BMOXF EMBEDDED SYSTEMS FOR MEDICAL APPLICATIONS 1 0 0 1

Course Objectives

- To integrate & educate students on clinical and Technical application of various medical sensors. The course provides a gentle introduction to the sensors used in medical industry and is intended for beginning users and those looking for a review. It is designed to give students a basic understanding of physiological parameter acquisition & medical instrumentation design with embedded systems using STM32
- To transform Biomedical Engineers to Clinical Engineers. (Fresher into Professional)
- To impart basic Technical knowledge about sensors and measurement. (Fundamental Knowledge & Principles)
- To impart data acquisition, measurement, problem solving & troubleshooting knowledge about medical sensors with microcontroller

Program Outcomes (POs)

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

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

c. 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.

d. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

e. Able to design new concepts in the domains of Microelectronics and Communication Engineering.

Course Outcomes (COs)

1. To understand the basic working principle of embedded controllers
2. To apply the peripheral interfacing with the controller for data acquisition.
3. To design biomedical devices using appropriate sensors.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3											1		
2	1	2	3		1								2	2	
3	3	2												2	

INTRODUCTION TO EMBEDDED SYSTEM 3 Hours

Introduction to Embedded Systems –Structural units in Embedded processor, selection of processor & memory devices- DMA — Memory management methods- Timer and Counting devices, Watchdog Timer, Real Time Clock, In circuit emulator, Target Hardware Debugging. Categories of embedded systems, Specialties of embedded systems, Recent trends in embedded systems, Hardware architecture, Software architecture, Communication software, Process of generation of executable image, Development/testing tools.

DATA ACQUISITION USING STM32 ARCHITECTURE **3 Hours**

STM 32 Overview-Architecture-Feature- Peripheral- Hardware setup- resources.

EMBEDDED COMMUNICATION PROTOCOLS **9 Hours**

ADC, Data processing & control- Analog read, digital read, digital write, UART, I2C, serial communication- Display interfacing.

Total: 15 Hours

Reference(s)

1. Wayne Wolf, "Computers as Components - Principles of Embedded Computing System Design",Morgan Kaufman Publishers, First Indian Reprint, 2001
2. LPC2364/66/68/78 User manual
3. Raj Kamal, "Embedded Systems Architecture Programming and Design", Second Edition,TMH, 2010.
4. MicroC/OS-II: The Real-Time Kernel by Jean J. Labrosse

19BM0XG NON INVASIVE (NIV)-BI LEVEL UNIT VENTILATOR 1 0 0 1

Course Objectives

- To Identify the electrical hazards and Implement methods
- To Understand different types and uses of Ventilators

Program Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

Course Outcomes (COs)

1. To identify the pathological condition for mechanical ventilation (MV).
2. To operate the ventilator in different modes based on the physiological condition of a patient.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1													2	3
2	1	2												2	2

INTRODUCTION BI LEVEL UNITS VENTILATORY SUPPORT SYSTEM OVERVIEW **7 Hours**

Physiological effects of electricity, important susceptibility parameters, Macro shock, Micro shock hazards, Patients electrical environment- Troubleshooting.

VENTILATOR MODES AND HANDS ON TRAINING **8 Hours**

Types of Ventilators: Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators- Hands on training

Total: 15 Hours

Reference(s)

1. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition,2014.
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Pearson Education India; 2nd Edition,2015.
3. Joseph J. Carr and John M. Brown, Introduction to Biomedical equipment technology, Pearson Education, 4th Edition,2014.

19BM0XH BIOINFORMATICS TECHNIQUES FOR THE ANALYSIS OF BIOLOGICAL SEQUENCES 1 0 0 1

Course Objectives

- To impart knowledge on next generation sequencing to diagnosis severe malignancies

Program Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c. 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.
d. Apply science, technology, engineering and mathematical knowledge for solving problems in health care
e. Identify appropriate design principles to provide solutions for biomedical needs.
f. Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

Course Outcomes (COs)

1. Understand the basic concepts of Bioinformatics and its significance in Biological data analysis.
2. Apply programming tools and algorithms for NGS analysis.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	2												
2			2	2											

Unit I **15 Hours**

Sequencing Fundamentals, Illumina Technology, Analysis of Microarray data, Genomic landscape, Quality control, Trimming and editing of biological sequences, denovo assembly, meta- genomics, Library preparation, mutation of sequences, variant calling techniques, cloud services for bioinformatics, Python for sequence analysis, Visualization of gene expression in R.

