EXCEL ENGINEERING COLLEGE

(Autonomous)

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
Accredited by NBA, NAAC with "A+" and Recognised by UGC (2f &12B)
KOMARAPALAYAM - 637303

B.E. BIOMEDICAL ENGINEERING
REGULATION - 2020
CHIOCE BASED CREDIT SYSTEM
I TO VIII SEMESTERS CURRICULUM AND SYLLABI

ISEMESTER									
Code No.	**Course**	**Category**	**Periods/ Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
20MA101	Mathematics – I for Electrical Sciences	BS	3	2	0	4	40	60	100
20BM101	Basicsof Electrical and Biomedical Engineering	ES	3	0	0	3	40	60	100
Theory with Practical Course(s)									
20ENEXX	Language Elective – I	HSS	2	0	2	3	50	50	100
20PH102	Physics for Electrical Sciences	BS	3	0	2	4	50	50	100
20CS102	Problem Solving using Python	ES	3	0	2	4	50	50	100
Practical Course									
20BM102	BiomedicalEngineering Practices Laboratory	ES	0	0	2	1	50	50	100
Mandatory Course									
20MC101	Induction Programme	MC	2 Weeks			0	100	-	100
TOTAL			**14**	**2**	**8**	**19**	**380**	**320**	**700**

Language Electives – I

Code No.	**Course**	**Category**	**Periods/ Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
20ENE01	Communicative English	HSS	2	0	2	3	50	50	100
20ENE02	Advanced Communicative English	HSS	2	0	2	3	50	50	100

IISEMESTER									
Code No.	**Course**	**Category**	**Periods/ Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course (s)									
20MA201	Mathematics – II for Electrical Sciences	BS	3	2	0	4	40	60	100
20BM201	Biochemistry	ES	3	0	0	3	40	60	100
Theory with Practical Course (s)									
20ENEXX	Language Elective – II	HSS	2	0	2	3	50	50	100
20CH202	Chemistry for Electrical Sciences	BS	3	0	2	4	50	50	100
20ME203	Engineering Graphics	ES	1	0	4	3	50	50	100
Practical Course									
20BM202	Biochemistry Laboratory	ES	0	0	4	2	50	50	100
Mandatory Course									
20MC202	Interpersonal Skills	MC	0	0	2	0	100	-	100
Total			**12**	**2**	**14**	**19**	**380**	**320**	**700**

Language Electives – II

Code No.	**Course**	**Category**	**Periods/ Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
20ENE02	Advanced Communicative English	HSS	2	0	2	3	50	50	100
20ENE03	Hindi	HSS	2	0	2	3	50	50	100
20ENE04	French	HSS	2	0	2	3	50	50	100
20ENE05	German	HSS	2	0	2	3	50	50	100

IIISEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
20MA302	Partial Differential Equation and Linear Algebra	BS	3	2	0	4	40	60	100
20BM301	Signals and Systems for Bioengineers	PC	3	2	0	4	40	60	100
20BM302	Circuit Theory	ES	3	0	0	3	40	60	100
20BM303	Electronic Device and Circuits	PC	3	0	0	3	40	60	100
20BM304	Biosensors and Measurements	PC	3	0	0	3	40	60	100
Theory with Practical Course(s)									
20BM305	Human Anatomy and Physiology	PC	3	0	2	4	50	50	100
Practical Course									
20BM306	Electronic Devices and Circuits Laboratory	PC	0	0	4	2	50	50	100
Mandatory Course									
20MC301	Environmental Sciences	MC	2	0	0	0	100	-	100
Total			**20**	**4**	**06**	**23**	**400**	**400**	**800**

IVSEMESTER									
Code No.	**Course**	**Category**	**Periods/ Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
20MA402	Probability and Stochastic Process	BS	3	2	0	4	40	60	100
20BM401	Digital Electronics	PC	3	2	0	4	40	60	100
20BM402	Medical and Radiation Physics	PC	3	2	0	4	40	60	100
20BM403	Healthcare Data Analytics	PC	3	2	0	4	40	60	100
20BM404	Pathology and Microbiology	PC	3	0	0	3	40	60	100
Theory with Practical Course(s)									
20CS407	Data Structure using Object Oriented Programming	ES	3	0	2	4	50	50	100
Practical Course									
20BM404	Pathology and Microbiology Laboratory	PC	0	0	4	2	50	50	100
Mandatory Course									
20MC401	Soft Skills	MC	2	0	0	0	100	-	100
Total			**20**	**4**	**6**	**23**	**400**	**400**	**800**

VSEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
20BM501	Biocontrol system	PC	3	2	0	4	40	60	100
20BM502	Biomedical Instrumentation	PC	3	0	0	3	40	60	100
20BM503	Digital Signal Processing	PC	3	2	0	4	50	50	100
20BM504	Radiological Equipments	PC	3	0	0	3	40	60	100
20BMEXX	Professional Elective-I	PE	3	0	0	3	40	60	100
20YYOXX	Open Elective-I	OE	3	0	0	3	40	60	100
Practical Course(s)									
20BM507	Biomedical Instrumentation Laboratory	PC	0	0	2	1	50	50	100
20BM508	Digital Signal Processing Laboratory	PC	0	0	2	1	50	50	100
Total			**18**	**4**	**4**	**22**	**350**	**450**	**800**

VI SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Course(s)									
20BM601	Regulatory Affairs and Medical Ethics	PC	3	0	0	3	40	60	100
20BM602	Biomaterials and Artificial Organs	PC	3	0	0	3	40	60	100
20BM603	Biomechanics	PC	3	0	0	3	40	60	100
20BMEXX	Professional Elective-II	PE	3	0	0	3	40	60	100
20YYOXX	Open Elective-II	OE	3	0	0	3	40	60	100
Theory with Practical Course									
20EC606	Microprocessors and Microcontrollers	PC	3	0	2	4	50	50	100
Practical Course(s)									
20BM604	Diagnostic and Therapeutic Equipment Laboratory	PC	0	0	2	1	50	50	100
20BM605	Mini Project	EEC	0	0	2	1	50	50	100
20BM606	Internship	EEC	2 weeks			1	100	0	100
Total			**18**	**0**	**6**	**22**	**450**	**450**	**900**

VIISEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Theory Courses									
20BM701	Professional Ethics and Hospital Management	HSS	3	0	0	3	40	60	100
20BM702	Principles of Digital Image Processing	PC	3	0	0	3	40	60	100
20BM703	Neural Networks and Fuzzy logic	PC	3	0	0	3	40	60	100
20BMEXX	Professional Elective-III	PE	3	0	0	3	40	60	100
20BMEXX	Professional Elective-IV	PE	3	0	0	3	40	60	100
20YYOXX	Open Elective-III	OE	2	0	0	2	40	60	100
Practical Course(s)									
20BM704	Digital Image Processing Laboratory	PC	0	0	4	2	50	50	100
20BM705	Hospital Training	EEC	0	0	2	1	100	00	100
20BM706	Design Project	EEC	0	0	2	1	50	50	100
Total			**17**	**0**	**8**	**21**	**440**	**460**	**900**

VIII SEMESTER									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
20BMEXX	Professional Elective-V	PE	3	0	0	3	40	60	100
20BMEXX	Professional Elective-VI	PE	3	0	0	3	40	60	100
20BM801	Major Project	EEC	0	0	20	10	50	50	100
Total			**6**	**0**	**20**	**16**	**130**	**170**	**300**

PROFESSIONAL ELECTIVES (PE)									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
Stream – 1Biomedical Signal and Image Processing (BSIP)									
20BME01	Biosignal Processing	PE	3	0	0	3	40	60	100
20BME02	Biometric Systems	PE	3	0	0	3	40	60	100
20BME03	Computer Vision, Pattern Recognition and its Biological applications	PE	3	0	0	3	40	60	100
20BME04	SpeechProcessing	PE	3	0	0	3	40	60	100
20BME05	Biostatistics	PE	3	0	0	3	40	60	100
20BME06	Quality Assurance & Medical Device Regulations	PE	3	0	0	3	40	60	100
20BME07	Medical Image Analysis	PE	3	0	0	3	40	60	100
20BME08	Brain Computer Interface and its Applications	PE	3	0	0	3	40	60	100
20BME10	Soft computing and applications	PE	3	0	0	3	40	60	100
20BME11	Deep Learning for Heathcare	PE	3	0	0	3	40	60	100
20BME12	Machine Learning for Healthcare	PE	3	0	0	3	40	60	100
20BME13	Neuro-Science Engineering	PE	3	0	0	3	40	60	100
20BME14	Real Time Embedded Systems	PE	3	0	0	3	40	60	100
Stream – 2Health Care Systems (HCS)									
20BME21	Human Assist Devices	PE	3	0	0	3	40	60	100
20BME22	Robotics in Medicine	PE	3	0	0	3	40	60	100
20BME23	Medical Device Design and Prototyping	PE	3	0	0	3	40	60	100
20BME24	Hospital Information System	PE	3	0	0	3	40	60	100
20BME25	Tele Health Technology	PE	3	0	0	3	40	60	100
20BME26	Wearable Systems	PE	3	0	0	3	40	60	100

20BME27	Body Area Networks	PE	3	0	0	3	40	60	100
20BME28	Health Information Technology	PE	3	0	0	3	40	60	100
20BME29	Data communication and Networking	PE	3	0	0	3	40	60	100
20BME30	Internet of Things in Medicine	PE	3	0	0	3	40	60	100
20BME31	Biomedical Data Science	PE	3	0	0	3	40	60	100
20BME32	Medical Informatics	PE	3	0	0	3	40	60	100
20BME33	Medical Ethics and Standards	PE	3	0	0	3	40	60	100
20BME34	BioInformatics and Drug Design	PE	3	0	0	3	40	60	100
Stream – 3BioEngineering (BE)									
20BME41	Biomaterials and Artificial Organs	PE	3	0	0	3	40	60	100
20BME42	Rehabilitation Engineering	PE	3	0	0	3	40	60	100
20BME43	Principles of Tissue Engineering	PE	3	0	0	3	40	60	100
20BME44	Molecular Biology	PE	3	0	0	3	40	60	100
20BME45	Biophotonics	PE	3	0	0	3	40	60	100
20BME46	Genetic Engineering	PE	3	0	0	3	40	60	100
20BME47	Nano Technology and Applications	PE	3	0	0	3	40	60	100
20BME48	Tissue Engineering and Artificial Organs	PE	3	0	0	3	40	60	100
20BME49	Bio MEMS	PE	3	0	0	3	40	60	100
20BME50	Lab-on-Chip &Point-of-care Devices	PE	3	0	0	3	40	60	100
20BME51	Physiological Modelling	PE	3	0	0	3	40	60	100
20BME52	Virtual Instrumentation	PE	3	0	0	3	40	60	100
20BME53	Medical Optics	PE	3	0	0	3	40	60	100

OPEN ELECTIVE COURSES (For Other Branches)									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
20BMO01	Principles of telemedicine	OE	3	0	0	3	40	60	100
20BMO02	Biosensor technology	OE	3	0	0	3	40	60	100
20BMO03	Data mining in bioinformatics	OE	3	0	0	3	40	60	100
20BMO04	Introduction to biomedical devices	OE	3	0	0	3	40	60	100
20BMO05	Medical nanotechnology	OE	3	0	0	3	40	60	100
20BMO06	Reliability engineering	OE	3	0	0	3	40	60	100
20BMO07	Medical electronics	OE	3	0	0	3	40	60	100
20BMO08	Biomedical instrumentation	OE	3	0	0	3	40	60	100
20BMO09	Hospital management	OE	3	0	0	3	40	60	100
20BMO10	Basics of bioinformatics	OE	3	0	0	3	40	60	100
20BMO11	Biochemistry	OE	3	0	0	3	40	60	100
20BMO12	Basics of human anatomy and physiology	OE	3	0	0	3	40	60	100

ONE CREDIT COURSES									
Code No.	**Course**	**Category**	**Periods / Week**			**C**	**Maximum Marks**		
			L	**T**	**P**		**CA**	**FE**	**Total**
20BMA01	Scientific Computing for Biologists	EEC	1	0	0	1	100	0	100
20BMA02	Frontiers in Medical Informatics	EEC	1	0	0	1	100	0	100
20BMA03	Ultrasound Machine	EEC	1	0	0	1	100	0	100
20BMA04	IoT using Arduino	EEC	1	0	0	1	100	0	100
20BMA05	Electronic Circuits Making and PCB Design	EEC	1	0	0	1	100	0	100
20BMA06	Ventilator with monitoring equipment	EEC	1	0	0	1	100	0	100
20BMA07	Human Computer Interaction	EEC	1	0	0	1	100	0	100
20BMA08	3D Modeling for Health Care	EEC	1	0	0	1	100	0	100

SUMMARY

S.No	Category	CREDITS PER SEMESTER									
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total Credits (AICTE)**	**Credits in %**
1	HSS	3	3					3	3	12 (10-14)	7.3%
2	BS	8	8	4	4			0		24 (22-28)	14.5%
3	ES	8	8	3	3			0		22 (24)	13.33%
4	PC			16	16	16	14	5		67 (48)	40.6%
5	PE					3	3	6	6	18 (18)	10.9%
6	OE					3	3	2		8	4.8%
7	EEC						2	2	10	14 (12-16)	8.48%
8	MC	0	0	0						0	0
Total		19	19	23	23	22	22	21	16	165	100%

HSS - Humanities and Social Sciences

BS - Basic Sciences

ES - Engineering Sciences

PC - Professional Core

PE - Professional Electives

OE - Open Electives

EEC - Employability Enhancement Courses

MC - Mandatory Courses (Non-Credit Courses)

CA - Continuous Assessment

FE - Final Examination

I SEMESTER

20MA104	Mathematics - I for Electrical Sciences (Common to ECE and BME)	L	T	P	C
		3	2	0	4
Nature of Course	Basic Sciences				
Pre requisites	Fundamentals of basic Mathematics				

Course Objectives

The course is intended to

1. Study the methodologies involved in solving problems related to fundamental principles of matrices and calculus.
2. Acquaint the student with mathematical tools needed in evaluating limits, derivatives and differentiation of one variable.
3. Learn the basic tools of calculus for the purpose of modeling the engineering problems mathematically and obtaining solutions.
4. Provide the concepts of evaluating multiple integrals and their usage.
5. Study the basics of vector calculus comprising of gradient, divergence, curl, line, surface, volume integrals and the classical theorems

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Apply the concept of orthogonal reduction to diagonals the given matrix	Apply
CO2	Understand the limit definition and rules of differentiation to differentiate functions.	Understand
CO3	Determine the circle of curvature, evaluate and envelope of the curves	Apply
CO4	Compute double and triple integrals	Understand
CO5	Apply the concepts of differentiation and integration to vectors	Apply

Course Contents

Unit – I Matrices **12**

Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties(statement only) – Cayley-Hamilton theorem and its applications – Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

Unit – II Limits, Continuity and Differentiability **12**

Representation of functions – Limit of a function – Continuity – Derivatives – Differentiation rules – Rolle 's Theorem – Mean value theorem - Maxima and Minima of one variable.

Unit – III Differential Calculus **12**

Curvature – radius of curvature (Cartesian and Polar co-ordinates) – Centre of curvature – Circle of curvature – Involute and evolute – envelope.

Unit – IV Multiple Integrals **12**

Double integration- Cartesian and Polar co-ordinates – Change of order of integration – Area between two curves – Area of double integral – Triple integration

Unit – V Vector Calculus **12**

Gradient, Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration – Green's, Gauss divergence and Stokes ' theorem – Statement, Verification and Simple applications.

Total: 60 Periods

Text Books:

1. Grewal B.S, "Higher Engineering Mathematics", Khanna Publishers, 44th Edition 2016.
2. Veerarajan T," Engineering Mathematics for Semester I and II", Tata McGraw Hill, 3rd Edition 2014.

Reference Books:

1. N.P.Bali, Manish Goyal, "A text book of Engineering Mathematics Semester II", Laxmi Publications, 6th Edition 2015.
2. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 3rd Edition 2012.

Web References

1. nptel.ac.in/courses/111/105/111105121
2. nptel.ac.in/courses/111/105/111105122

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2										2		
CO2	3	3	2										3		
CO3	3	2	2										3		
CO4	3	3	2										2		
CO5	3	3	2										3		
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyze				
Evaluate				
Create				

CHAIRMAN - BOARD OF STUDIES

20BM101	BASICS OF ELECTRICAL AND BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3
Nature of Course	**Engineering Sciences**				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Understand the basic concepts of electric circuits and wiring.
2. Learn the principles of three phase circuits and magnetic circuits
3. Understand the operation of AC and DC machines.
4. Explore the knowledge on evolution and modern health care system in biomedical engineering
5. Study the properties of neurons and equivalent circuit model

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Explain the concepts related with electrical circuits and wiring	Understand
CO2	Explain the different three phase connections and the concepts of magnetic circuits	Apply
CO3	Interpret the operating principle of AC and DC machines	Understand
CO4	Identify the major role that advances in medical technology	Understand
CO5	Describe the process used for communication among neurons	Understand

Course Contents

UNIT – I BASIC CIRCUITS AND DOMESTIC WIRING 10

Electrical circuit elements (R, L and C)-Dependent and independent sources – Ohm's Law-Kirchhoff's laws - mesh current and node voltage methods (Analysis with only independent source) - Phasors – RMS-Average values-sinusoidal steady state response of simple RLC circuits. Types of wiring- Domestic wiring - Specification of Wires-Earthing-Methods-Protective devices.

UNIT – II THREE PHASE CIRCUITS AND MAGNETIC CIRCUITS 10

Three phase supply – Star connection – Delta connection –Balanced and Unbalanced Loads-Power in three-phase systems – Comparison of star and delta connections – Advantages- Magnetic circuits-Definitions-MMF, Flux, Reluctance, Magnetic field intensity, Flux density, Fringing, self and mutual inductances-simple problems.

UNIT – III ELECTRICAL MACHINES 10

Working principle of DC generator, motor-EMF and Torque equation-Types –Shunt, Series and Compound-Applications. Working principle of transformer-EMF equation-Operating principles ofthree phase and single phase induction motor-Applications. Working principles of alternator-EMF equation-Operating principles of Synchronous motor, stepper motor-Applications.

UNIT – IV HISTORICAL PERSPECTIVE OF BIOMEDICAL ENGINEERING 9

The evolution and modern of health care system-Introduction to Biomedical Engineering-Recent advances in Biomedical engineering-Ethical issues, Definition-Ethical issues in emergency use and treatment use-The role of biomedical engineer in FDA process.

UNIT – V BIOELECTRIC PHENOMENA 6

Introduction-Neurons-Basic Biophysics tools-Equivalent circuit model for cell membrane-The Hodgkin-Huxley Model of Action Potential-model of whole neuron.

Total: 45 periods

Text books

1. Dr.Kothari D.P, Prof Nagrath I J,"Basic Electrical Engineering" , 3rd edition, Tata McGraw Hill, 2009.

2.John D. Enderle and Joseph D. Bronzino "Introduction to Biomedical Engineering", Elsevier International Projects Ltd., Boston, 3rd edition, 2012.

3. Muthusubramaniam R, Salivahanan S and Muraleedharan A.K, "Basic Electrical, Electronics and Computer Engineering", TMH 2007.

Reference books

1. Vijay kumar Garg,"Basic Electrical Engineering (A complete Solution)", Wiley, Reprint 2015.

2. Sen,P.C, "Principles of Electrical Machines and Power Electronics", Wiley, Reprint 2016

3. John D. Enderle and Susan M. Blanchard, "Introduction to Biomedical Engineering", Elsevier International Projects Ltd., Boston, 3rd edition, 2011

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
CO1	3	3	1										2	1	
CO2	3	3	1										2	1	
CO3	3	3	1										2	1	
CO4	3	3	1					2				1	2	2	
CO5	3	3	1					2				1	2	2	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Understand	Direct Measures: Quiz/Presentation/Tutorial	5	15
Understand	Indirect measures: Assignment/ Video presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment**			**Final Examination (Theory) (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

CHAIRMAN - BOARD OF STUDIES

20ENE01	COMMUNICATIVE ENGLISH (Common to all B.E. / B.Tech. Programmes)	L	T	P	C
		2	0	2	3
Nature of Course	Humanities and Social Science				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Improve lexical, grammatical and semantic competence.
2. Enhance communicative skills in real life situations.
3. Augment thinking in all forms of communication.
4. Equip with oral and written communication skills.
5. Gain employability skills.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Use effectively the lexical, grammatical and semantic knowledge	Remember
CO2	Communicate with clarity using intentional vocabulary in English	Apply
CO3	Articulate perfectly and express their opinions confidently using communicative strategies	Remember
CO4	Accomplish listening and reading skills for lifelong learning	Understand
CO5	Comprehend, interpret and present data	Understand

Course Contents

Unit - I Basic structure and Usage **6**

Parts of Speech –- Articles –Tenses - Subject-Verb Agreement – Different Grammatical forms of the same word - Listening to Speeches and Conversations from Communication software – Listening to Announcements – Listening and Gap Filling.

Unit - II Vocabulary and Language Development **6**

Intentional vocabulary used in and around Airport, Hospital, Hotel, Court – Abbreviations and acronyms - One Word Substitution - Compound words – Homophones and Homonyms – Types of sentences - Ordering Jumbled Sentences Letter writing – informal.

Unit – III Oral Communication Skills **6**

Improving fluency – Articulation with pronunciation – Voice modulation in Speaking – One minute talk -Self Introduction and introducing ones friend – Telephonic conversations – Group Discussion – Modal Auxiliaries – discourse markers.

Unit – IV Comprehensive Listening and Reading **6**

Effective listening Strategies –– Listening to Interviews from Communication software – Phrasal verbs – Reading Comprehension – “An Astrologer’s Day” by R.K.Narayan and “Building a New State” by Dr. A.P.J. Abdul Kalam.

Unit – V Effective Writing **6**

Interpretation and presentation of data – developing Hints – general essays and paragraph writing – Report Writing – survey report and accident report - Instructions and Recommendations.

Total: 30 Periods

Laboratory Components

S.No	List of Exercises	CO Mapping	RBT
1	Role-play – One minute talk	3	Understand
2	Role-play – Telephonic conversations	3	Understand
3	Listening to speeches and lectures and gap filling	4	Understand
4	Group Discussion.	4	Understand
5	Articulation with pronunciation practice	3	Apply
6	Listening to Announcements – Listening and Gap Filling	4	Understand
7	Listening to Interviews & Native speakers' Conversations	4	Understand
8	Reading practice with articles in magazine and news papers.	4	Understand
9	Model – Job Interviews	4	Understand
10	Introspective report – Personal analysis	5	Understand
11	Telephone etiquette	3	Remember
12	Reading – Shorter texts and News Articles	4	Understand
13	Role Play – Getting and Giving Permission	3	Remember
14	Self Introduction(Formal)	3	Understand
15	Recommendations/Suggestions	3	Apply

Total: 30 Periods

Text Books

1. Rizvi, Ashraf M., "Effective Technical Communication", Tata McGraw Hill Publishing Company Limited, New Delhi, 5th Edition, 2007.

2. Board of Editers, "Using English – A Coursebook for Undergraduate Engineers and Technologists", Orient BlackSwan Private Limited, Hyderabad, 2nd Edition, 2017.

Reference Books:

1. Meenakshi Raman and Sangeetha Sharma, "Technical Communication", Oxford University Press, USA, 10th Edition, 2007.

2. John Cunnison Catford, "A Practical Introduction to Phonetics", Clarendon Press, Jamaica, 2nd Edition, 2001.

3. Hewings. M, "Advanced English Grammar", Cambridge University Press, Chennai, 3rd Edition, 2000.

4. S P Dhanavel "English and Soft Skills", Orient BlackSwan Private Limited, Hyderabad, 1st Edition, 2010.

Web reference:

https://www.googleadservices.com/pagead/aclk?sa=L&ai=DChcSEwij4dCTucfsAhXE1pYKHch4ABMYABABGgJ0bA&ohost=www.google.com&cid=CAASEuRo76H-Vx9BpazOOBfXeJSKVQ&sig=AOD64_3O-HNEnUO4A5sc31MsUfaTBGG-dQ&q&adurl&ved=2ahUKEwjC3ceTucfsAhXBeisKHatlBewQ0Qx6BAgfEAE

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Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1							1			3	2	2	2		
CO2							1			3	2	2	2		
CO3							1			3	2	2	2		
CO4							1			3	2	2	2		
CO5							1			3	2	2	2		
	3	**High**				**2**	**Medium**				**1**	**Low**			

Summative assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) [50 marks]**
	Theory Marks				**Practical**	
	IAE-I [7.5]	**IAE-II [7.5]**	**IAE -III [10]**	**Attendance [5]**	**Rubric based CIA [20 Marks]**	
Remember	20	20	20		40	40
Understand	20	20	20		40	40
Apply	10	10	10		20	20
Analyze						
Evaluate						
Create						

20PH102	Physics for Electrical Sciences (Common to ECE and BME)	L	T	P	C
		3	0	2	4
Nature of Course	Basic Sciences				
Pre requisites	Fundamentals of Basic Physics				

Course Objectives: The course is intended to

1. Impart knowledge of optics, especially laser and their applications in fiber optics.
2. Gain knowledge to learn thermal properties of materials and their applications.
3. Provide knowledge of properties of matter like elasticity and its applications.
4. Learn the electronic properties of materials like semiconductors and its applications.
5. Develop a clear understanding of optical devices like solar cell, LED etc.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Compare the working of lasers and propagation of light through optical fibers and its applications.	Understand
CO2	Demonstrate the thermal conductivity of the good and bad conductors	Understand
CO3	Explain the knowledge about elasticity	Understand
CO4	Interpret the knowledge about semiconductor materials.	Understand
CO5	Illustrate the working of optoelectronic devices.	Understand

Course Contents:

UNIT I Laser and Fiber Optics 9

Lasers: population of energy levels, Einstein's A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction – Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibers (material, refractive index, mode) – optical fiber communication system – fiber optic endoscope.

UNIT II Thermal Physics 9

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications : heat exchangers in refrigerators, ovens and solar water heaters.

UNIT III Properties of Matter 9

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever – uniform and non-uniform bending - I-shaped girders - stress due to bending in beams.

UNIT IV Semiconductor Physics 9

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – variation of Fermi level with temperature and impurity concentration –Hall effect and its applications.

UNIT V Optical Properties of Materials 9

Classification of optical materials – carrier generation and recombination processes - photo current in a P- N diode: principle and working – solar cell and photo detectors: working principle – LED: principle and working – Organic LED: principle and working, advantages over LED – Laser diodes: principle, working and applications.

Total : 45 Periods

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Laboratory Components

S.No	List of Experiments	CO Mapping	RBT
1	Determination of rigidity modulus – Torsion pendulum	CO3	Apply
2	Determination of Young's modulus by non-uniform bending method.	CO3	Apply
3	Determination of wavelength, and particle size using Laser	CO1	Apply
4	Determination of acceptance angle in an optical fiber	CO1	Apply
5	Determination of thermal conductivity of a bad conductor by Lee's Disc method	CO2	Apply
6	Determination of velocity of sound and compressibility of liquid - Ultrasonic interferometer	CO3	Apply
7	Determination of Coefficient of viscosity of liquid	CO3	Apply

Total: 30 Periods

TEXT BOOKS:

1. Bhattacharya, D.K and Poonam, T, "Engineering Physics", 2nd edition, Oxford University Press, 2015.
2. M.N. Avadhanulu, M.N. & Kshirsagar PG. "A Text book of Engineering Physics", 10th edition, S.Chand and company, Ltd., New Delhi, 2014.
3. William D.Callister,Jr and David. G.Bethwisch, "Materials Science and Engineering", 9th edition, John Wiley & Sons, Inc, 2019.

REFERENCES:

1. Halliday, D, Resnick, R and Walker, J, "Principles of Physics", 10th edition, Wiley, 2014.
2. Serway, R.A. & Jewett, J.W, "Physics for Scientists and Engineers", 9th edition, Cengage Learning, 2019.
3. Raghavan, V. "Materials Science and Engineering, A First course", 5th edition, PHI Learning, 2015.

Web References:

1. https://nptel.ac.in/courses/115/107/115107095/
2. https://www.coursera.org/lecture/fe-exam/stresses-in-beams-strains-in-pure-and-nonuniform-bending-6aMRx
3. https://nptel.ac.in/courses/115/105/115105099/#
4. https://www.youtube.com/watch?v=uv0LxMoalEQ

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1												
CO2	3	1	1												
CO3	3	2	1												
CO4	3	1	1												
CO5	3		1												
	3	High				2	Medium					1	Low		

Summative assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) [50 marks]**
	Theory Marks				**Practical**	
	IAE-I [7.5]	**IAE-II [7.5]**	**IAE-III [10]**	**Attendance [5]**	**Rubric based CIA [20 Marks]**	
Remember	30	30	30		-	30
Understand	62	62	62		40	62
Apply	8	8	8		60	8
Analyse	-	-	-		-	-
Evaluate	-	-	-		-	-
Create	-	-	-		-	-

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20CS102	PROBLEM SOLVING USING PYTHON (Common to all Branches)	L	T	P	C
		3	0	2	4
Nature of Course	Engineering Sciences				
Pre requisites	Mathematical and Logical Knowledge				

Course Objectives

The course is intended

1. To think logically and write algorithm and draw flow charts for problems.
2. To read and write simple Python programs.
3. To develop Python programs with conditionals and loops.
4. To define Python functions and call them.
5. To use Python data structures –- lists, tuples, dictionaries and files.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Develop algorithmic solutions to simple computational problems and read, write, execute by simple python programs.	Apply
CO2	Structure simple python programs for solving problems.	Understand
CO3	Administer the role of control statements and functions involving the idea of modularity.	Apply
CO4	Represent compound data using python strings and lists.	Apply
CO5	Read and write data from/to files in python Programs.	Understand

Course Contents:

Unit I Basics of Computers & Problem Solving 9

Computer Basics – Components-Computer organization - Computer Software- Types of software - Software Development steps -Need for logical analysis and thinking- Algorithms – Flowchart - Number system.

Unit II Introduction of Python Programming 9

Introduction-Python Interpreter-Interactive and script mode -Values and types, variables, operators, expressions, statements, precedence of operators, Multiple assignments, comments, Input and Output Statements.

Unit III Control statements and Functions 9

Conditional (if), alternative (if-else), chained conditional (if-elif-else)-Iteration-while, for, break, continue, pass – Functions - Introduction, inbuilt functions, user defined functions, passing parameters, return values, recursion, Lambda functions.

Unit IV Strings and Lists 9

Strings-String slices, immutability, string methods and operations -Lists-creating lists, list operations, list methods, mutability, aliasing, cloning lists, list and strings, list and functions-list processing-list comprehension, searching and sorting.

Unit V Tuples, Dictionaries and Files 9

Tuples- Tuple assignment, lists and tuples, Tuple as return value- Dictionaries-operations and methods, Files and Exception-Text files, reading and writing files, format Operator, Exception handling.

TOTAL : 45 Periods

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Laboratory Components

S.No	List of Experiments	CO Mapping	RBT
1	Write a algorithm & draw flowchart for simple computational problems	CO1	Understand
2	Write a program to perform different arithmetic operations on numbers in python.	CO2	Understand
3	Write a python program to implement the various control structures	CO3	Apply
4	Write a python program for computational problems using recursive function.	CO3	Apply
5	Demonstrate use of list for data validation.	CO4	Apply
6	Develop a python program to explore string functions	CO4	Analyze
7	Implement linear search and binary search.	CO4	Apply
8	Develop a python program to implement sorting methods	CO4	Analyze
9	Develop python programs to perform operations on dictionaries.	CO5	Analyze
10	Write a python program to read and write into a file	CO5	Apply

TOTAL: 30 Periods

Text Books:

1. Reema Thareja, "Problem Solving and Programming with Python", Oxford University Press, 2018
2. Dr. R. Nageswara Rao, "Core Python Programming", Dreamtech Press, 2017 Edition

Reference Books:

1. Kenneth A. Lambert, "Fundamentals of Python: First Programs", CENGAGE Learning, 2012
2. Ashok Namdev Kamthane, Amit Ashok Kamthane, "Programming and Problem Solving with Python" , Mc-Graw Hill Education, 2018.
3. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem Solving Focus", Wiley India Edition, 2013
4. Timothy A. Budd," Exploring Python", Mc-Graw Hill Education (India) Private Ltd., 2015

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1										3	1	
CO2	3	2	1										3	1	
CO3	3	2	2										3	1	
CO4	3	2	2										3	1	
CO5	3	2	2										3	1	
	3	High				2	Medium					1	Low		

Summative assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) [50 marks]**
	Theory Marks				**Practical**	
	IAE-I [7.5]	**IAE-II [7.5]**	**IAE-III [10]**	**Attendance [5]**	**Rubric based CIA [20 Marks]**	
Remember	10	10	10			20
Understand	20	20	20		30	50
Apply	20	20	20		50	30
Analyse	-	-	-		20	-
Evaluate	-	-	-		-	-
Create	-	-	-		-	-

CHAIRMAN - BOARD OF STUDIES

20BM102	BIOMEDICAL ENGINEERING PRACTICES LAB (Common to ECE & BME Branches)	L	P	T	C
		3	0	0	3
Nature of Course	Engineering Science				
Pre requisites	NA				

Course Objectives

The course is intended to

1. Provide hands on experience on various Hospital wiring and its Control Circuit
2. Understand patient and electrical safety including calibration
3. Provide a comprehensive understanding of basic electronic components and equipment's
4. Study the basic circuits using Active and Passive Components
5. Understand the fundamental principles of logic gates

Course Outcomes

On successful completion of the course, students will be able to

1. Construct basic Hospital electrical wirings for Intensive Care Units [ICU]
2. Test and Measure patient lead leakage including electrical quantities using Patient Safety Analyzers
3. Demonstrate sine, square and triangular waveforms with required frequency and amplitude using function generator
4. Identify the RLC Components and Logic gates
5. Design medical electronic circuits using Electronic Design tools

CYCLE-1

S.No.	Course Content	CO	Bloom's Level
1	Hospital Wiring using switches, fuse, indicator, lamp and energy meter with Control Circuits	CO 1	Understanding
2	Fluorescent lamp wiring	CO 1	Applying
3	Stair case wiring	CO 1	Applying
4	Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit	CO 2	Understanding
5	Measurement of energy using single phase energy meter	CO 2	Understanding
6	Calibration and Testing of Biomedical Equipment's	CO 2	Applying

CYCLE-2

S.No.	Course Content	CO	Bloom's Level
1	Study of Electronic components and equipments – Resistor - Color coding. Measurement of AC signal parameter (peak-peak Voltage, RMS Voltage, frequency) using CRO	CO 4	Understanding
2	Study of logic gates AND, OR, EX-OR and NOT	CO 4	Understanding
3	Generation of Clock Signal	CO 3	Remembering
4	Soldering practice – Components Devices and Circuits – Using general purpose PCB	CO 5	Applying
5	Measurement of ripple factor of HWR & FWR	CO 3	Analyzing
6	Design Bio-amplifier for Noise elimination	CO 5	Applying

Mapping of Course Outcomes (COs) with ProgramOutcomes (POs) ProgramSpecific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	1	1		1	1							3	1	1
2	3	1	1		1	1							3	1	1
3	3	1	1		1	1							3	1	1
4	3	1	1		1	1							3	1	1
5	3	1	1		1	1							3	1	1
	3	High				2	Medium					1	Low		

Summative assessment based on Continuous and Final Examination		
Bloom's Level	**Rubric based Continuous Assessment [50 marks]**	**Final Examination [50 marks]**
Remember	10	10
Understand	50	50
Apply	30	30
Analyze	10	10
Evaluate	-	-
Create	-	-

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20MC101	Induction Programme (Common to all Branches)	L	T	P	C
		2	0	0	0
Nature of Course	Mandatory, Non Credit				
Pre requisites	Completion of Schooling at Higher Secondary Level				

Course Objectives

The course is intended to

1. To nurture the character and behavior as a student.
2. To have broad understanding of society andrelationships.
3. To impart interpersonal and softskills.
4. To inspire the students in the field ofengineering.
5. To provide exposure toindustries.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO 1	Perform curricular and co-curricular activities excellently.	Knowledge
CO 2	Do the skill based training with excellence.	Understand
CO 3	Work as team for the given task	Apply
CO 4	Gain character and behaviour	Knowledge
CO 5	Demonstrate the acquired skills effectively	Apply

Course Contents

PHYSICAL ACTIVITY

Yoga, Sports

CREATIVE ARTS (students can select any one of their choice)

Painting, sculpture, pottery, music, craft making and so on

UNIVERSAL HUMAN VALUES

Enhancing soft skills

LITERARY AND PROFICIENCY MODULES

Reading, Writing, Speaking- Debate, Role play etc.,

Communication and computer skills

LECTURES BY EMINENT PEOPLE

Guest lecture by subject experts

VISIT TO LOCAL CITIES

Meditation centers / Industry

FAMILARIZATION TO DEPARTMENT / BRANCH INNOVATION

Lectures by Departments Head and senior faculty members

Total Hours: 45

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Mapping of COs with POs and PSOs

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1						2	1	2				3	2		
CO2						2	1	2				3	2		
CO3						2	1	2				3	2		
CO4						2	1	2				3	2		
CO5						2	1	2				3	2		
	3	High				2	Medium					1	Low		

Bloom's Level	**Continuous Assessment (Non-Credit, Mandatory)**				
	Test -I [20]	**Test -II [20]**	**Test - III [20]**	**Assignment/ Activity [20]**	**Attendance [20]**
Remember	10	10	10		
Understand	20	20	20	10	
Apply	20	20	20	10	
Analyse					
Evaluate					
Create					

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20ENE02	Advanced Communicative English (Common to all B.E./ B.Tech Programmes)	L	T	P	C
		2	0	2	3
Nature of Course	Humanities and Social Sciences				
Pre requisites	Basics of Communicative English				

Course Objectives

The course is intended to

6. Demonstrate satisfactory control over complex structures and mechanics in English.
7. Develop fluency and accuracy in oral communication.
8. Communicate effectively and actively in social interactions.
9. Read English at inspectional level.
10. Face interviews with confidence.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Apply knowledge of English grammar for effective communication	Remember
CO2	Make use of common English phrases and vocabulary strength.	Understand
CO3	Build self-confidence and enhance professionalism	Apply
CO4	Implement listening, reading and writing skills in real - life situations	Apply
CO5	Speak fluently in English with proper pronunciation, intonation, tone and accent.	Understand

Course Contents

Unit – I Grammar and usage **6**

Active voice and passive voice – Prefixes and suffixes – Connotation – Clauses - If conditionals – Idioms & Phrases - Right forms of verbs – Modal Auxiliaries - Spotting errors.

Unit - II Lexical competence **6**

Technical Vocabulary - Expressions – Frequency – Cause and effect - Words often Miss-spelled – Syntax and structure - Homophones and Homonyms- Verbal analogy - Idioms and Phrases.