Total: 15 Hours

Reference(s)

1. Bioinformatics: Principles and Applications by Zhumur Ghosh and Bibekanand Mallick, 2010.
2. Mount D.W. Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, 2001.

19BM0XI MODELING OF NANO BIOMATERIAL BASED SENSORS

1 0 0 1

Course Objectives

- To integrate & educate students on clinical and Technical application of various nano & micro technologies. The course provides a gentle introduction to the biosensor design and is intended for beginning users and those looking for a review. It is designed to give students a basic understanding of biomaterial, sensor design, simulation & analysis.
- To impart design, simulation & analysis knowledge about biosensors.
- To transform Biomedical Engineers to Clinical Engineers in terms of design. (Fresher into Professional)
- To impart basic Technical knowledge about biosensor design. (Fundamental Knowledge & Principles)

Program Outcomes (POs)

a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b. 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.
c. Apply science, technology, engineering and mathematical knowledge for solving problems in health care

Course Outcomes (COs)

1. To understand the basic concepts and properties of biomaterials for health care application. .
2. To apply nano biomaterials for diagnostic applications.
3. To analyze the behavior of nano material based sensors through simulation.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1			1	1			1							1	1
2	2	3	2										2	2	
3	2	2	1	1	1							1	3	2	1

BIOMATERIALS **3 HOURS**

Biocompatibility- introduction to biological fluids- material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear - host response - the inflammatory process - coagulation and hemolysis approaches to thrombo- resistant materials development. Cells: theirs surface and interaction with materials.

DIAGNOSTIC NANOBIOMATERIALS & APPLICATIONS 4 HOURS

Intrinsic biocompatibility of nanoparticle in cellular system - Nanomaterial as contrast agent, photosensitizer, degradable and non-degradable polymers, degradable and resorbable materials, biocompatible polymer coated magnetic nanoparticles for MRI imaging, gold and silver loaded bio conjugated carbon nanotube and graphene for tumor targeting, Silica / CdSe / CdS / ZnO core - shell nanostructures for optical diagnostics and imaging – multifunctional Nano biomaterials for multi imaging modality approaches. CAD for MEMS - Micro Total Analysis Pattern - Lab-on chip devices, Micro actuators and Drug delivery - DNA microarrays - Implantable microelectrodes - Micro Stools for surgery

MODEL BASED SIMULATION 8 HOURS

Consistent Modeling Workflow with the Model Builder - Modeling - electromagnetics - structural mechanics - acoustics - fluid flow - heat transfer - chemical reaction You can also combine physics phenomena from these areas in a single model. Geometry and CAD - Physics-based modeling - Equation-based modeling - Meshing - Studies and optimization - Solvers - Visualization and results evaluation. Manage Models and Simulations with the Model Manager - Connect Analysis, Design, and Production with the Application Builder - Compiler - Server - Electromagnetic modules - structural mechanics & acoustics modules - Fluid flow & Heat Transfer modules - Chemical Engineering

Total: 15 Hours

Reference(s)

1. Park Joseph D.Bronzino, “Biomaterials-Principles and Applications”, CRC press, 2003
2. Guozhong Cao, Y. Wang, "Nanostructures and Nanomaterials-Synthesis, Properties & Applications", Imperials College Press, 2011.
3. COMSOL Multiphysics® 5 - A Brief Introduction to CFD and Electromagnetism

19BM0YA AMBULANCE AND EMERGENCY MEDICAL SERVICE MANAGEMENT **3 0 0 3**

Course Objectives

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

Course Outcomes (COs)

1. Identify ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Understand the Emergency response team, Transportation interfaces, Transportation Service Characteristics& regulatory reforms involved.
4. Identify ambulance services, types and allied services
5. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2												2	
2	2													3	
3		2												2	
4	2	2													
5	2												2		

UNIT I **9 Hours**

INTRODUCTION

Introduction-transportation ambulance types-Advanced Life Support Ambulance-Basic Life Support Ambulance-Patient Transport Ambulance-Emergency services-Ambulances-Allied services-telephone management

UNIT II **9 Hours**

AMBULANCE DESIGN AND EQUIPMENT

Design and Equipment of Ambulances -Minimum Ambulance Rescue Equipment-Emergency drugs medicines Recruitment validation Training to handle in house Ambulance emergency procedures Checklist measures Roles of paramedics, midwives, community nurses, hospice workers in emergency handling via ambulance