Unit - III Conversational etiquette **6**

Processes description – Tone and accent in speech – Role-play (Job-Interview) – Presentation skills – Mechanics of presentation - Telephone etiquette – Group Discussion strategy - Formal & Informal subjective and objective introduction – Body Language – Mock Interview.

Unit – IV Listening reading and writing **6**

Listen to Scientific / Technical talks and gap filling – Listening to TED/INK Talks – Reading – “Water: The Elixir of Life” by Sir. C.V.Raman. “Progress” by St. John Ervine - Instructions and Recommendations – Letter writing formal – Job application- Report writing – Introspective report – Creative writing – Essays and Paragraphs.

Unit – V Phonetics **6**

Production and classification of speech sound – International Phonetic Alphabet and transcriptions – Phonological rules – way and Place of articulation – Vowels, consonants and diphthongs. Specific characteristics feature of vowel sounds.

Total: 30 Periods

Laboratory Components

S.No	List of Exercises	CO Mapping	RBT
1	Role-play – Processes Description	2	Remember
2	Listening to TED/INK Talks and gap filling	4	Understand
3	Group Discussion	3	Understand
4	Articulation with pronunciation practice	3	Apply
5	Reading – Longer texts and Technical Articles (Skimming & Scanning).	4	Apply
6	Presentation skills – Mechanics of presentation	5	Understand
7	Individual presentation on given topics	5	Remember
8	Telephone etiquette	5	Understand
9	Instructions and Recommendations	5	Remember
10	Writing – General Essays.	4	Apply
11	Report writing technique- write up	4	Remember
12	Introspective report – Personal analysis	4	Understand
13	Model Job Interviews	3	Understand
14	Job Interviews(Role play)	3	Apply
15	Body Language	3	Understand

Total: 30 Periods

Text Books

3. Rizvi, Ashraf.M, “Effective Technical Communication”, Tata McGraw Hill Publishing Company Limited, New Delhi, 5th Edition, 2007.

4. Hewings. M, “Advanced English Grammar”, 3rd Edition, Cambridge University Press, Chennai, 5th Edition, 2000.

5. Board of Editers, “Using English – A Coursebook for Undergraduate Engineers and Technologists”, Orient BlackSwan Private Limited, Hyderabad, 2nd Edition, 2017.

Reference Books:

5. Raman M & Sangeetha Sharma, “Technical Communication”, Oxford University Press, USA, 10th Edition, 2007.

6. John Cunnison Catford, “A Practical Introduction to Phonetics”,Clarendon Press, Jamaica, 2nd Edition, 2001.

7. Norman Whitby, Business Benchmark – “Pre-Intermediate to Intermediate, Students Book”, Cambridge University Press, 1st Edition, 2006.

8. Dhanavel S. P., “English and Soft Skills”, 1st Edition,Orient BlackSwan Private Limited, Hyderabad, 1st Edition, 2010.

Web reference:

1. https://www.coursera.org/lecture/tesol-speaking/video-2-listening-strategies-for-learners-3AeBL?utm_source=mobile&utm_medium=page_share&utm_content=vlp&utm_campaign=top_button

2. blob:https://www.youtube.com/73f7256d-d302-4563-bed5-9e84c94a26ac

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Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1										3	1	2	2		
CO2										3	1	2	2		
CO3										3	1	2	2		
CO4										3	1	2	2		
CO5										3	1	2	2		
	3	High				2	Medium				1	Low			

Summative assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) [50 marks]**
	Theory Marks				**Practical**	
	IAE-I [7.5]	**IAE-II [7.5]**	**IAE -III [10]**	**Attendance [5]**	**Rubric based CIA [20 Marks]**	
Remember	20	20	20		40	40
Understand	20	20	20		40	40
Apply	10	10	10		20	20
Analyse						
Evaluate						
Create						

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II SEMESTER

20MA204	Mathematics - II for Electrical Sciences (Common to ECE and BME)	L	T	P	C
		3	2	0	4
Nature of Course	Basic Sciences				
Pre requisites	Fundamentals of Basic Mathematics				

Course Objectives

The course is intended to

1. Learn rigorous and analytic approach to analyze the conformal mapping.
2. Study the knowledge of evaluating contour integrals using residue theorem.
3. Explain the concept of Laplace transforms and its applications to various problems related to Engineering.
4. Acquaint the student with Fourier transform techniques used in wide variety of situations
5. Study the knowledge of specific mathematical tools and techniques such as Z-transforms and solutions of difference equations

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Compute an analytic function ,when its real or imaginary part is known	Understand
CO2	Identify the Singularities and its corresponding Residues for the given function	Apply
CO3	Compare Laplace transform, Inverse Laplace transform and solve the linear differential equations by Laplace transform techniques.	Apply
CO4	Solve Engineering problems using Fourier transform techniques	Apply
CO5	Solve difference equations using Z-transforms that arise in discrete time systems	Apply

Course Content

Unit - I Complex Differentiation and Conformal Mapping 12

Functions of a complex variable – Analytic functions – Statement of Cauchy – Riemann equation – Harmonic functions – Harmonic conjugate – Construction of analytic functions – Conformal mapping : w=z +c, cz, 1/z and Bilinear transformation.

Unit - II Complex Integration and Calculus of Residues 12

Cauchy's Integral theorem (statement only) – Cauchy's integral formula – Liouville's theorem - Maximum Modulus Principle - Taylor's series and Laurent's series – Classification of singularities – Cauchy's residue theorem – Contour integration.

Unit - III Laplace Transforms 12

Laplace transforms – Transform of elementary functions – Properties – Transform of periodic functions. Definition of Inverse Laplace transforms – Statement and applications of Convolution theorem – Initial and Final theorems – Solution of linear ODE of second order with constant coefficient by Laplace transforms.

Unit - IV Fourier Transforms 12

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity - Application to boundary value problems.

Unit - V Z - Transforms 12

Z-Transform, Elementary Properties, Inverse Z-Transform, Convolution Method- Partial fraction method, Solution of Difference Equations using Z-Transform.

Total: 60 Periods

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Text Books:

1. Grewal B.S, "Higher Engineering Mathematics", Khanna Publishers, 44th Edition 2016.
2. Veerarajan T, "Engineering Mathematics for Semester I and II", Tata McGraw Hill, 3rd Edition, 2014.

Reference Books:

1. Bali N.P and Dr. Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications(P)Ltd, 8th Edition, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons(Asia) Limited, 10th Edition, 2018.

Web References:

1. nptel.ac.in/courses/111/105/111105134
2. nptel.ac.in/courses/111/102/111102129

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSOs)

	POs												PSOs		
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1										2		
CO2	3	2	1										2		
CO3	2	3	2										3		
CO4	3	3	3										2		
CO5	3	2	3										2		
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

CHAIRMAN - BOARD OF STUDIES

20BM201	BIOCHEMISTRY	L	T	P	C
		3	0	0	3
Nature of Course	Engineering Sciences				
Pre requisites	NIL				

Course Objectives:

The course is intended to

1. To learn the fundamentals of bio chemical reactions and bio molecules.
2. Tostudystructuralandfunctionalpropertiesofcarbohydrates.
3. To understanding of the core principles and structure ofproteins,lipidsandnucleicacids.
4. Toemphasizetheroleofthesebiomoleculesbyprovidingbasicinformationonspecificmetabolicdiseasesanddisordersofthesebiomolecules.
5. Acquire knowledge and understanding of metabolicfunctions and synthesis.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explain the Chemical bonds and its application	Understand
CO2	Classify the Metabolic activity of Carbohydrates	Understand
CO3	Understand the basics of Protein Metabolism	Understand
CO4	Compare fattyacidmetabolismandnucleicacidmetabolism	Understand
CO5	Classify the bio energetic and high energy compounds	Understand

Course Contents:

UNIT I Introduction to Biochemistry **9**

Introduction of organic chemistry-Chemical Bonds–role of carbon–type of functional group-chemical nature of water-pH-Buffers–Biological Buffer-Carbohydrates-Lipids–Proteins–transamination–deamination–decarboxylation.

UNIT II Metabolism of Carbohydrates **9**

Introduction to Metabolism-Glycolysis–Citricacid cycle–Gluconeogenesis-Glycogenmetabolism–Glycogenesis–Glycogenolysis-Biochemical aspects of Diabetes Mellitus.

UNIT III Protein Metabolism **9**

Introduction-Metabolism of amino acids-Transamination-Deamination-Metabolism of ammonia-Ureacycle-Biosynthesis of amino acids-Disorders of tyrosine (phenylalanine) metabolism

UNIT IV Fatty Acid Metabolism and NucleicAcid Metabolism **9**

Introduction-Fattyacidoxidation-Ketone bodies & Ketogenesis-Biosynthesis of Fatty acids-Eicosanoids–Cholesterol Biosynthesis–Lipoproteins–Disorders of Lipid metabolism-Nucleicacids Biosynthesis of Purine and Pyrimidines-Degradation of purine nucleotides and pyrimidine Nucleotides-Disorders of Purine and pyrimidine metabolism.

UNIT V Oxidative Phosphorylation **9**

Introduction-Bioenergetics, High energy compounds, Biological oxidation Electron transport chain, Oxidative phospholyration, Chemiosmotic theory–Shuttle pathway Glycerol phosphate Shuttle, Malate aspartate Shuttle – Shunt pathways.

TOTAL PERIODS:45

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TEXT BOOK

1.JL,Jain,Nitin,SunjayJain.,"*FundamentalsofBiochemistr*",S.ChandGroup, 7th edition, 2016.
2. U.Satyanarayana. andU.Chakrapani.,"*Biochemistry",* BooksAndAllied(p)Ltd.,5th edition, 2019

REFERENCES

1.DavidL.Nelson,AlbertLesterLehninger,MichaelM.Cox.,"Lehninger principlesofBiochemistry", 5th Edition,llustrated,W.H.Freeman,2008.

2. JeremyM.Berg,JohnL.Tymoczko,LubertStryer.,"*Biochemistry*",W.H.Freeman,7thEdition,2012.

Web References:

1.https://nptel.ac.in/content/storage2/courses/126104004/LectureNotes/Week-1_06 Carbohydrate.pdf
2.https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod10.pdf

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
CO1	3	1	1			2	2		1	2			1	1	
CO2	3	1	1			2	2		1	2			1	1	
CO3	3	1	1			2	2		1	2			1	1	
CO4	3	1	1			2	2		1	2			1	1	
CO5	3	1	1			2	2		1	2			1	1	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment**			**Final Examination (Theory) (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	30	30	30	60
Analyse				
Evaluate				
Create				

CHAIRMAN - BOARD OF STUDIES

20CH202	CHEMISTRY FOR ELECTRICAL SCIENCES (Common to ECE and BME)	L	T	P	C
		3	0	2	4
Nature of Course	Basic Sciences				
Prerequisites	Nil				

Course Objectives:

The course is intended to

1. Impart knowledge and understanding about the constituents present in water and the need for purification of water.
2. Understand the fundamentals of batteries.
3. Provide knowledge about materials like metals, refractories and cement.
4. Develop the understanding and applications of basic concepts ofelectrochemistry.
5. Understand the causes and control measures of corrosion.

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO1	Develop innovative and eco-friendly method for water purification to meet the growing industrial demand	Apply
CO2	Understand the basic principles and mechanism of working of batteries and fuel cells	Understand
CO3	Discussabout various types of alloys and engineering materials	Understand
CO4	Use the principles of electro chemical cells,EMF, electroplating and electrolysis	Apply
CO5	Demonstrate the importance of protection of metals from corrosion	Apply

Course Contents

Unit-I Water Analysis and Water Treatment 9

Water analysis: Sources of water, Hard water and soft water, Hardness of water, acidity, alkalinity, pHvalue, amount of free CO2, fluoride content and chloride content. Biological Oxygen Demand (BOD), Chemical Oxygen Demand(COD). Water treatment: Definition, Zeolite process, Conditioning methods:internalconditioning (Phosphate, Calgon) and external conditioning (Demineralisation), Desalination, Reverseosmosis (RO).

Unit-II Energy Storage Devices 9

Batteries: Definition, characteristics and classification, Primary battery: Alkaline battery, Secondary battery: lead acid battery, nickelcadmium battery,lithium battery and lithium ionbattery, Fuel cells: construction and working ofphosphoric acid fuel cell.

Unit-III Alloys and Engineering Materials 9

Alloys: classification and types, Ferrous alloys (Nichrome and stainless steel only), Non- ferrous alloys (brass and bronze), Heat treatment of steel, Refractories: characteristics, classification – manufacture, Cement: manufacture and setting.

Unit-IV Electrochemistry 9

Electrodepotential,Nernstequationandproblems,Referenceelectrodes,Standardhydrogen electrode, Calomel electrode, Ionselective electrode (glass electrode), Determination of pH by glass electrode,Electro chemical series, Electrochemical cell, Galvanic cell: measurement of EMF, Electrolytic cell.

Unit-V Corrosion and its Control 9

Corrosion: Classification, Types: Chemical corrosion and electrochemical corrosion, mechanism. Corrosion control: Corrosion inhibitors, cathodic protection (sacrificial anodic protection, impressed current cathodic protection), Protective coating and Paint. Electroplating (Au).

TOTALPERIODS:45

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Laboratory Component

S.No	Name of the Experiment	CO Mapping	RBT
1	Determination of hardness of water	CO1	Apply
2	Determination of chloride content in water sample	CO1	Apply
3	Conductometric titration of strong acid versus strong base	CO2	Understand
4	Determination of strength of HCl by pH metry	CO2	Understand
5	Estimation of copper in brass by EDTA method	CO3	Apply
6	Determination of CaO in cement	CO3	Apply
7	Estimation of strength of iron by potentiometric titration	CO4	Apply
8	DDetermination alkalinity of water sample and making a comparative studyof corrosion rate	CO5	Apply

Text Books

1. O.G.Palanna, “Engineering Chemistry”Tata McGraw-Hill Pub.Co.Ltd,1st Edition, New Delhi,2017.
2. P.C.Jain and Monicka Jain, “Engineering Chemistry”,DhanapatRai Publishing Company Pvt. Ltd, 2nd Edition,2017.

Reference Books

1. B.Sivasankar“EngineeringChemistry”TataMcGraw-HillPub.Co.Ltd,2nd Edition, New Delhi 2009.
2. R.Sivakumar and N.Sivakumar,“EngineeringChemistry”TataMcGraw-Hill Pub.Co.Ltd, New Delhi, 1st Edition, 2009.
3. Dr.Sivanesanand Nandagopal, “Engineering Chemistry-I” V.K.Pub.Pvt.Ltd,2nd Edition, 2011.

Additional Resources

1. https://nptel.ac.in/downloads/122101001
2. https://nptel.ac.in/courses/103103033/module9/lecture1.pdf
3. https://nptel.ac.in/courses/102103044/3
4. https://www.sciencedirect.com/topics/chemistry/phosphoric-acid-fuel-cells

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2									1				
CO2	3	2									1				
CO3	3	2									1				
CO4	3	2									1				
CO5	3	1									1				
	3	High				2	Medium				1	Low			

Summative Assessment						
	ontinuous Assessment					**Final**
	Theory					
	IAE-I [7.5]	**IAE-II [7.5]**	**IAE-III[10]**	**Attendance [5]**	**Rubric based CIA [20]**	
Remember	30	20	10		20	
Understand	10	20	30		20	
Apply	10	10	10		10	
Analyze						
Evaluate						
Create						

CHAIRMAN - BOARD OF STUDIES

20ME203	Engineering Graphics	L	T	P	C
		1	0	4	3
Nature of Course	Engineering Sciences				
Pre requisites	Nil				

Course Objectives:

The course is intended to

1. Understand technical drawings in various fields of engineering
2. Imagine and visualize the geometric details of engineering objects.
3. Translate the geometric information of engineering objects into engineering drawings.
4. Develop the graphical skills for communication of concepts, ideas and design of engineering products through technical drawings.
5. Visualize and draw isometric and perspective views

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO 1	Develop the conic sections, special curves, and draw orthographic views from pictorial views.	Apply
CO 2	Apply the principles of orthographic projections of points in all quadrants, lines and planes in first quadrant.	Apply
CO 3	Construct the projections of simple solids like prisms, pyramids, cylinder and cone.	Apply
CO 4	Build the sectional views of solids like cube, prisms, pyramids, cylinders & cones and development of its lateral surfaces.	Apply
CO 5	Organize and draw isometric and perspective sections of simple solids.	Apply

Course Contents

Concepts and Conventions (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT -I Plane Curves and Free Hand Sketching (3+12)

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

UNIT –II Projection of Points, Lines and Plane Surfaces (3+12)

Orthographic projection- principles-Principal Planes-First angle projection-projection of points Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT –III Projection of Solids (3+12)

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.

UNIT- IV Projection of Sectioned Solids and Development of Surface (3+12)

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section, Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes

UNIT -V Isometric and Perspective Projections (3+12)

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method.

TOTAL: (15+60) Periods

TEXT BOOKS

1. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2011
2. Natarajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2012.

REFERENCE BOOKS

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.
2. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Parthasarathy N S and Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015.

Web References

1. http://nptel.ac.in/courses/112103019/Engineering drawing
2. http://pioneer.netserv.chula.ac.th/~kjirapon/self-practice.html

Publication of Bureau of Indian Standards

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable only to Final Examinations of Engineering Graphics:

1. There will be five questions, each of either-or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2										1	2		
CO2	3	2										1	2		
CO3	3	2										1	2		
CO4	3	3										1	2		
CO5	3	2										1	2		
	3	High				2	Medium				1	Low			

Summative assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) [50 marks]**
	Theory				**Practical**	
	IAE-I [7.5]	**IAE-II [7.5]**	**IAE-III [10]**	**Attendance [5]**	**Rubric based CIA [20 Marks]**	
Remember	10	10	10		20	20
Understand	20	20	20		40	40
Apply	20	20	20		40	40
Analyse						
Evaluate						
Create						

CHAIRMAN - BOARD OF STUDIES

20BM202	BIOCHEMISTRY LABORATORY	L	T	P	C
		0	0	4	2
Nature of Course	Engineering Sciences				
Pre requisites					

Course Objectives

The course is intended to

1. Estimation and Quantification of bio molecules
2. Separation of macromolecules
3. Estimation and interpretation of biochemical parameter.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO 1	Get knowledge on the PH and buffer solution preparation.	Understand
CO 2	Have adequate knowledge on qualitative analysis of bio molecules.	Analysis
CO 3	Gain knowledge on the estimation of biomolecules.	Analysis
CO 4	Acquire knowledge on collections of blood .	Understand
CO 5	Get sufficient knowledge on the concept of SDS electrophoresis.	Understand

CYCLE-1

S.No.	Course Content	Bloom's Level
1	Standardization of pH meter, preparation of buffers, emulsions	Understand
2	General tests for carbohydrates, proteins and lipids.	Understand
3	Identification of Blood Collection Tubes and Phlebotomy equipments	Analysis
4	Preparation of serum and plasma from blood.	Analysis
5	Estimation of blood glucose-Benedict's method	Analysis
6	Estimation of Hemoglobin	Understand

CYCLE-2

S.No.	Course Content	Bloom's Level
1	Estimation of creatinine.	Understand
2	Estimation of urea	Analysis
3	Estimation of Uric acid	Analysis
4	Estimation of cholesterol	Analysis
5	Assay of SGOT/SGPT.	Analysis
6	Separation of proteins by SDS electrophoresis (Demo)	Analysis

Mapping of Course Outcomes (CO) with Program Outcomes (PO) Program Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1				2	2	2	2	2	2			2	3	1	
2				2	2	2	2	2	2			2	3	1	
3				2	2	2	2	2	2			2	3	1	
4				2	2	2	2	2	2			2	2	1	
5				2	2	2	2	2	2			2	2	1	
	3	High				2	Medium					1	Low		

Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment [50 marks]**	**Finalr Examination [50 marks]**
Remember	-	-
Understand	20	20
Apply	-	-
Analyze	30	30
Evaluate	-	-
Create	-	-

CHAIRMAN - BOARD OF STUDIES

20MC202	INTERPERSONAL SKILLS	L	T	P	C
		2	0	2	0
Nature of Course	Mandatory, Non Credit				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Use interpersonal communication skills to influence and build good relationships.
2. Identify and pursue personal learning goals.
3. Obtain feedback skills in service of evolving learning goals.
4. Learn about group dynamics, behaviors and feelings
5. Enhance the communication process in both formal and informal contexts

Course Outcomes

On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO1	Practice interpersonal communication skills to influence and build good relationships	Understand
CO2	Identify and pursue personal learning goals.	Understand
CO3	Give evident feedback	Understand
CO4	Reveal group dynamics and amiable behavior	Understand
CO5	Emphasis the communication process	Understand

Course Contents:

Unit I: Fundamentals of Interpersonal Communication **6**

Facts of communication and Interpersonal communication – culture and gender – Communication and Self disclosure – Presentation of Interpersonal perception - Learning goals – Feeling and feedback.

Unit II: Interpersonal communication in action **6**

Nature of language – language and culture – usage and abuse of language –Positive communication -Non verbal communication - Listening strategies – Barriers of listening.

Unit III: Emotional Intelligence **6**

Influence of emotional experience and expressions – Accepting the responsibilities and changes - Negotiation tactics - Dealing with criticism and appreciation - Collaborative Problem Solving - Resilience Building.

Unit IV: Transactions **6**

Different types of transactions - Building Positive Relationship - Managing Conflict – Connecting across Difference – Factors hampering Interpersonal interactions – Assertiveness in communication.

Unit V: Essential Interpersonal Competencies **6**

Behaviour – Understanding limiting behaviour - Interpersonal and small group behavior – Critical and lateral thinking- Win – Win attitude – Positive thinking – Stress management – Assertive feedback - Personal Evaluation of Interpersonal Relationship Skills

Total 30 Periods

CHAIRMAN - BOARD OF STUDIES

Activity Component

S.No	Name of the Exercises	CO Mapping	RBT
1	Self-Introduction	1	Remember
2	Presentation of Individual perception	2	Understand
3	Role play - Non-verbal communication - Body language	4	Apply
4	Role play - Interpersonal interactions & Assertive feedback	3	Remember
5	Group Discussion	4	Apply
6	Role play - Situational conversation (On spot)	5	Understand

Text Books

1. Bozeman, Jeanine C and Argile Smith, “Interpersonal Relationship Skills for Ministers” Gretna, LA: Pelican Publishing Company, 1st Edition, 2004.
2. Floyd, Kory, “Interpersonal Communication”, 2d. Boston: McGraw-Hill, 2nd Edition, 2011.

Reference Books:

1. Augsburger, David, “Caring Enough to Confront How to Understand and Express Your Deepest Feelings Towards Others”, updated ed. Ventura, CA: Regal Books, 2nd Edition 2009.
2. Vohs, Kathleen D., and Eli J., Finkel, eds, “Self and Relationships: Connecting Intrapersonal and Interpersonal Processes”, New York: Guilford Press, 1st Edition, 2006.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1										3	2	1	2		
CO2										3	2	1	2		
CO3										3	2	1	2		
CO4										3	2	1	2		
CO5										3	2	1	2		
	3	High				2	Medium				1	Low			

Bloom’s Level	Summative Assessment (Internal Mode)	
	Assessment 1 (50 Marks)	**Assessment 2 (50 Marks)**
Remember	20	20
Understand	10	10
Apply	20	20
Analyze		
Evaluate		
Create		

CHAIRMAN - BOARD OF STUDIES

20ENE02	Advanced Communicative English (Common to all B.E./ B.Tech Programmes)	L	T	P	C
		2	0	2	3
Nature of Course	Humanities and Social Sciences				
Pre requisites	Basics of Communicative English				

Course Objectives

The course is intended to

1. Demonstrate satisfactory control over complex structures and mechanics in English.
2. Develop fluency and accuracy in oral communication.
3. Communicate effectively and actively in social interactions.
4. Read English at inspectional level.
5. Face interviews with confidence.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Apply knowledge of English grammar for effective communication	Remember
CO2	Make use of common English phrases and vocabulary strength.	Understand
CO3	Build self-confidence and enhance professionalism	Apply
CO4	Implement listening, reading and writing skills in real - life situations	Apply
CO5	Speak fluently in English with proper pronunciation, intonation, tone and accent.	Understand

Course Contents

Unit – I Grammar and usage **6**

Active voice and passive voice – Prefixes and suffixes – Connotation – Clauses - If conditionals – Idioms & Phrases - Right forms of verbs – Modal Auxiliaries - Spotting errors.

Unit - II Lexical competence **6**

Technical Vocabulary - Expressions – Frequency – Cause and effect - Words often Miss-spelled – Syntax and structure - Homophones and Homonyms- Verbal analogy - Idioms and Phrases.

Unit - III Conversational etiquette **6**

Processes description – Tone and accent in speech – Role-play (Job-Interview) – Presentation skills – Mechanics of presentation - Telephone etiquette – Group Discussion strategy - Formal & Informal subjective and objective introduction – Body Language – Mock Interview.

Unit – IV Listening reading and writing **6**

Listen to Scientific / Technical talks and gap filling – Listening to TED/INK Talks – Reading – "Water: The Elixir of Life" by Sir. C.V.Raman. "Progress" by St. John Ervine - Instructions and Recommendations – Letter writing formal – Job application- Report writing – Introspective report – Creative writing – Essays and Paragraphs.

Unit – V Phonetics **6**

Production and classification of speech sound – International Phonetic Alphabet and transcriptions – Phonological rules – way and Place of articulation – Vowels, consonants and diphthongs. Specific characteristics feature of vowel sounds.

Total: 30 Periods

Laboratory Components

S.No	List of Exercises	CO Mapping	RBT
1	Role-play – Processes Description	2	Remember
2	Listening to TED/INK Talks and gap filling	4	Understand
3	Group Discussion	3	Understand
4	Articulation with pronunciation practice	3	Apply
5	Reading – Longer texts and Technical Articles (Skimming & Scanning).	4	Apply
6	Presentation skills – Mechanics of presentation	5	Understand
7	Individual presentation on given topics	5	Remember
8	Telephone etiquette	5	Understand
9	Instructions and Recommendations	5	Remember
10	Writing – General Essays.	4	Apply
11	Report writing technique- write up	4	Remember
12	Introspective report – Personal analysis	4	Understand
13	Model Job Interviews	3	Understand
14	Job Interviews(Role play)	3	Apply
15	Body Language	3	Understand

Total: 30 Periods

Text Books

6. Rizvi, Ashraf.M, “Effective Technical Communication”, Tata McGraw Hill Publishing Company Limited, New Delhi, 5th Edition, 2007.

7. Hewings. M, “Advanced English Grammar”, 3rd Edition, Cambridge University Press, Chennai, 5th Edition, 2000.

8. Board of Editers, “Using English – A Coursebook for Undergraduate Engineers and Technologists”, Orient BlackSwan Private Limited, Hyderabad, 2nd Edition, 2017.

Reference Books:

9. Raman M & Sangeetha Sharma, “Technical Communication”, Oxford University Press, USA, 10th Edition, 2007.

10. John Cunnison Catford, “A Practical Introduction to Phonetics”,Clarendon Press, Jamaica, 2nd Edition, 2001.

11. Norman Whitby, Business Benchmark – “Pre-Intermediate to Intermediate, Students Book”, Cambridge University Press, 1st Edition, 2006.

12. Dhanavel S. P., “English and Soft Skills”, 1st Edition,Orient BlackSwan Private Limited, Hyderabad, 1st Edition, 2010.

Web reference:

3. https://www.coursera.org/lecture/tesol-speaking/video-2-listening-strategies-for-learners-3AeBL?utm_source=mobile&utm_medium=page_share&utm_content=vlp&utm_campaign=top_button

4. blob:https://www.youtube.com/73f7256d-d302-4563-bed5-9e84c94a26ac

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Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1										3	1	2	2		
CO2										3	1	2	2		
CO3										3	1	2	2		
CO4										3	1	2	2		
CO5										3	1	2	2		
	3	High				2	Medium				1	Low			

Summative assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) [50 marks]**
	Theory Marks				**Practical**	
	IAE-I [7.5]	**IAE-II [7.5]**	**IAE -III [10]**	**Attendance [5]**	**Rubric based CIA [20 Marks]**	
Remember	20	20	20		40	40
Understand	20	20	20		40	40
Apply	10	10	10		20	20
Analyse						
Evaluate						
Create						

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20ENE03	HINDI	L	T	P	C
		2	0	2	3
Nature of Course	Humanities and Social Sciences				
Pre requisites	Basic Perceptive of Language				

Course Objectives

The course is intended for learners.

1. To help students acquire the basics of Hindi
2. To teach them how to converse in Hindi on simple day-to-day situations
3. To help students acquire the ability to understand a simple technical text in Hindi

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO.1	Construct simple sentences and use vocabulary required for day-to-day conversation	Remember
CO.2	Distinguish and understand the basic sounds of Hindi language.	Remember
CO.3	Appear for Hindi examinations conducted by Dakshin Bharat Hindi PracharSabha.	Remember

Course Contents:

UNIT I: Introduction 6

Hindi Alphabet: Introduction - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - owel Signs- Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

UNIT II: Reading 6

Nouns: Genders (Masculine & Feminine Nouns long vowels and short vowels - -Masculine & Feminine - Reading Exercises

UNIT III:Grammar 6

Pronouns and Tenses: Categories of Pronouns - Personal Pronouns - Second person you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences – Interrogative Sentences.

UNITI V : Vocabulary 6

Classified Vocabulary: Parts of body - Relatives - Spices - Eatables - Fruit & Vegetables - Clothes - Directions - Seasons - Professions

UNIT V:Speaking 6

Speaking: Model Sentences and Rhymes - Speaking practice for various occasions.

Total: 30 Periods

Reference:

1. Hindi Prachar Vahini-1 by Dakshin Bharat Hindi Prachar Sabha Chennai
2. B.R.Kishore, Self Hindi Teacher for Non-Hindi Speaking People, VeeKumar Publications(P)Ltd., NewDelhi,2009
3. Videos, Stories, Rhymes and Songs.

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20ENE04	FRENCH	L	T	P	C
		2	0	2	0
Nature of Course	Humanities and Social Sciences				
Pre requisites	Basic Perceptive of Language				

Course Objectives

The course is intended for learners.

1. To prepare the students for DELFA1Examination
2. To teach them to converse fluently in French in day-to-dayscenarios

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	To help students acquire familiarity in the French alphabet &basic vocabulary	Remember
CO2	listen and identify individual sounds of French	Remember
CO3	Use basic sounds and words whiles peaking	Remember
CO4	Read and understand short passages on familiar topics	Understand
CO5	Understand and use basic grammar and appropriate vocabulary in completing language tasks	Understand

Course Contents:

UNIT I : Entrer En Contact **6**

La langue francaise, alphabets, les numeros, les jours, les mois. Grammaire Les verbes s''appeler,etre, avoir, les articles definis, indefinis Communication - Saluer, s''informer sur quelquun, demander de se presenter Lexique - Les alphabets, les nationalites, age, les pays, les couleurs, les jours de la semaine, les mois de l''annee, les professions

UNIT II :Partager Son Lieu De Vie **6**

Lesfrancaisetleur habitat, des habitation s in solitesGrammaire- Verbes - Conjugaison : Present (Avoir / etre / ER, IR, RE : RegulieretIrregulier) –AdjectifsIdelieuCommunication - Chercher un logement, d''ecrire son voisin, s''informersur un logementLexique - L''habitat, les pieces, l''equipement, la descriptionphysiqu

UNIT III: Vivre Au Quotidien **6**

Grammaire - Articles contractes, verbesvouloir, pouvoir, devoir, adjective interrogative, future proche Communication- Exprimersesgouts, parler de sesloisirs, justifier un choix, exprimeruneenvieLexique - le temps libreet les loisirs, les saisons, les activitesquotidiennes, le temps (lematin, le soir, lanuit)

UNIT IV: Comprendre Son EnvironnementOuvrir La Culture **6**

Grammaire - Verbes- Finir, Sortir, les adjectifsdemonstratifs, le passe compose, l''imparfait Communication - Propose aÃƒ?Ã‚quelqu''''un de faire quelque chose, raconteur une sortie au passeparlerunfilmLexique - Les sorties, la famille, art, les vetementsetlesaccessoires

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UNIT V: Gouter ALa Campagne **6**

Grammaire La forme negative, les verbesacheter, manger, payer, articles partitifs, le pronomen de quantite Communication Accepter et refuse rune invitation, donner des instructions, commander au restaurant Lexique Les services et les commerces, les aliments, les ustensiles, argent.

Total: 30 Periods

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1										2					
CO2										2					
CO3										3					
CO4										3					
CO5										2					
	3	High				2	Medium					1	Low		

III SEMESTER

20MA302	PARTIAL DIFFERENTIAL EQUATIONS AND LINEAR ALGEBRA (Common to ECE and BME)	L	T	P	C
		3	2	0	4
Nature of Course	Basic Sciences				
Pre requisites	Mathematics-I & II for Electrical Sciences				

Course Objectives

The course is intended to

1. Learn vector spaces, subspaces, bases and dimensions.
2. Study the concepts of linear maps and inner product spaces in orthogonalization.
3. Provide the procedure to solve partial differential equations.
4. Acquire the knowledge of odd and even function, half range Fourier series.
5. Acquaint with the Fourier series techniques in solving one dimensional wave and heat equations**.**

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Apply linear independence and dependence of vectors and basis of vector spaces	Apply
CO2	Construct an orthonormal basis by applying the Gram-Schmidt process.	Apply
CO3	Classify the linear and non-linear partial differential equations.	Understand
CO4	Apply Fourier series to solve engineering problems	Apply
CO5	Interpret the solution of Partial Differential Equations.	Understand

Course Contents:

UNIT I Vector Spaces **12**

Vector Spaces – Subspaces – Linear Combinations and Linear System of Equations-Linear independence and Linear dependence – Bases and Dimensions.

UNIT II Linear transformation and Inner Product Spaces **12**

Linear transformation – Null and Range Spaces – Dimension theorem – Inner product: Norms – Gram Schmidt Orthogonalization Process.

UNIT III Partial Differential Equations **12**

Solutions of standard types of first order non-linear partial differential equations: (i) f(p,q)=0, (ii) Clairaut's type – Lagrange's linear equation –Homogeneous linear partial differential equations of second & higher order with constant coefficients (R.H.S = Constant, e^{ax+by}, $cos(ax + by)$,$sin(ax + by)$

UNIT IV Fourier series and Harmonic Analysis **12**

Dirichlet's conditions – General Fourier series – Even and Odd functions - Half range Expansions – Harmonic analysis: π, degree and T- forms.

UNIT V Applications of Partial Differential Equations **12**

Classifications of Partial differential equations – Method of separation of variables –Solutions of one dimensional wave equation – Solutions of one dimensional heat equation.

Total: 60 Periods

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Text Books:

1. Grewal B.S, "Higher Engineering Mathematics", 39th Edition, Khanna Publishers, 2014.
2. Friedberg, A.H., Insel, A.J. and Spence, L., Linear Algebra, Prentice Hall of India, New Delhi, 2004.

Reference Books:

1. Bali N.P and Manish Goyal, "A Text book of Engineering Mathematics", Lakshmi Publications Pvt Ltd, 3rd Edition, 2014.
2. Lay, D.C., Linear Algebra and its Applications, Pearson Education, 5th Edition, 2015
3. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India Publications, 8th Edition, 2012.

Additional References:

1. https://nptel.ac.in/courses/111/106/111106051/
2. https://pvpsitrealm.blogspot.com/2016/09/higher-engineering-mathematics-by-bs.html

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2										2		
CO2	3	2	2	2						2			2		
CO3	3	3	1			1							2		
CO4	2	2	2	2									1		
CO5	3	3	2							2			2		
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

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20BM301	SIGNALS AND SYSTEMS FOR BIOENGINEERS	L	T	P	C
		3	2	0	4
Nature of Course	Professional Core				
Pre requisites	Engineering Mathematics				

Course objectives:
The course is intended to

1. Understand the classification of signals and systems with state space model.
2. Analyze CT signals using Fourier series & Transforms in Time domain.
3. Analyze DT signals and systems using Fourier transform and Z-Transform.
4. Analyze concurrent, Coupled and Correlated Physiological Processes.
5. Understand Joint Time Frequency [JTF] concepts to Biosignal applications.

Course Outcomes:
On successful completion of the course, students will be able to

CO.No	Course Outcome	Bloom's Level
CO1	Explain the basic concepts of Biosignals and Physiological Systems with its Characteristics	Understand
CO2	Analyze Analog CT signals and systems with Fourier series, CTFT including Laplace Transform for LTI Analog System Analysis	Analyze
CO3	Analyze Discrete DT signals and systems using Fourier transform, DTFT and Z-Transform Transform for LTI Discrete System Analysis	Analyze
CO4	Analyze Concurrent, Coupled and Correlated Physiological Process with examples for event detection in Biomedical applications	Analyze
CO5	Explain Joint Time Frequency [JTFA] Concepts for Biosignal interpretation and Classification	Understand

Course Content

UNIT I CLASSIFICATIONS OF BIOSIGNALS AND PHYSIOLOGICAL SYSTEMS 12

Basics of Biosignals and Physiological Systems – Characteristics and representation of Biosignals - Sampling and quantization concepts- Coders/Encoders- Elementary signals – Representations of signals–Classifications of signals – Signal Operations. Analog Vs Discrete Signals - Periodic, aperiodic, transient, stationary and non-stationary signals including 2-dimensional signals as Images. Classifications of Systems-Non-linear, Stability and Feedback Physiological Systems-Multi-input Multi-output [MIMO] Systems

UNIT II ANALYSIS OF CONTINOUS TIME SIGNALS AND LTI SYSTEMS 12

Fourier series for CT Periodic Signals – Time domain Analysis- Dirichlet's conditions – Fourier transform for CT Aperiodic signals. LTI- Linear Time Invariant Systems Analysis in theTime Domain – Differential Equation-Impulse response of LTI systems - Convolutional Integral – Signal Averaging for Noise elimination-SNR-Analog Filters – Basics of Laplace Transform-Transfer function concepts.