UNIT III **9 Hours**

TRANSPORTATION REGULATION FOR EMERGENCY MEDICAL SERVICE

Crisis Management-Anxiety & Stress Management-the Emergency response team-police assistance- Information handling & processing-Establishing customer service levels - Developing and Reporting customer service standards - Impediments to an Effective customer Service strategy - Improving customer Service Performance Transportation

UNIT IV **9 Hours**

AMBULANCE PREVENTIVE MAINTENANCE

Legal obligationsSwitch Console Front, Main Electrical, Patient Compartment Climate Oxygen system On board Suction system 110/12 VOLT system, Modular Body, Medical Equipment - Cot & Stretcher, safety belts-driver(s), passenger, Patients-child restraint device-incubator

UNIT V **9 Hours**

THE MOTOR VEHICLE ACT

The Motor Vehicle Act, 1988- Rules of the road Regulations 1989- Overall Dimensions of Motor Vehicles (Prescription of conditions for exemption) Rules 1991-Use of Red light on the top front of the vehicle

Total: 45 Hours

Reference(s)

1. Fawcett,"Supply Chain Management", Pearson Education India, 01-Sep-2008 - 600 pages.
2. B. Feroz, A. Mehmood, H. Maryam, S. Zeadally, C. Maple and M. A. Shah, "Vehicle-Life Interaction in Fog-Enabled Smart Connected and Autonomous Vehicles," in IEEE Access, vol. 9, pp. 7402-7420, 2021, doi: 10.1109/ACCESS.2020.3049110.
3. R. Jin, T. Xia, X. Liu, T. Murata and K. -S. Kim, "Predicting Emergency Medical Service Demand With Bipartite Graph Convolutional Networks," in IEEE Access, vol. 9, pp. 9903-9915, 2021, doi: 10.1109/ACCESS.2021.3050607.
4. Les Pringle,"Call the Ambulance",Transworld Publishers, 2010.
5. Edward J. Bardi, John Joseph Coyle, Robert A. Novack"Management of Transportation", Thomson/South-Western, 2006

19BM0YB HOSPITAL AUTOMATION 3 0 0 3

Course Objectives

- Introduce the concepts of hospital systems and need for central monitoring
- Exemplify the power generation, utility and protection systems.
- Apply the distributed and central monitoring functions in hospital environment

Course Outcomes (COs)

1. Identify the factors in central power generating and monitoring systems
2. Analyze the sensors and actuators for the automation systems
3. Classify the equipment types and its applications.
4. Apply software tools and digital computer for monitoring of parameters and medical data handling
5. Design central monitoring station for hospitals for control and surveillance applications

Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2													2	
2		2												2	
3		2											3		
4		2												2	
5	3													2	

UNIT I **9 Hours**

AUTOMATION IN HEALTHCARE

Introduction to automation Role of automation in healthcare Remote Patient Monitoring Maximizing resources on patient care Reducing variability, Automating clinician and patient interactions through products.

UNIT II **9 Hours**

POWER GENERATION AND MEDICAL GAS PRODUCTION

Power generator, Battery : Maintenance and troubleshooting, energy conservation and monitoring system - Automation in dryer, compressor, air conditioning, lighting, heating systems.

UNIT III **9 Hours**

AUTOMATION IN PIPING

Monitoring of flow and pressure of medical gas System components Vacuum control units Automatic changeover system - Types of Outlets - Leakage test- Prevention and safety automation.

UNIT IV **9 Hours**

INSTRUMENTATION SYSTEMS

Optical sensors , Pressure Sensors - Ultrasonic Sensors - Tactile Sensors - Thermal sensors -Biosensor - Linear Actuators, Central monitoring station - Alarm system - Regulation and standards.

9 Hours

UNIT V
APPLICATIONS

Business intelligence & executive dashboards - Radio-Frequency Identification (RFID)- based patient and asset tracking solutions - Tablet-based applications for bed side access to doctors/nurses - Healthcare CRM for patient relationship management - Patient kiosk, tele-health – HIS integration.

Total: 45 Hours

Reference(s)

1. Khandpur RS, Handbook of Biomedical Instrumentation, Prentice Hall of India, New Delhi, 3 rd edition, 2014.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education India, Delhi, 4 th edition 2008
3. Curtis Johnson D Process Control Instrumentation Technology, Prentice Hall of India, 8th edition 2006
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.