UNIT III ANALYSIS OF DISCRETE TIME SIGNALS AND LTI SYSTEMS 12

Discrete Time Fourier transform [DTFT] for DT periodic signals – LTI- Linear Time Invariant Systems Analysis in the Frequency Domain – Difference Equation-Linear Convolution – Circular convolution – Digital Filters – Basics of Z-Transforms – Digital Transfer function -linearized model of the Guyton-Coleman body fluid balance system

UNIT IV ANALYSIS OF CONCURRENT,COUPLED, AND CORRELATEDPROCESSES 12

Illustration of the Problem with Physiological Case Studies-The ECG and the PCG interpretation -The

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importance of HRV [Heart Rate Variability]- The knee joint and muscle vibration signals-The Pan–Tompkins algorithm for QRS detection Theory & Concepts

UNIT V JOINT TIME-FREQUENCY ANALYSIS OF BIOMEDICAL SIGNALS 12

Introduction to Joint Time Frequency Analysis (JFTA) Using Wavelets - Applications of JTFA to Physiological Signals – Heart Sound, Murmurs Analysis for congenital heart diseases

Total :60 Periods

Text Books:

1. John Semmlow," Signals and Systems for Bioengineers" Elsevier India Private Limited, 2012
2. Rangayyan M. Rangaraj, “Biomedical Signal Analysis” 2nd Edition-Wiley (2015)
3. Robert B. Northrop”Signals and Systems Analysis in Biomedical Engineering”2nd Edition,2010 CRC Press
4. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, “Signals and Systems”, Pearson, 2015 (UNIT 1 to 3)

References:

1. B. P. Lathi, “Principles of Linear Systems and Signals”, Second Edition, Oxford, 2009.
2. R.E.Zeimer, W.H.Tranter and R.D.Fannin, “Signals & Systems -Continuous and Discrete”, Pearson, 2007.
3. John Alan Stuller, “An Introduction to Signals and Systems” Thomson, 2007.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM302	CIRCUIT THEORY	L	T	P	C
		3	0	0	3
Nature of Course	Engineering Sciences				
Pre requisites	Engineering Physics				

Course Objectives

The course is intended to

1. Introduce the basic concepts of DC and AC circuits behavior
2. Introduce different methods of circuit analysis using Network theorems and Topology
3. Understand the basic concepts of resonance circuits
4. Study and compare the transient and steady state response of the circuits subjected to step and sinusoidal excitations.
5. Understand the basic concepts of coupled circuits

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Interpret DC and AC circuits using basic laws	Understand
CO2	Solve and verify network theorems	Apply
CO3	Analyze transient response of RC, RL and RLC circuits	Analyze
CO4	Analyze any circuits by using frequency domain method	Analyze
CO5	Illustrate the magnetically coupled circuits	Understand

Course Contents

UNIT I DC CIRCUIT ANALYSIS 9

Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff‘s Current Law, Kirchoff‘s voltage law, The single Node-Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis.

UNIT II NETWORK THEOREMS 9

Useful Circuit Analysis techniques - Linearity and superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion.

UNIT III TRANSIENTS AND RESONANCE IN RLC CIRCUITS 9

Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, The Unit-Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.

UNIT IV SINUSOIDAL STEADY STATE ANALYSIS 9

Sinusoidal Steady – State analysis , Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power Factor, Complex Power.

UNIT V COUPLED CIRCUITS AND TOPOLOGY 9

Magnetically Coupled Circuits, mutual Inductance, the Linear Transformer, the Ideal Transformer, An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis.

TOTAL: 45 PERIODS

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Text Book:

1. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", Mc Graw Hill education, 9th Edition, 2018.

Reference Books:

1. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014.
2. Sudhakar .A and Shyammohan S Pall, “Circuits and Networks” Tata McGraw Hill, 4th edition, 2010.
3. Charles.K.Alexander, Mathew N.O.Sadiku,"Fundamentals of Electric Circuits", McGraw Hill, 5th Edition, 2012.
4. Thomas L. Floyd and David M.Buchla, Principles of ‘Electric Circuits: Conventional Current’, Pearson Education, 10th Edition, 2020.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
CO1	3	2	2	1	2							1	3	2	
CO2	3	3	2	2	2							1	3	2	
CO3	3	3	3	2	3							1	3	2	
CO4	3	3	3	2	3							1	3	2	
CO5	2	3	3	2	2							1	3	2	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Understand	Direct Measures: Quiz/Presentation/Tutorial	5	15
Understand	Indirect measures: Assignment/ Video presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment**			**Final Examination (Theory) (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	20	20	20	30
Analyse	10	10	10	30
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM303	ELECTRONIC DEVICES AND CIRCUITS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Circuit Theory				

Course Objectives

The course is intended to

1. Introduce the basic concepts of PN junction diode
2. Study the characteristics of Bipolar Junction Transistors and Field Effect Transistors
3. Understand the operation of feedback amplifier and oscillators
4. Introduce the operational amplifiers and characteristics
5. Understand the practical applications of linear integrated circuits.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Explain the characteristics of PN junction diode and Zener diode	Understand
CO2	Interpret the construction, operation and characteristics of BJT and FET devices	Understand
CO3	Identify and design a suitable amplifier for a given specification	Apply
CO4	Summarize Explain the performance of operational amplifier	Understand
CO5	Analyze the applications of operational amplifier	Analyze

Course Contents

UNIT I PN JUNCTION DEVICES 9

PN junction diode–structure, operation and V-I characteristics, Diode clampers and clippers, Rectifiers-Half Wave and Full Wave Rectifier, Zener diode-characteristics-Zener Reverse characteristics – Zener as regulator.

UNIT II TRANSISTORS 9

BJT-structure, operation, characteristics, biasing, amplifier and switch, JFET- structure, operation, characteristics, biasing, amplifier and switch, MOSFET- structure, operation, characteristics, and biasing,IGBT-structure and characteristics, Thyristors-(SCR, Diac, Triac, UJT)-structure and operation.

UNIT III FEEDBACK AMPLIFIERS AND OSCILLATORS 9

Basic concepts of feedback-Properties of negative feedback-voltage / current, series, Shunt Feedback-Positive feedback-Condition for oscillations-phase shift-Wienbridge, Hartley, Colpitts and Crystal oscillators.

UNIT IV INTRODUCTION TO OPERATIONAL AMPLIFIER 9

Operational amplifier-ideal characteristics, Performance Parameters, Linear and Nonlinear Circuits and their analysis-Inverting amplifier,Non-inverting Amplifiers.

UNIT V APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Voltage Follower, Differentiator, Integrator, Voltage to Current converter, Instrumentation amplifier, Low pass, High pass filter and band pass filters, Comparator, Multivibrator and Schmitt trigger.

TOTAL: 45 PERIODS

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Text Book:

1. David A. Bell, “Electronic Devices and Circuits”, 6th Edition, Oxford University Press, 2009.
2. D.RoyChoudhry, Shail Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd., 2000.

Reference Books:

1. Thomas L. Floyd, “Electronic devices” Prentice Hall”, 10th Edition, 2018
2. Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory”, 11th Edition, Pearson Education, 2015.
3. Sergio Franco, “Design with operational amplifiers and analog integrated circuits”, 3rd Edition, Tata McGraw-Hill, 2007.
4. G.K.Mithal, “Electronic devices and circuits”, Khanna Publishers, 2010.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
CO1	3	2	2	2	1								3	2	
CO2	2	3	2	2	2								3	2	
CO3	2	2	3	3	1								3	2	
CO4	3	2	2	3	2								3	2	
CO5	3	2	3	3	2								3	2	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Understand	Direct Measures: Quiz/Presentation/Tutorial	5	15
Understand	Indirect measures: Assignment/ Video presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment**			**Final Examination (Theory) (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	30
Apply	20	20	20	40
Analyse	10	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM304	BIOSENSORS AND MEASUREMENTS	L	T	P	C
		3	0	0	3
Nature of Course	Professional Core				
Pre requisites	Basics of Electrical Engineering and Biology				

Course objectives:

The course is intended to

1. Understand science of bio-measurement with desirable properties of biosensors, miniaturization and applications related to agriculture, bio-production and environment
2. Know in detail various electrochemical sensors and its sensing capabilities
3. Know the principles behind Seismic (mass) and Thermal sensors for human body status
4. Understand biochemical assaying formats and molecular level recognition
5. Explore benefits of optical sensors with its relevant source and detectors for non-invasive devices & quantification

Course Outcomes:

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO1	Understand common biochemical interactions used to quantify biological molecules and the electronic technologies used to detect and measure them	Understand
CO2	Apply principles of electrochemical sensors and its sensing capabilities	Apply
CO3	To know the principles behind Seismic (mass) and Thermal sensors for human body status	Understand
CO4	Understand biochemical assaying formats and molecular level recognition	Understand
CO5	To fully explore benefits of optical sensors with its relevant source and detectors for non-invasive devices & quantification	Understand

Course Contents:

UNIT I SCIENCE OF BIOMEASUREMENT 9

Measurement System – Instrumentation – Classification and Characteristics of Transducers (Static and Dynamic) – Errors in Measurements – Calibration – Primary and secondary standards. Interfacing Biosensor to real world – resistive, capacitive, inductive types. Major components of Biosensor based systems - Biosensor applications and issues- - Overview of biosensor applications: medicine, agriculture, bioproduction, and environment - Desired characteristics of biosensors: reliability, simplicity, cost, operating conditions and safety.

UNIT II ELECTROCHEMICAL SENSORS 9

Biochemical recognition - Chemical reactions: history of gravimetric and colorimetric reactions. Problems of specificity - Redox potentials, membrane potential, basic electrochemistry; conductimetric sensors; potentiometric sensors (ISE's and ISFETs); Amperometric sensors; Charge sensing with FET.

UNIT III SEISMIC (MASS), GAS AND THERMAL SENSORS 9

Electromechanical resonance -Piezoelectric, Quartz crystal Microbalance (QCM), Hall effect Sensor, Proximity sensor and Gyroscopes - Henry's and ideal gas laws-Gas detection. Surface acoustic wave (SAW) devices; Atomic force microscopy (AFM); Thermometric detection.

UNIT IV ASSAYING FORMATS 9

Labels: Radioisotopes, fluorophores, dyes, enzymes/substrates, liposomes, electroactive compounds. ELISA's and nucleotide capture assays- Immobilization of biorecognition element; conjugation of labels-Aptamer (oligonucleotide) based recognition and molecularly imprinted polymers.

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UNIT V OPTICAL SENSORS 9

Fundamentals of optics- sources (LED's, lasers, lamps), detectors (photodiodes, photomultiplier tubes, charge coupled devices), and optical circuits (filters, gratings, fiber optics); detection of absorbance, reflectance, and fluorescence; Surface plasmon resonance (SPR) based devices

Total: 45 Periods

Text Books:

1. Eggins. B. R, "Chemical Sensors and Biosensors", John Wiley & Sons, 2014.
2. Jon Cooper, Tony Cass "Biosensors-A practical approach" 2nd edition Oxford University Press, (2014)

References:

1. Florinel-Gabriel Banica "Chemical Sensors and Biosensors - Fundamentals and Applications" John Wiley & Sons, Ltd,2012
2. Gabor Harsanyi "Sensors in Biomedical Applications– Fundamentals, Technology & Applications" CRC Press,2014
3. Donald G. Buerk (Author) – Biosensors- Theory and Applications-CRC Press (2013)
4. Spichiger-Keller. U. E "Chemical Sensors and Biosensors for Medical and Biological Applications", Wiley-VCH, 2008.
5. Robert S. Marks, Christopher R. Lowe, David C. Cullen, Howard H. Weetall, Isao Karube "Handbook of Biosensors and Biochips" Vol 2-John Wiley & Sons (2017)

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	10	10	10	10
Understand	30	30	30	40
Apply	10	10	10	10
Analyze				
Evaluate				
Create				

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20BM305	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	2	4
Nature of Course	Professional core				
Pre requisites	Basics of Biology				

Course Objectives

The course is intended to

1. Know basic structural and functional elements of human body
2. Learn organs and structures involving in system formation and functions
3. Understand structure and functions of the various types of systems of human body.
4. Demonstrate anatomical features and physiology of human systems

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explain basic structure and functions of cell	Understand
CO2	Understand anatomy and physiology of various systems of human body	Understand
CO3	Identify all systems in the human body.	Remember
CO4	Explain organs and structures involving in system formation and functions.	Understand
CO5	Understand human digestive and excretory system functional aspects	Understand

Course Contents:

UNIT I CELL AND TISSUE STRUCTURE 9

Structure of Cell – structure and functions of sub organelles – Cell Membrane –Transport of Across Cell Membrane - Action Potential – Cell to Cell Signaling - origin of cell membrane potential. Types of Specialized tissues – Functions

UNIT II SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS 9

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

UNIT III CIRCULATORY SYSTEM 10

Blood composition-functions of blood–functions of RBC. WBC types and their functions. Blood groups – importance of blood groups – identification of blood groups. Blood vessels- Structure of heart – Properties of Cardiac muscle – Conducting system of heart – Cardiac cycle – ECG - Heart sound - Volume and pressure changes and regulation of heart rate –Coronary Circulation. Factors regulating Blood flow.

UNIT IV NERVOUS AND ENDOCRINE SYSTEMS AND SENSE ORGANS 9

Nervous: Cells of Nervous systems – Types of Neuron and Synapses – Mechanisms of Nerve impulse – Brain: Parts of Brain – Spinal Cord – Tract and Pathways of Spines – Reflex Mechanism – Classification of Nerves - Autonomic Nervous systems and its functions. Endocrine - Pituitary and thyroid gland, Sense Organs: Eye and Ear

UNIT V DIGESTIVE AND URINARY SYSTEMS 9

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

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Total: 45 Periods

LIST OF EXPERIMENTS

S.No.	Course Content	CO	Bloom's Level
1	Collection of Blood Samples	CO 1	Understand
2	Identification of Blood groups (Forward and Reverse)	CO 2	Understand
3	Bleeding and Clotting time	CO 2	Apply
4	Estimation of Hemoglobin	CO 3	Apply
5	Calculate the amount of Total RBC Count present in the blood	CO 3	Apply
6	Calculate the amount of Total WBC Count present in the blood	CO 3	Apply
7	Differential count of Blood cells	CO 3	Apply
8	Estimation of ESR	CO 3	Apply
9	Calculate the amount of PCV, MCH, MCV, MCHC present in blood cells	CO 3	Analyze
10	Hearing test – Tuning fork	CO 4	Analyze
11	Visual Activity – Snellen's Chart and Jaeger's Chart	CO 5	Analyze

TEXT BOOKS:

1. Prabhjot Kaur,"Text Book of Anatomy and Physiology" Lotus Publishers. 2014
2. Elaine.N. Marieb, "Essential of Human Anatomy and Physiology", Eight Edition, Pearson Education, New Delhi, 2007

REFERENCES:

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. Pearson Publishers, 2014
2. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2013
3. William F.Ganong, "Review of Medical Physiology", 22nd Edition, Mc Graw Hill, New Delhi, 2010
4. Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", W.B. Saunders Company, 2015
5. Guyton & Hall, "Medical Physiology", 13th Edition, Elsevier Saunders, 2015

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	
CO1								2			3		3	2	
CO2	2					2		2	1			2	3	2	
CO3								2			2		3	2	
CO4	1					3		3	3			3	3	2	
CO5	1	1				3		3	2			3	3	2	
	3	High				2	Medium				1	Low			

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Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	20	20	20	40
Analyze	10	10	10	20
Evaluate				
Create				

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20BM306	ELECTRONIC DEVICES AND CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2
Nature of Course	Professional core				
Pre requisites	Engineering Physics				

Course Outcomes

On successful completion of the course, students will be able to

1. Find the V-I characteristics of PN junction and Zener diode
2. Demonstrate the construction, operation and characteristics of BJT and FET
3. Design and Analyze the frequency response of amplifiers and oscillators
4. Analyze the application of operational amplifier
5. Analyze the operation of multivibrators using 555 timer

CYCLE-1

S.No.	Course Content	CO	Bloom's Level
1	Practical Verification of superposition theorem and Maximum power transfer theorem	CO 1	Apply
2	Construct and testing of half wave and full wave rectifiers circuit using PN Junction Diode	CO 1	Apply
3	Conduct the experiment of Characteristics of Zener Diode application as voltage regulator	CO 1	Understand
4	Determine the BJT and FET Characteristics	CO 2	Understand
5	Perform the Frequency Response of CE Amplifier	CO 3	Understand
6	Design of RC Oscillators and LC Oscillators using BJT	CO 3	Apply

CYCLE-2

S.No.	Course Content	CO	Bloom's Level
1	Design of Inverting, non-inverting amplifier and comparator	CO 4	Analyze
2	Design and verify the output of Integrator and Differentiator	CO 4	Apply
3	Design and analysis of active filters using opamp	CO 4	Analyze
4	Measure the threshold point of Schmitt trigger using operational amplifier	CO 4	Understand
5	Design Instrumentation amplifier using operational amplifier	CO 4	Analyze
6	Measure the frequency of oscillation of Multivibrators using IC 555 Timer	CO 5	Understand

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Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
1	3	1	3		2	1			3				2	3	
2	3	1	3		2	1			3				2	3	
3	3	1	3		2	1			3				2	3	
4	3	1	3		2	1			3				2	3	
5	3	1	3		2	1			3				2	3	
	3	High				2	Medium					1	Low		

Summative assessment based on Continuous and Final Examination		
Bloom's Level	**Rubric based Continuous Assessment [50 marks]**	**Final Examination[50 marks]**
Remember	10	10
Understand	20	20
Apply	30	30
Analyze	40	40
Evaluate	-	-
Create	-	-

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20MC301	ENVIRONMENTAL SCIENCE (Common to CSE, IT, AI&DS, ECE and BME)	L	T	P	C
		2	0	0	0
Nature of Course	Mandatory				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Understand the concept of eco system and environment.
2. Become conversant with ecological balance and values of bio diversity.
3. Know the role of human in prevention of pollution and making a clean environment.
4. Get knowledge about conservation of non conventional energy resources.
5. Study about the nature and management of e-waste and solid waste.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Describe the ecosystem and environment	Understand
CO2	Understand the ecological balance and preservation of bio diversity	Understand
CO3	Demonstrate various types of pollution in order to control pollution	Apply
CO4	Classify the energy sources for the conservation of non conventional energy sources	Understand
CO5	Identify the nature and management of e-waste and solid waste	Understand

Course Contents

UNIT I Ecosystem **6**

Eco system **-** Food chains, Food webs and Ecological pyramids. Ecosystem - (a) Forest eco system, (b) Aquatic eco system (pond ecosystem and marine ecosystem).

UNIT II Biodiversity **6**

Introduction to Bio diversity, Values of Bio diversity**,** Threads to Bio diversity**,** Endangered and Endemic species of India, Hotspots of biodiversity. Conservation of Bio diversity: In-Situ and Ex-Situ conservation of bio diversity.

UNIT III Environmental Pollution **6**

Definition, Causes, Effects and Control of (a) Air pollution (b) Water pollution (c) Soil pollution. Electrostatic Precipitator for controlling air pollution.

UNIT IV Non Conventional Energy Resources **6**

Introduction, Types: Solar Energy, Wind Energy and Geo Thermal Energy.

UNIT V Environmental Management **6**

Sustainable Development, Role of Information technology in Environment and Human. HIV and AIDS: causes and control measures. Green chemistry: Definition and Principles

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Activity Component

S.No	Name of the Experiment	CO Mapping	RBT
1	Field study of simple eco system: pond, river and hill slopes	CO1	Understand
2	Case studyregarding environmental management	CO5	Apply

Total: 30 periods

Text Books

1. AnubhaKaushik and C.P. Kaushik, “Environmental Science and Engineering, New Age International Publishers, New Delhi, 2nd Edition, 2015.
2. V. Kumar, “An Introduction to Green Chemistry” Vishal publishing Co. Reprint Edition, 2010.

Reference Books

1. Masters, Gilbert M, “Introduction to Environmental Engineering and Science”, Pearson Education, New Delhi, 2nd Edition, 2012.
2. Santosh Kumar Garg and Rajeshwari Garg “Ecological and Environmental Studies”, Khanna Publishers, NaiSarak, Delhi, 2nd Edition, 2014.

Additional Resources

1. https://nptel.ac.in/courses/122103039/38
2. https://bch.cbd.int/cms/ui/collaboration/download/download.aspx?id=909
3. https://nptel.ac.in/courses/105102089/air%20pollution%20(Civil)/Module-3/3a.htm
4. www.vssut.ac.in/lecture_notes/lecture1428910296.pdf
5. nptel.ac.in/courses/120108004/module7/lecture8.pdf

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							3					3			
CO2							3					3			
CO3							3					3			
CO4							3					3			
CO5							3					3			
	3	High					2	Medium				1	Low		

Bloom’s Level	Continuous Assessment				
	IAE-I [20]	IAE-II [20]	IAE-III [20]	Attendance [10]	Activity [30]
Remember	30	20	20		
Understand	10	20	20		
Apply	10	10	10		
Analyze					
Evaluate					
Create					

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20BMA01	Scientific Computing for Biologists	L	T	P	C
		1	0	0	1
Nature of course	Employability Enhancement Course				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Acquire live data from individuals, instruments, cards, sensors, or Internet of Things approaches
2. Automate biological analysis tasks such as cell counting
3. Develop bioinformatics analysis workflows needed to code and applications
4. Use extensive statistics capabilities to determine significance in studies
5. Create plots and reports for tabular data

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand the principles of acquiring biological data	Understand
CO 2	Summarize the tools of biomedical signals	Understand
CO 3	Classify the biological signals and patterns	Understand
CO 4	Apply statistics capabilities to determine significance in Bio-studies	Apply
CO 5	Create plots and reports for tabular biological data	Understand

Course Contents

Application of Matrix Algebra to Biological Systems - MATLAB as a powerful and user-friendly package in scientific computing -standard plots, explore and analyze your data, conduct biological analysis and solve mathematical models of biological systems. **05**

Introduction to IoT and Analytics in the context of IoT- IoT Reference architecture, IoT Data overview- IoT Use cases, IoT Data Processing- Introduction to ML and Python for ML- IoT Analytics Data Science Life Cycle – Case study in health care **05**

KPIs in IoT Analytics and Data Acquisition for IoT-IoT Data Cleaning, Descriptive IoT Data Analytics-Inferential Data Analytics, Predictive Data Analytics- Prescriptive Analytics **05**

Total: 15 Hours

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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1													1	2	
CO 2													1	2	
CO 3													1	2	
CO 4													1	2	
CO 5													1	2	
	3	**High**				**2**	**Medium**					**1**	**Low**		

Bloom's Level	**Summative Assessment (Internal Mode)**	
	Assessment 1 (50 Marks)	**Assessment 2 (50 Marks)**
Remember	10	10
Understand	10	10
Apply	30	30
Analyze		
Evaluate		
Create		

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IV SEMESTER

20MA402	PROBABILITY AND STOCHASTIC PROCESS (Common to ECE & BME)	L	T	P	C
		3	2	0	4
Nature of Course	Basic Sciences				
Pre requisites	Mathematics –I & II for Electrical Sciences				

Course Objectives
The course is intended to

1. Acquire the concepts of random variables essential for analog of digital communication.
2. Introduce the basic concepts of random variables.
3. Acquaint the basic concepts of random processes which are widely used in many fields.
4. Familiarize with the concept of correlation and spectral densities.
5. Study the significance of linear systems with random inputs.

Course Outcomes

On successful completion of the course,the students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Explain the concepts of random variables and probability distributions.	Understand
CO2	Compare the functions of multiple random variables.	Analyze
CO3	Interpret the concepts of random processes in their fields.	Understand
CO4	Determine correlation and spectral densities.	Apply
CO5	Estimate the response of linear time invariant systems for random inputs with more than one variable.	Understand

Course Contents:

UNIT I Random Variables and Distributions 12

Basics of Probability-Random Variables – Types of Random Variables: Discrete random variables – Continuous random variables– Probability functions, Moment Generating Functions –Discrete Distributions: Binomial and Poisson distributions–Continuous Distributions: Uniform and Exponential distributions.

UNIT II Two Dimensional Random Variables 12

Joint distributions – Marginal distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit Theorem(for independent and identically distributed random variables).

UNIT III Random Processes 12

Classifications, First Order- Second Order - Strictly Stationary - Wide Sense Stationary and Ergodic Stationary Process – Markov process – Poisson process – Random telegraph process.

UNIT IV Correlation and Spectral Densities 12

Auto correlation - Cross correlation – Properties - Power spectral density - Cross spectral density – Properties - Wiener-Khintchine relation - Relationship between cross power spectrum and cross correlation function.

UNIT V Linear Systems with Random Inputs 12

Linear Time Invariant System – System Transfer Function – Linear Systems with Random Inputs – Auto Correlation and Cross Correlation Functions of Input and Output.

Total: 60 Periods

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Text Books:

1. Oliver lbe," Fundamentals of Applied Probability and Random Processes", Indian Reprint,Elsevier, 2nd Edition,2014.
2. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill, 4th Edition, 2017.

Reference Books:

1. Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Edition,2012.
2. Yates.R.D. and Goodman.D.J.Probability and Stochastic Processes",Wiley India Pvt. Ltd., Bangalore, 4th Edition,2018.

Additional References:

1. https://nptel.ac.in/courses/117/103/117103067
2. https://nptel.ac.in/courses/117/105/117105085

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	1									1	2		
CO2	3	2	1									1	3		
CO3	3	3	2									1	3		
CO4	3	3	2									1	3		
CO5	3	3	2									1	2		
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Terminal Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyze				
Evaluate				
Create				

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20BM401	DIGITAL ELECTRONICS	L	T	P	C
		3	2	0	4
Nature of Course	Professional Core				
Pre requisites	Electronic devices				

Course Objectives

The course is intended to

1. Understand the digital fundamentals, Boolean algebra and its applications in digital systems
2. Design the various combinational digital circuits using logic gates
3. Introduce the analysis and design procedures for synchronous sequential circuits
4. Study the various semiconductor memories and integrated circuits
5. Understand the basic concepts of ADC and DAC

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Apply Boolean theorems to minimize logic expressions in different forms and implement them using logic gates	Apply
CO2	Design various combinational circuits using logic gates	Design
CO3	Design synchronous-sequential circuits for a given specification	Design
CO4	Analyze the characteristics and structure of different memory systems and programmable logic devices	Analyze
CO5	Interpret the various ADC and DAC	Understand

Course Contents

UNIT I DIGITAL FUNDAMENTALS 13

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

UNIT II COMBINATIONAL CIRCUIT DESIGN 13

Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 13

Flip flops – SR, JK, T, D, Master/Slave FF – operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Design - Moore/Mealy models, state minimization, state assignment, circuit implementation – Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.

UNIT IV MEMORY DEVICES AND DIGITAL INTEGRATED CIRCUITS 13

Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using PLA, PAL.

Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS.

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UNIT V ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 8

Analog and Digital Data Conversions – specifications – D/A converter– weighted resistor type, R–2R Ladder type – Voltage Mode and Current Mode - R–2R Ladder types– high speed sample–and–hold circuits – A/D Converters– Flash type – Successive Approximation type.

TOTAL: 60 PERIODS

Text Books:

1. M.Morris Mano and Michael D.Ciletti, “Digital Design”, Pearson, 5th Edition, 2013.
2. Thomas L. Floyd, ―Digital Fundamentals‖, 10th Edition, Pearson Education Inc, 2011

Reference Books:

1. Sergio Franco, “Design with operational amplifiers and analog integrated circuits”, Mc GrawHill Education, 3rd Edition, 2017.
2. S.Salivahanan and S.Arivazhagan, “Digital Circuits and Design”, 5th Edition, Oxford UniversityPress, 2018.
3. A.Anand Kumar, Fundamentals of Digital Circuits‖, 4th Edition, PHI Learning Private Limited, 2016.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
CO1	3	3	3	2	1						2		3	2	
CO2	3	3	3	2	1						2		3	2	
CO3	3	3	3	2	1						2		3	2	
CO4	3	3	3	2	1						2		3	2	
CO5	3	3	3	2	1						2		3	2	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Understand	Direct Measures: Quiz/Presentation/Tutorial	5	15
Understand	Indirect measures: Assignment/ Video presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment**			**Final Examination (Theory) (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	10
Understand	10	10	10	20
Apply	20	10	20	40
Analyse	10	20	10	30
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM402	MEDICAL AND RADIATION PHYSICS	L	T	P	C
		3	0	0	3

Nature of Course	Professional core
Pre requisites	Physics for Electrical Sciences

Course Objectives

The course is intended to

1. Study principles and effects of ionizing and non-ionizing radiation in human body
2. Discuss the physics of the senses
3. Explore the effects of radiation in matter and how isotopes are produced
4. Understand interaction of radiations with biological subjects.
5. Understand various detectors for detecting the presence of ionizing radiation

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Interpret about non-ionizing radiation, interaction with tissue and its effects.	Understand
CO2.	Define and compare intensities of sensory stimuli	Remember
CO3.	Summarize how ionizing radiation interacts with the human body, how to quantify it and its levels seen in the environment and healthcare	Understand
CO4.	Explain the fundamentals of radioactivity and radioactive isotopes	Understand
CO5.	Illustrate the methods of detecting and recording the ionizing radiation and its interaction with matter	Understand

Course Contents

UNIT I NON-IONIZING RADIATION AND ITS MEDICAL APPLICATION 9

Introduction and objectives - Tissue as a leaky dielectric - Relaxation processes, Debye model, Cole–Cole model, Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Physics of light, Measurement of light and its unit- limits of vision and color vision an overview, Thermography- Application

UNIT II BASIC RADIATION QUANTITIES 9

Introduction - Different radiation Unit, Roentgen, gray, Sievert -Exposure-Inverse square law-KERMA-Kerma and absorbed dose–stopping power -relationship between the dosimetric quantities -Bremsstrahlung radiation, Bragg's curve-concept of LD 50-Stochastic and Non-stochastic effects-Radiolysis of water – Basics of Target Theory

UNIT III PRINCIPLES OF RADIOACTIVE NUCLIDES 9

Radioactive Decay – Spontaneous Emission – Isometric Transition – Gamma ray emission, alpha, beta, Positron decay, electron capture, Sources of Radioisotopes Natural and Artificial radioactivity, Radionuclide used in Medicine and Technology ,Decay series, Production of radionuclides – Cyclotron produced Radionuclide- Reactor produced Radio- nuclide-fission and electron Capture reaction, Target and Its Processing Equation for Production of Radionuclides, radionuclide Generator-Technetium generator.

UNIT IV RADIOACTIVE DECAY AND INTERACTION OF RADIATION WITH MATTER 9

Spontaneous Fission- Isomeric Transition-Alpha Decay-Beta Decay-Positron Decay-Electron Capture-Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation ,Interaction of X and Gamma radiation with matter Photoelectric effect, Compton Scattering , Pair production, Attenuation of Gamma Radiation ,Interaction of neutron with matter and their clinical significance.

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UNIT V SCINTILLATION, SEMICONDUCTOR AND GAS FILLED DETECTORS 9

Scintillation Detectors - Solid Scintillation Counters - Gamma-Ray Spectrometry-Liquid Scintillation Counters-Characteristics of Counting Systems-Gamma Well Counters-Thyroid Probe-Principles of Gas-Filled Detectors - Ionization Chambers-Geiger–Müller Counters

Total: 45 Periods

TEXT BOOKS:

1. Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine", 4th Edition, Springer, 2013.
2. John R Cameran , James G Skofronick "Medical Physics" John-Wiley & Sons. 1978
3. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, "Medical Physics and Biomedical Engineering", 2nd Edition, IOP Publishers.2001.
4. W.J.Meredith and J.B. Massey " Fundamental Physics of Radiology" Varghese Publishing house. 1992

REFERENCES:

1. S.Webb" The Physics of Medical Imaging", Taylor and Francis, 1988
2. J.P.Woodcock, "Ultrasonic,Medical Physics Handbook series 1", Adam Hilger, Bristol, 2002
3. HyltonB.Meire and Pat Farrant "Basic Ultrasound" John Wiley & Sons, 1995
4. P.Uma Devi, A.Nagarathnam , B S SatishRao , "Intorduction to Radiation Biology" B.I Chur Chill Livingstone pvt Ltd, 2000

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
CO1	3					3				3					
CO2	3	2													
CO3	3			3		2		3			3				
CO4			2						2		2	3			
CO5			3	3					3			2			
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Understand	Direct Measures: Quiz/Presentation/Tutorial	5	15
Understand	Indirect measures: Assignment/ Video presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment**			**Final Examination (Theory) (60)**
	IAE 1(7.5)	**IAE 2(7.5)**	**IAE 3 (10)**	
Remember	10	10	10	10
Understand	10	10	10	20
Apply	20	10	20	40
Analyse	10	20	10	30
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM403	HEALTHCARE DATA ANALYTICS	L	T	P	C
		3	0	0	3

Nature of Course	Professional core
Pre requisites	Fundamentals of Computers

Course Objectives

The course is intended to

1. Study principles and basics of Bigdata platform
2. Understand biomedical text processing and discuss the retrieval of health data
3. Explore the role of social media in health analytics with data-ware housing.
4. Understand predictive models with biological subjects.
5. Understand various wireless health and quantified-self parameters on daily routine basis.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Understand the basics of big data and its contribution towards health analytics.	Understand
CO2	Analyze the use of medical text data for processing/retrieval of health information	Analyze
CO3	Determine the role of social media in health analytics and the need for data Warehousing	Apply
CO4	Use R environment for analyzing healthcare data using Bayesian, Stochastic approach and markov models.	Analyze
CO5	Illustrate the need for wireless health and quantified self -movement in health analytics.	Understand

Course Contents

UNIT I AN INTRODUCTION TO HEALTHCARE DATA ANALYTICS 9

Introduction - Healthcare Data Sources and Basic Analytics-Data Analytics for Healthcare-Applications and Practical Systems for Healthcare-Big Data Principles and their Application to Healthcare - social media as a Big Data Resource for Analytics, Health Surveys and Patient Reported Outcome (PRO) Analytics

UNIT II GENOMIC DATA ANALYSIS FOR PERSONALIZED MEDICINE 9

Genomic Data Generation-Methods and Standards for Genomic Data Analysis-Biomedical Text Processing, Health Information Retrieval, and Working with Healthcare Data Warehouses to inform Clinical Operations

UNIT III DESCRIPTIVE ANALYSIS AND STATISTICS 9

Measures of Central tendency - Arithmetic Mean, Median, Mode, Measures of Variability - Range, Variance, Standard Deviation, Co-efficient of Variation, Measures of Relative Standing. Testing of hypothesis-Large sample test - Test of significance for single proportion,difference of proportions, single mean and difference of means, F-test for variances, Chi square test for goodness of fit and independence of attributes - ANOVA one and Two way.

UNIT IV PREDICTIVE ANALYTICS 9

Probability distribution- axioms, conditional probability, law of total probability, Baye's theorem, independence. Applications in predictive analytics and Predictive Modelling

UNIT V APPLICATIONS IN HEALTHCARE 9

Health data expenditure, machine learning, data transformation, deriving rules, patterns, opportunities, Wireless Health and the Quantified Self Movement: Overview and Implications for Healthcare Analytics, Complete Human Condition Monitoring and Guidance, Electronic Health Records, Patient - Provider – Portals

Total Periods: 45

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TEXT BOOK

1. Reddy, Chandan K., Aggarwal, Charu C “Healthcare Data Analytics” Taylor & Francis ,2019
2. Nilanjan Dey(editor), " Big Data Analytics for Intelligent Healthcare Management” Academic press,2019.

REFERENCES

1. Wullianallur Raghupathi and VijuRaghupath, "Big data analytics in Healthcare: Promise and Potential", Healthinformation Science and Systems-Biomed Central, 2014.
2. Chris Eaton, Dirk Deroos, Tom Deutsch et al., "Understanding Big Data", McGrawHill, 2013.
3. Kim Seefeld, Ernst Linder, "Statistics using R with Biological Examples", University of North Hampshire 2017.
4. Alberto Cordoba, "Understanding the Predictive Analytics Lifecycle", Wiley, 2014.
5. Baoying Wang, Ruowang Li, "Big Data Analytics in Bioinformatics and Healthcare", William Perrizo, CRC press,2015.

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
CO1	3	2	2							2			3	2	
CO2	3	2	2							2			3	2	
CO3	3	2	2							2			3	2	
CO4	3	2	2							2			3	2	
CO5	3	2	2							2			3	2	
	3	High				2	Medium				1	Low			

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Understand	Direct Measures: Quiz/Presentation/Tutorial	5	15
Understand	Indirect measures: Assignment/ Video presentation	5	
	Attendance	5	

Summative Assessment				
Bloom’s Category	**Continuous Assessment**			**Final Examination (Theory) (60)**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	
Remember	10	10	10	10
Understand	10	20	0	30
Apply	20	10	20	40
Analyse	0	10	10	20
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM404	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
		3	0	0	3
Nature of Course	Professional core				
Pre requisites	Biochemistry				

Course Objectives

The course is intended to

1. Gain knowledge on the structural and functional aspects of living organisms.
2. Know the etiology and remedy in treating the pathological diseases.
3. Empower the importance of public health.
4. Learn the different staining methods and principles of different types of microscopy
5. Practice on chemical and structural examinations, histopathological examinations etc

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1	Analyze structural and functional aspects of living organisms.	Analyze
CO2	Summarize the function of microscope	Understand
CO3	Interpret the importance of public health.	Understand
CO4	Compare the methods involved in treating the pathological diseases.	Remember
CO5	Infer the immunology related concepts	Understand

Course Content

UNIT I CELL DEGENERATION, REPAIR AND NEOPLASIA 9

Cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification, cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours. Autopsy and biopsy.

UNIT II FLUID AND HEMODYNAMIC DERRANGEMENTS 9

Edema, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas.

UNIT III MICROBIOLOGY 9

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

UNIT IV MICROSCOPES 9

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

UNIT V IMMUNOPATHOLOGY 9

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, immuno electrophoresis, RIA and ELISA, monoclonal antibodies.

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Total: 45 Periods

TEXT BOOKS:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition,WB Saunders Co. 2005 (Units I & II).
2. Ananthanarayanan&Panicker, "Microbiology" Orientblackswan, 2017 10th edition. (Units III,IV and V).

REFERENCES:

1. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
2. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2007
3. Prescott, Harley and Klein, "Microbiology", 10th edition, McGraw Hill, 2017

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

Cos	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2			2			3							
CO2	2				1				3			2			
CO3					3	3		2	1						
CO4		3				2		3		1	2	2			
CO5															
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Internal Assessment Examinations**			**Final Examination**
	IAE 1 (7.5)	**IAE 2 (7.5)**	**IAE 3 (10)**	**(60)**
Remember	10	10	10	20
Understand	10	10	10	20
Apply	20	20	20	40
Analyze	10	10	10	20
Evaluate				
Create				

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20CS407	DATA STRUCTURES USING OOPS	L	T	P	C
		3	0	2	4
Nature of Course	Engineering Sciences				
Pre requisites	Fundamentals of computers				

Course Objectives

The course is intended to

1. Learn the basics of C++
2. Comprehend the fundamentals of member functions and classes.
3. Learn the concepts of inheritance and polymorphism in C++.
4. Learn linear, non-linear data structures and their applications.
5. Use object oriented programming to perform sorting and searching.

Course Outcomes

On successful completion of the course, students will be able to

CO. No.	Course Outcome	Bloom's Level
CO1.	Understand the basics of C++.	Understand
CO2.	Illustrate the member function and classes,	Understand
CO3.	Summarize the inheritance and polymorphism.	Understand
CO4.	Identify the linear and non-linear data structures.	Analyze
CO5.	Solve the sorting and searching problems.	Apply

Course Contents

Unit - I BASICS OF C++ 9

Basic components of a C++, Program and program structure, Compiling and Executing C++ Program. Selection of control statements in C++ – arrays - functions.

Unit - II MEMBER FUNCTIONS AND CLASSES 9

Member Functions and Classes - Scope and Accessing Class Members – Reference Variables – Initialization – Constructors – Destructors – Friend Function – Dynamic Memory Allocation Overloading: Function overloading and Operator Overloading.

Unit - III INHERITANCE & POLYMORPHISM 9

Inheritance - Base Classes and Derived Classes – Protected Members – Casting Class pointers – Constructors and Destructors in derived Classes - Virtual functions – This Pointer – Dynamic Binding.

Unit – IV LINEAR AND NON-LINEAR DATA STRUCTURES 9

Abstract Data Types (ADTs) – List ADT: array-based implementation – Singly linked list implementation- Stack ADT: array-based implementation – Trees – Binary Trees – Binary tree representation and traversals.

Unit - V SEARCHING AND SORTING ALGORITHMS 9

Sorting algorithms: Insertion sort – Quick sort – Merge sort – Searching: Linear search –Binary Search.

Total: 45 Periods

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List of Exercises

S.No	List of Exercises	CO Mapping	RBT
1	Develop simple programs in C++ using Control statements.	CO1	Apply
2	Implement looping in C++.	CO1	Apply
3	Implement friend function in C++.	CO2	Apply
4	Develop the simple program with function and operator overloading.	CO2	Apply
5	Build a C++ program with classes and objects.	CO3	Apply
6	Make use of inheritance in C++ application.	CO3	Apply
7	Build a C++ program to perform list operations using linked list.	CO4	Apply
8	Construct a C++ program to perform stack operation using array	CO4	Apply
9	Build a C++ application to perform merge sort.	CO5	Apply
10	Construct a C++ program to perform Binary search	CO5	Apply

Text Books:

1. Deitel and Deitel, “C++, How To Program”, Fifth Edition, Pearson Education, 2005.
2. Mark Allen Weiss, “Data Structures and Algorithm Analysis in C++”, Third Edition, AddisonWesley, 2007.

Reference Books:

1. Bhushan Trivedi, “Programming with ANSI C++, A Step-By-Step approach”, Oxford University Press, 2010.
2. Goodrich, Michael T., Roberto Tamassia, David Mount, “Data Structures and Algorithms in C++”, 7th Edition, Wiley. 2004.
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, “Introduction to Algorithms”, Second Edition, Mc Graw Hill, 2002.
4. Bjarne Stroustrup, “The C++ Programming Language”, 3rd Edition, Pearson Education, 2007.
5. Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, “Fundamentals of Data Structures in C++”, Galgotia Publications, 2007

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2									1	3	1	
CO2	3	3	2									1	3	1	
CO3	3	3	2									1	3	1	
CO4	3	3	2									1	3	1	
CO5	3	3	2									1	3	1	
	3	High				2	Medium					1	Low		

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Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Classroom or Online Quiz	5	15
Understand	Class Presentation/Power point presentation	5	
	Attendance	5	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE1 (7.5)	**IAE2 (7.5)**	**IAE3 (10)**	
Remember	10	10	10	20
Understand	20	20	20	50
Apply	20	20	20	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM405	PATHOLOGY AND MICROBIOLOGY LABORATORY	L	T	P	C
		0	0	4	2
Nature of Course	Professional Core				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Use Compound microscope.
2. Practice on chemical examinations, Cryoprocessing, Histopathological examinations etc
3. Understand the growth of microorganism.
4. Study Antigen-Antibody reaction.
5. Practice different staining processes.

Course Outcomes

On successful completion of the course, students will be able to

1. Explain the function of microscope microscope.
2. Perform different chemical examinations, Histopathological examinations,
3. Perform practical experiments on tissue processing, cryoprocessing, staining Processes etc
4. Discover the growth of microorganism.
5. Identify Antigen-Antibody reaction.

CYCLE 1

S.No.	Course Content	CO	Bloom's Level
1	Study of parts of compound microscope	CO 1	Understand
2	Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood)	CO 2	Apply
3	Histopathological slides of benign and malignant tumours.	CO 2	Understand
4	Manual paraffin tissue processing and section cutting (demonstration)	CO 3	Apply
5	Cryo processing of tissue and cryosectioning (demonstration)	CO 3	Apply
6	Haematology slides of anemia and leukemia.	CO 3	Understand
7	Study of bone marrow charts.	CO 4	Remembering

CYCLE 2

S.No.	Course Content	CO	Bloom's Level
1	Identify the type of bacteria by conducting Basic staining – Hematoxylin and eosin staining for the given Pathological tissue	CO 3	Understand
2	Identify the type of bacteria by conducting Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS for the given Pathological tissue	CO 3	Understand
3	Perform capsule staining of given Pathological tissue	CO 3	Apply

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5	Perform Gram staining of given Pathological tissue	CO 3	Apply
6	Identify the given bacterial sample by performing AFB staining technique	CO 3	Understand
7	Perform Ag-Ab immune-electrophoresis and interpret results for determining the antibody specificity	CO 5	Understand
8	Write a comment on Slides of malarial parasites, micro filaria and leishmania donovani.	CO 4	Understand

Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSO)

COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	
1	3	1	2		2	1			3						
2	3	1	2		2	1			3						
3	3	1	2		2	1			3						
4	3	1	2		2	1			3						
5	3	1	2		2	1			3						
	3	High				2	Medium					1	Low		

Summative assessment based on Continuous and Final Examination		
Bloom's Level	**Rubric based Continuous Assessment [50 marks]**	**Final Examination [50 marks]**
Remember	10	10
Understand	40	40
Apply	30	30
Analyze	20	20
Evaluate	-	-
Create	-	-

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20MC401	SOFT SKILL	L	T	P	C
		2	0	0	0
Nature of Course	Mandatory Course				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Improve language skills in personal and professional life.
2. Equip students with the vital communication and soft skills to succeed in the highly competitive international arena.
3. Focus on the fundamental soft skills and of their practical social and work place usage.
4. Learn to identify and overcome the barriers in interpersonal relationships.
5. Enhance employability skills and ensure career success.

Course Outcomes

On successful completion of the course, students will be able to

CO.No.	Course Outcome	Bloom's Level
CO1	Relate the significance and fundamental nature of soft skills.	Remember
CO2	Take part in a wide range of Public speaking and professional group discussions.	Apply
CO3	Plan one's time effectively and productively, especially at work.	Apply
CO4	Make use of leadership skills to manage stress & conflict.	Apply
CO5	Organize presentation effectively and participate in interview with confidence.	Apply

Course Contents

Unit - I Introduction to soft skills and Interpersonal Communication 6

An Introduction – Definition and Significance of Soft Skills; Interpersonal communication-types of interpersonal communication.

Unit - II Public Speaking and Oral Communication skills 6

Public Speaking: Skills, Methods, Strategies Group Discussion: Importance, Planning, Elements.

Unit – III Time Management and Personality Development 6

Time Management – concepts and essentials tips. Personality-development – meaning, SWOT analysis & goal setting- Stress and conflict management.

Unit – IV Leadership skills and Emotional intelligence 6

Leadership skills: Concept of Leadership and honing Leadership skills - Problem-Solving Skills - Group and Ethical Decision-Making. Emotional Intelligence: Strategies to enhance Emotional Intelligence.

Unit-V Interview Skills 6

Interviewer - Interviewee perspectives - Self Introduction and Presentation: Types, Content and Essential Tips–before, during and after a presentation, Overcoming Nervousness - Mock Interview.

Total:30 Periods

Text Books

1. Managing Soft Skills for Personality Development–edited by B.N.Ghosh, McGraw Hill India, 2018.
2. English and Soft Skills–S.P. Dhanavel, Orient Black swan India, 2017

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Reference Books:

1. Soft Skill Business and Professional Communication Book by Sutapa Banerjee, 2016
2. Communication Skills Book by Pushp Lata and Sanjay Kumar, 2015

WEB REFERENCE:

https://nptel.ac.in/courses/109/107/109107121/

Mapping of Course Outcomes (CO) with Programme Outcomes (PO) Programme Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1								1	2	3		2			
CO2								1	2	3		2			
CO3								1	2	3		2			
CO4								1	2	3		2			
CO5								1	2	3		2			
	3	**High**				**2**	**Medium**				**1**	**Low**			

Bloom's Level	**Summative Assessment (Internal Mode)**	
	Assessment 1 (50 Marks)	**Assessment 2 (50 Marks)**
Remember	10	10
Understand	10	10
Apply	30	30
Analyze		
Evaluate		
Create		

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20BMA02	Frontiers in Medical Informatics	L	T	P	C
		1	0	0	1
Nature of course	Employability Enhancement Course				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Explore practical aspects of Digital Healthcare
2. Apply DICOM & HL7 towards Interoperability and Portability
3. Develop diagnostic display in computer aided diagnosis
4. Use extensive guidelines of National Digital Health Blueprint
5. Create plots and reports for clinical decision support system

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand the principles of Medical Informatics (MI)	Understand
CO 2	Summarize the standards, applications, and uses in demanding clinical environment	Understand
CO 3	Identify and solve MI problems	Apply
CO 4	Apply MI concepts to build and run Clinical processes	Apply
CO 5	Optimize complex healthcare processes	Apply

Course Contents

Introduction to Medical Informatics MI - Digital Healthcare-Challenges in Digital Healthcare-Technology acceptance by healthcare professionals - Interoperability and Portability - Privacy - Cyber-Security - Largescale Data Handling & Analysis Medical standards (DICOM and HL7) HIS, RIS, PACS. IHE and workflow integration- Basic medical imaging: acquisition, diagnostic display, enhancement and analysis- Computer aided diagnosis (CAD) **8 Hours**

National Digital Health Blueprint-Networking and teleradiology- Fault-tolerance, scalability, and robustness - Security and confidentiality in medicine- Clinical modelling and performance optimization-Bringing MI to hospitals - Patient flow analysis. Scheduling problems-Clinical decision support- Clinical software development- Medical start-ups **7 Hours**

Total: 15 Hours

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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1													1	2	
CO 2													1	2	
CO 3													1	2	
CO 4													1	2	
CO 5													1	2	
	3	**High**				**2**	**Medium**					**1**	**Low**		

Bloom's Level	**Summative Assessment (Internal Mode)**	
	Assessment 1 (50 Marks)	**Assessment 2 (50 Marks)**
Remember	10	10
Understand	10	10
Apply	30	30
Analyze		
Evaluate		
Create		

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V Semester

20BM501	**Biocontrol System**	**L**	**T**	**P**	**C**
		3	**2**	**0**	**4**
Nature of course	Professional Core				
Pre requisites	Basics of Electrical Sciences				

Course Objectives

The course is intended to

1. Understand the concept behind feedback and continuum in various systems and subsystems
2. Analyse the systems in time and frequency domain and to understand the concept of stability
3. Aapply mathematical modelling principles in understanding the various fundamental biological systems
4. Analyse biological system models using MATLAB

Course Outcomes

On successful completion of the course, students will be able to

CO. No	**Course Outcome**	**Bloom's Level**
CO 1	Understand the need for mathematical modeling of various systems, representation of systems in block diagrams and signal flow graphs and are introduced to biological control systems	Understanding
CO 2	Analyze the time response of various systems and discuss the concept of system stability	Analyzing
CO 3	Analyze the frequency response characteristics of various systems using different charts	Analyzing
CO 4	Understand the concept of modeling basic physiological systems	Understanding
CO 5	Comprehend the application aspects of time and frequency response analysis in physiological control systems.	Applying

Course Contents

Unit – I	**Introduction**	**12**

Concepts of control systems- Open loop and closed loop control systems and their differences- Different examples of control systems- classification of control systems. Mathematical models of physical systems: Differential equations transfer function and block diagram representation of physical systems- translational and rotational mechanical systems, electrical systems-analogous systems- Block diagram reduction using algebra- Representation by signal flow graph- reduction using Mason's gain formula

Unit – II	**Time Response Analysis**	**12**

Standard test signals- impulse, step and ramp response analysis of first order and second order systems- Characteristics Equation of Feedback control systems, Transient Response of second order systems- Time domain specifications Steady state response- Steady state errors and error constants- Effects of proportional derivative, proportional integral systems, performance indices First order and second order systems, time domain specifications of first and second order systems, steady state error constants, Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability

Unit – III	**Frequency Response Analysis**	**12**

Frequency response specifications- Bode diagrams- Determination of Frequency domain specifications and transfer function from the Bode diagram- Phase margin and Gain margin- Stability Analysis from Bode plots. Polar plots, Nyquist plots and applications of Nyquist criterion to find the stability- Effects of adding poles and zeros to G(s)H(s) on the shape of the Nyquist diagrams, Constant M and N circles- Nichols Chart- Frequency Domain specifications from Nichols Chart

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Unit – IV	**State-Variable Analysis**	**12**

Introduction of state, state variables and state model, derivation of state models from block diagrams, Relationship between state equations and transfer functions- Characteristic equation, eigenvalues, eigenvectors, canonical forms Diagonalization- solving the time invariant state equations- State Transition Matrix. Controllability and observability

Unit – V	**Biological Control System Analysis**	**12**

Simple models of muscle stretch reflex action, Study of steady state analysis of muscle stretch reflex action, Study of transient response analysis of neuromuscular reflex model action, Study of frequency response of circulatory control model, Stability analysis of Pupillary light reflex.

Total : 60 Periods

Text Books

1. J. Nagarath and M. Gopal Control Systems Engineering", Fifth Edition, Anshan Publishers, 2008.
2. Michael C K Khoo, Physiological Control Systems, IEEE Press, Prentice Hall of India, 2005

Reference Books

1. Norman S. Nise, "Control Systems Engineering", John Wiley & Sons, 2014, 7th Edition
2. Benjamin C. Kuo, Automatic Control Systems, Prentice Hall of India, 2014.
3. John Enderle Susan Blanchard, Joseph Bronzino Introduction to Biomedical Engineering, second edition, Academic Press, 2005.
4. Richard C. Dorf, Robert H. Bishop, Modern control systems, Pearson, 2004.

Additional / Web References

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	3	2										2		
CO2	3	2	2	2						2			2		
CO3	3	3	1			1							2		
CO4	2	2	2	2									1		
CO5	3	3	2							2			2		
	3	High		2	Medium			1	Low						

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

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Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Final Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	10	10	10	20
Understand	30	30	30	60
Apply	10	10	10	20
Analyse				
Evaluate				
Create				

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20BM502	Biomedical Instrumentation	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites	Basics of Biomedical Engineering				

Course Objectives

The course is intended to

1. Elaborate the development of biomedical instrumentation and its application in medical field, and the concepts behind measuring the blood pressure, cardiac output and heart sounds.
2. Revise the basics of EEG and to introduce the concepts of measuring the brain activity,
3. Familiarize with the basic principle, working and design of various automated diagnostic equipment related to ENT and ophthalmology.
4. Elaborate the need of scopy techniques in medical field and to develop the understanding towards the medical laboratory equipment.
5. Deliver the awareness towards shocks and hazards.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Comprehend the development of biomedical instrumentation and its application in medical field.	Understanding
CO 2	Excel in measuring the blood pressure, cardiac output and heart sounds and to design small products related to this application.	Applying
CO 3	Conceive the basics of EEG and the concepts of measuring the brain activity	Analyze
CO 4	Understand the basic principle, working and design of various automated diagnostic equipment related to ENT and ophthalmology.	Understanding
CO 5	Ability to plan, design and implement an instrument for medical applications.	Applying

Course Contents

Unit – I	Introduction	9

Introduction to Physiological System of Human Body, Development of Biomedical Instrumentation, Man instrument system, Problems encountered in the measurement, Body as a Control System, General constraints in design of medical instrumentation system.

Unit – II	Cardiovascular And Respiratory Instrumentation	9

Heart and cardiovascular system-model, Physiological Pressures, Blood pressure measurement, Measurement of heart sounds, Systemic and Pulmonary Circulation, Blood flow measurement, Cardiac output, Measurement of Pulmonary function, ECG, Standard Lead System, Respiratory system-model, Spirometer, Plethysmography.

Unit – III	Nervous System and Instrumentation	9

Neuronal communication system, The organization of the brain, measurements from the nervous system, EEG, Standard Lead System, Amplitude and Frequency Bands, Evoked Potential Recording, Sensory Measurement, Experimental Analysis of Behavior, Biofeedback Instrumentation

Unit – IV	Ent, Ophthalmic and Urological Instrumentation	9

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Mechanism of hearing, Measurement of Sound, Basic Audiometer, Pure Tone and Speech Audiometer, Hearing Aids, Optometry, EOG - Glucometer, ELISA, Endoscope, Cystoscope, Urological system: Nephroscope, Resectoscope, Ureteroscope		
Unit – V	**Medical Laboratory Instrumentation and Electrical Safety**	**9**
Calorimeter, Flame photometer, Spectrophotometer, pH and Blood Gas Analyzer, Auto Analyzer, Electrical Safety and Hazards - Physiological Effects of Electrical Current, Shock Hazards, Methods of Accident Prevention		
		Total : 45 Periods

Text Books
1. Joseph Carr, Brown, Introduction to Biomedical Equipment, Pearson, 2014
Reference Books
1. Leslie Cromwell, “Biomedical Instrumentation and measurement”, PHI, New Delhi, 2015 2. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, 2015. 3. Khandpur R.S Hand Book of Biomedical Instrumentation – Tata McGraw Hill publication , New Delhi, 2014
Additional / Web References

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

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Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM503	Biosignal Processing	L	T	P	C
		3	2	0	4
Nature of course	Professional Core				
Pre requisites	Signals and Systems				

Course Objectives

The course is intended to

1. Understand the basic concepts of Discrete Fourier Transform (DFT)
2. Learn the characteristics of digital filters, design digital IIR filter
3. Understand the characteristics of digital filters, design digital FIR filter
4. Acquire knowledge of wave detection techniques in ECG signals
5. Analyze the PCG and EEG signals using adaptive segmentation technique

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Apply DFT for the analysis of digital signals and systems	Applying
CO 2	Design IIR filters using Impulse invariance and bilinear transformation techniques.	Analyzing
CO 3	Design FIR filters using the windowing and sampling techniques	Analyzing
CO 4	Apply the wave detection techniques in ECG signals	Applying
CO 5	Analyze the PCG and EEG signals using adaptive segmentation technique	Analyzing

Course Contents

Unit – I	**Discrete Fourier Transform**	**12**

Discrete Fourier Transform (DFT) - deriving DFT from DTFT, properties of DFT - periodicity, symmetry, circular convolution. Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation in- frequency (DIF) Fast Fourier transform (FFT).

Unit – II	**Design of Infinite Impulse Response Filter**	**12**

Analog filter design – Discrete time IIR filter from analog filter – IIR filter desgin: Impulse Invariance, Bilinear transformation technique – Realization using Direct form – Cascade and Parallel forms

Unit – III	**Design of Finite Impulse Response Filter**	**12**

Design of linear phase FIR filters – windowing (Rectangular, Hamming, Hanning) and Frequency sampling methods- Realization of FIR filters Transversal and Linear phase

Unit – IV	**Analysis of Biomedical Signals**	**12**

Nature of Biomedical Signals - Objectives of Biomedical Signal Analysis – Detection of events and waves of P wave and QRS in ECG – Correlation analysis of EEG rhythms – Morphological analysis of ECG signals – analysis of activity – Analysis of Exercise ECG and respiration - Spectral Modeling and Analysis of PCG Signals

Unit – V	**Analysis Of Nonstationary And Multicomponent Signals**	**12**

Time-variant systems-Fixed Segmentation-Adaptive Segmentation-Wavelets and Time frequency Analysis-Separation of Mixtures of Signals-Application of Adaptive Segmentation in EEG and PCG Signals

Total : 60 Periods

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Text Books
1. John G. Proakis & Dimitris G.Manolakis, “Digital Signal Processing – Principles, Algorithms & Applications”, Pearson Education / Prentice Hall, Fourth Edition, 2007. 2. Rangaraj M Rangayyan, ”Biomedical Signal Analysis A Case Study Approach” John Wiley, 2002
Reference Books
1. Sanjit K.Mitra,“Digital Signal Processing–A Computer Based Approach”,Mc Graw Hill,4thedition 2013 2. Reddy D C, “Biomedical Signal Processing -Principles and Techniques”, The McGraw Hill Publishing Company Limited, New Delhi, 2005. 3. Willis J. Tompkins,”Biomedical Digital Signal Processing”, Prentice Hall of India Publications, 1995
Additional / Web References
1. http://www.nptelvideos.in/2012/11/digital-signal-processing.html, “Digital Signal Processing”, Prof.T.K.Basu, IIT Kharagpur 2. https://nptel.ac.in/courses/108/105/108105101/Biomedical Signal Processing, “Biomedical Signal Processing”, Prof.Sudipta Mukhopadhyay, IIT Kharagpur

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2	1								3	2	
CO2	3	2	2	2	1								3	2	
CO3	3	3	2	2	1								3	3	
CO4	3	3	2	2	1								3	3	
CO5	3	3	2	2	1								3	3	
	3	High		2	Medium					1	Low				

Formative assessment

Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment

Bloom’s Category	**Internal Assessment Examinations**			**Final Examination (60)**
	IAE – I (7.5)	**IAE – II (7.5)**	**IAE – III (10)**	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	10	10	10	20
Analyze	20	20	20	40
Evaluate				
Create				

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20BM504	Radiological Equipments	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites	Basics of Electrical Sciences				

Course Objectives

The course is intended to

1. Understand the generation of X-ray and its uses in imaging.
2. Describe the principle of Computed Tomography
3. Know the techniques used for visualizing various sections of the body using MRI
4. Learn the principles of different Nuclear medicine equipment in Imaging
5. Discuss the radiation therapy techniques and radiation safety

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Describe the working principle of X ray machine and its application	Understand
CO 2	Illustrate the principle computed tomography	Apply
CO 3	Interpret the technique used for visualizing various sections of the body using magnetic resonance imaging	Apply
CO 4	Demonstrate the applications of radio nuclide imaging	Apply
CO 5	Outline the methods of radiation safety	Understand

Course Contents

Unit – I	**Medical X-ray Equipment**	**9**

Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Cathode and filament currents, Focusing cup, Thermionic emission, Electromagnetic 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 temp due to over exposure, x-ray tube rating charts.X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, Cine Angiography, Digital subtraction Angiography. Mammography and Dental x-ray unit.

Unit – II	**Computed Tomography**	**9**

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 imaging equipment: Image plate, Plate readers, Image characteristics, Image reconstruction techniques- back projection and iterative method. Spiral CT, 3D Imaging and its application.

Unit – III	**Magnetic Resonance Imaging**	**9**

Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI 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	**Nuclear Medicine Techniques**	**9**

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Introduction of state, state variables and state model, derivation of state models from block diagrams, Relationship between state equations and transfer functions- Characteristic equation, eigenvalues, eigenvectors, canonical forms Diagonalization- solving the time invariant state equations- State Transition Matrix. Controllability and observability

Unit – V	**Radiation therapy and radiation safety**	**9**

Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT,-Recent Techniques in radiation therapy - 3DCRT – IMRT – IGRT and Cyber knife- radiation measuring instrumentsDosimeter, film badges, Thermo Luminescent dosimeters- electronic dosimeter- Radiation protection in medicine- radiation protection principles.

Total : 45 Periods

Text Books

1. Steve Webb, “The Physics of Medical Imaging”, Adam Hilger, Philadelpia,1988 (Units I, II, III & IV).
2. R.Hendee and Russell Ritenour “Medical Imaging Physics”, Fourth Edition William, Wiley Liss, 2002

Reference Books

1. Gopal B. Saha “Physics and Radiobiology of Nuclear Medicine”- 4th edition Springer, 2013.
2. Myer Kutz, “Standard handbook of Biomedical Engineering and design”, McGraw Hill, 2003.
3. P.Ragunathan, “Magnetic Resonance Imaging and Spectroscopy in Medicine Concepts and Techniques”,Paperback – Import, 2007
4. Paul Suetens, “Fundamentals of Medical Imaging”, Cambridge University Press, 3rd ed 2017.
5. Russell K. Hobbie, Bradley J. Roth, “Intermediate Physics for Medicine and Biology”, Springer International Publishing 1st edition 2015

Additional / Web References

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

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Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM507	Biosignal Processing Laboratory	L	T	P	C
		0	0	2	1
Nature of course	Professional Core				
Pre requisites	Signals and Systems				

Course Outcomes

On successful completion of the course, students will be able to

1. Perform basic signal processing operations using Open Source Software or MATLAB
2. Perform convolution, DFT and FFT operations using Open Source Software MATLAB
3. Design FIR and IIR filter for the specification derived from the given problem and simulate the frequency response.
4. Perform event detection in EEG and ECG signals
5. Apply PCA and ICA algorithm in the given biomedical signal

CYCLE-1

S.No.	Course Content	CO	Bloom's Level
1	Generation of impulse, sinusoidal, saw tooth, square and exponential signals	CO 1	Understanding
2	Perform the operations of Linear and Circular convolutions	CO 2	Understanding
3	Implement DFT and FFT algorithms for the given signal	CO 2	Applying
4	Design of IIR Butterworth filter using bilinear transformation method	CO 3	Analyzing
5	Design of Chebyshev IIR filter using one to one mapping method	CO 3	Analyzing

CYCLE-2

S.No.	Course Content	CO	Bloom's Level
1	Design of FIR filter using Hamming window	CO 3	Analyzing
2	Detection of the dicrotic notch in the carotid pulse signal	CO 4	Applying
3	Design and Implement the Pan–Tompkins method for QRS detection	CO 4	Analyzing
4	Design of cross-correlation for EEG spike and Wave detection using template matching	CO 4	Analyzing
5	Separation of Mixtures of Signals using PCA and ICA	CO 5	Analyzing

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Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3		3								3	3	
2	3	3	3		3								3	3	
3	3	3	3		3								3	3	
4	3	3	3		3								3	3	
5	3	3	3		3								3	3	
	3	High				2	Medium					1	Low		

Assessment based on Continuous and Final Examination			
Bloom's Level	**Continuous Assessment (50 marks) (Attendance – 5 marks)**		**Final Examination [50 marks]**
	Rubric based Continuous Assessment [25 marks]	**Model Examination [20 marks]**	
Remember			
Understand	40	40	40
Apply	60	60	60
Analyze			
Evaluate			
Create			

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VI Semester

20BM601	Regulatory Affairs and Medical Ethics	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites	Basics of Biomedical Engineering				

Course Contents		
Unit – I	**Introduction to Regulatory Affairs for Medical Devices**	**9**
Basic concepts - Taxonomy of medical devices and their risk classes - The regulatory process Regulatory Affairs Pre-Clinical Trial-Clinical Trial-Regulatory Bodies in India Central Drug Regulatory System-Drug & Cosmetics Act-Medical Device Registration in India Product Development Protocol-Environmental Protection Act		
Unit – II	**Medical Device and in Vitro Diagnostics**	**9**
Types of devices including combination devices and Drug Vs device Vs IVD, Medical Device Rules, 2017: Implications on medical devices, Classification. Labeling of medical devices.		
Unit – III	**Standards of Medical Device, Quality Assurance, and Testing**	**9**
Biocompatibility Studies on Medical Devices, Clinical Investigation of Medical Devices - Quality Assurance and Quality Management System: ISO9000 and ISO13485 - Risk management: ISO14971		
Unit – IV	**Manufacture of Medical Devices and IVDs**	**9**
How to obtain a license to manufacture a medical device?, Risk Management System for medical devices (ISO 14971) - Inspection of medical device and IVD establishments, Import and export of medical devices and IVDs, Medical device regulation: International practices		
Unit – V	**Medical Ethics**	**9**
Introduction to ethics - Law within medical practice- Issues in the doctor– patient relationship- Ethico- legal issues by medical specialism- Statutory provisions - Regulation of human tissue- The definition of mental disorder under the Mental Health Act		
		Total : 45 Periods

Text Books

1. Jack Wong, Raymond Tong “Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products”Jenny Stanford Publishing,2022
2. Anna Smajdor, Jonathan Herring, Robert Wheeler “Oxford Handbook of Medical Ethics and Law” OUP Oxford ,2022

Reference Books

1. Douglas J. Pisano, David Mantus “ FDA Regulatory Affairs- A Guide for Prescription Drugs, Medical Devices, and Biologics”Informa Healthcare,2003
2. Stephen Amato,Bob Ezzell “Regulatory Affairs for Biomaterials and Medical Devices”Woodhead Publishing,2014
3. John Harris ,”The Value of Life- An Introduction to Medical Ethics”Routledge,1990

Additional / Web References

3. Additional / web Reference 01
4. Additional / web Reference 02
5. Additional / web Reference 03

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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM602	Biomaterials and Artificial Organs	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites	Basics of Biomedical Engineering				

Course Objectives

1. Understand the properties of the Bio-compatible materials
2. Expose to different types of Biomaterials
3. Estimate artificial organs and its constraints

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	To understand and classify biomaterials based on their characteristics property.	Understand
CO 2	To justify different metals and ceramics usage based on different application.	Analyze
CO 3	To decide polymeric materials and its distinctive combinations that could be used as a tissue replacement implants	Analyze
CO 4	To apply the knowledge in artificial organ using these materials	Analyze
CO 5	To comprehend the knowledge about the need for artificial organs with its desired design consideration, organ replacement and steps required to evaluate the device.	Understand

Course Contents

Unit – I **Structure of Biomaterials and Biocompatibility** **9**

Definition and classification of biomaterials, mechanical properties, surface and bulk properties of biomaterials, viscoelasticity, wound-healing process, body response to implants, blood compatibility.

Unit – II **Metal and Ceramic Materials** **9**

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

Unit – III **Polymeric Implant Materials** **9**

Polymerization, polyolefin, polyamicles, Acrylic, polymers, rubbers, high strength thermoplastics, natural and synthetic polymer, medical applications

Unit – IV **Tissue Replacement Implants** **9**

Soft-tissue replacements, sutures, surgical tapes, adhesive, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.

Unit – V **Design of Artificial Organs** **9**

Substitutive medicine, Biomaterial Concentration, Outlook for Organ Replacement, Design Consideration, Evaluation of Artificial Organs

Total : 45 Periods

Text Books

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1. Park, Biomaterials: An Introduction, Springer Science & Business Media, 2012
2. Michael Lysaght, Thomas J Webster, Biomaterials for Artificial Organs, Elsevier Science, 2018

Reference Books

1. Sujata V. Bhatt, Biomaterials Second Edition, Narosa Publishing House, 2005
2. Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGraw-Hill, 2003
3. Introduction to Biomedical Engineering – John Enderle, Joseph D. Bronzino, Susan M. Blanchard, Elsevier, 200

Additional / Web References

6. Additional / web Reference 01
7. Additional / web Reference 02
8. Additional / web Reference 03

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BM603	Biomechanics	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites	Basics of Electrical Sciences				

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Illustrate the ways in which the kinetic and kinematics quantities can be applied to study human movement	
CO 2	Describe tissue injury in bone and cartilage using principle of mechanics	
CO 3	Identify the viscoelastic properties of blood and analyze Newtonian and non-Newtonian fluids	
CO 4	Derive the criteria for orthopedic implant design using complex mechanics of skeletal muscles	
CO 5	Analyze the stresses and strains in shoulder, spine and hip using different loading conditions	

Course Contents

Unit – I **9**

Use of statics, kinetics – rigid and non rigid bodies – Forces and motion – Newtons laws – Moment of force – Static equillibrum – Centre of gravity – Stability of equilibrium - Steps in analyzing a biomechanical problem – Graphical methods – contact forces – resolution of forces.

Unit – II **9**

Bone structure & composition mechanical properties of bone, cortical and cancellous bones - Electrical properties of bone, fracture mechanism and crack propagation in bones, fracture fixators, repairing of bones. Pseudo elasticity, nonlinear stress-strain relationship, viscoelasticity, structure, function and mechanical properties of skin, ligaments and tendons.

Unit – III **9**

Skeletal joints, skeletal muscles, basic considerations, basic assumption and limitations, forces and stresses in human joints, mechanics of the elbow, shoulder, spinal column, hip, knee and ankle. Human locomotion, gait analysis and goniometry, Ergonomics, Foot Pressure measurements – Pedobarograph, Force platform, mechanics of foot. Total Hip Prosthesis: requirements, different types of components, Stress analysis & instrumentation, Knee Prosthesis.

Unit – IV **9**

Alveoli mechanics, interaction of blood and lung, P-V curve of lung, breathing mechanism, airway resistance, physics of lung diseases.

Unit – V **9**

Mechanical properties of blood vessels – arteries, arterioles, capillaries, veins, physics of cardio vascular diseases, prosthetic heart valves and replacement. Fluids – density – pressure – blood pressure and gravity – buoyancy – moments of force and stability – movement in water - Rheological properties of blood, laminar flow, Couette flow and Hagen-poiseuille equation, turbulent flow.

Total : 45 Periods

Text Books

1. Susan J Hall, “Basic Biomechanics”, 8th Edition, 2019, Mc Graw Hill, USA
2. Y C Fung, “Biomechanics – Mechanical Properties of Living Tissue” 2nd Edition, 1993,

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Reprinted in 2016, Springer, USA

Reference Books

1. Frank Bell, Principles of Mechanics and Biomechanics, Stanley Thorne (Publishers) Ltd., 1998 (UNIT I, V)
2. Donald R. Peterson and Joseph D. Bronzino, Biomechanics Principles and applications, CRC press, Taylor & Francis Group, LLC, 2008 (UNIT II, III)
3. Duane Knudson, Fundamentals of Biomechanics, Second Edition, Springer publication , 2007 (UNIT IV)
4. Cynthia Norkins, “Joint Structure and Function: A Comprehensive Analysis”, 2019, 6th Edition, F. A. Davis Company, USA

Additional / Web References

1. Additional / web Reference 01
2. Additional / web Reference 02

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20EC606	Microprocessors and Microcontrollers	L	T	P	C
		3	0	2	4
Nature of course	Professional Core				
Pre requisites	Digital Electronics				

Course Objectives

The course is intended to

1. Study the Architecture, Memory Organization and addressing mode of 8085/8086 microprocessor
2. Explore the need and use of Peripherals and Interfacing
3. Study about the 8051 microcontroller Architecture, Instruction set, and addressing modes
4. Learn about microcontroller based system design
5. Learn about 32-bit ARM processor

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Describe the basic concept of architecture, Memory Organization and modes of 8085/8086	Remembering
CO 2	Discuss the different peripherals interfaced with the microprocessor	Understanding
CO 3	Illustrate the 8051 Architecture, Instruction Set, addressing modes and programming	Understanding
CO 4	Analyze the concept of interfacing unit and its applications	Analyzing
CO 5	Describe 32 bit ARM processor	Understanding

Course Contents

Unit – I	**8-Bit and 16 Bit Microprocessor**	**9**

8085 Architecture, Instruction set, Addressing modes, Interrupts, Timing diagrams, Memory and I/O interfacing. 8086 Architecture, Instruction set and programming, Minimum and Maximum mode configurations

Unit – II	**Peripheral and Interfacing**	**9**

Programmable Peripheral Interface (8255), Keyboard display controller (8279), ADC0808 and DAC0808 Interface, Programmable Timer Controller (8254), Programmable interrupt controller (8259), Serial Communication Interface (8251)

Unit – III	**Microcontroller**	**9**

8051 – Architecture, Special Function Registers (SFRs), Instruction set, addressing modes, Assembly language programming, I/O Ports, Timers / counters, Interrupts and serial communication

Unit – IV	**Microcontroller Based System Design**	**9**

Interfacing to: matrix display, (16x2) LCD, high power devices, optical motorshaft encoder, Stepper Motor, DC Motor speed Control using PWM, RTC and EEPROM interface using I2C protocol

Unit – V	**32- BIT ARM Processor**	**9**

RISC Vs CISC Architecture, ARM Processor Architecture, ARM Core data flow model, Barrel Shifter, ARM processor modes and families, pipelining , ARM instruction Set and its Programming

Total : 45 Periods

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Laboratory components			
S.No	**List of Experiments**	**CO Mapping**	**Revised Blooms Taxonomy**
1.	Basic arithmetic and Logical operations for 8085/8086 microprocessor	CO 1	Applying
2.	Floating point operations, string manipulations, sorting and searching for 8086	CO 1	Applying
3.	ADC & DAC Interfacing using 8255	CO 2	Applying
4.	Serial Communication between two microprocessors kits using 8251	CO 2	Applying
5.	D.C and Stepper motor interfacing using 8255	CO 2	Applying
6.	Key board and Display interfacing using 8255	CO 2	Applying
7.	Programming using Arithmetic, Logical and Bit Manipulation instructions of the 8051 microcontroller.	CO 3	Applying
8.	Programming and verifying Timer, Interrupts and UART operations in 8051 microcontroller	CO 3	Applying
9.	Interfacing – DAC and ADC and 8051 based temperature measurement	CO 4	Applying
10.	Communication between 8051 Microcontroller kit and PC.	CO 4	
11.	Programming ARM processor using Embedded C	CO 5	Applying
			Total : 30 Periods

Text Books

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085", Penram International Publishing reprint, 6th Edition, 2017.
2. Douglas V. Hall, "Microprocessor and Interfacing, Programming and Hardware", Tata McGraw Hill, Revised 2nd Edition 2006, 11th reprint 2015

Reference Books

1. Mohammed Ali Mazidi and Janice Gillispie Mazidi, “The 8051 Microcontroller and Embedded Systems using Assembly and C”, Pearson Education, Second Edition 2013
2. A.K.Ray and K.M.Bhurchandi, ”Advanced Microprocessors and Peripherals “,MC Graw Hill Education, Third Edition, 2013.
3. Krishna Kant, “Microprocessors and Microcontrollers”, PHI Learning Private Limited, Eastern Economy Edition, 2013.
4. Kenneth J. Ayala., “The 8051 Microcontroller, Thompson Delmar Learning’’, 3rd Edition, 2012.

Additional / Web References

1. https://nptel.ac.in/courses/117/104/117104072/
2. https://www.classcentral.com/course/swayam-microprocessors-and-microcontrollers-9894

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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	2	2	2										3	
CO 2	3	2	2	2										3	
CO 3	3	3	2	2										3	
CO 4	3	3	2	2										3	
CO 5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Remember	Online Quiz	5	15
Understand	Tutorial Class / Assignment	5	
	Attendance	5	

Summative Assessment						
Bloom's Level	**Continuous Assessment**					**Final Examination (Theory) (50)**
	Theory				**Practical's**	
	IAE – 1 (7.5)	**IAE – 2 (7.5)**	**IAE – 3 (10)**	**Attendance (5)**	**Rubric based CIA (20)**	
Remember	30	20	10		20	40
Understand	10	20	30		20	40
Apply	10	10	10		10	20
Analyze						
Evaluate						
Create						

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20BM604	Diagnostic and Therapeutic Equipment Laboratory	L	T	P	C
		0	0	2	1
Nature of course	Professional Core				
Pre requisites	Biomedical Instrumentation				

Course Outcomes

On successful completion of the course, students will be able to

1. Measure different bioelectrical signals using various methods
2. Record the ECG, EEG and EMG signals using surface electrodes.
3. Examine the electrical safety measurements
4. Illustrate various diagnostic and therapeutic techniques.
5. Analyze the different bio signals using suitable tools

CYCLE-1

S.No.	Course Content	CO	Bloom's Level
1	Measurement of various physiological signals using biotelemetry	CO 1	Understanding
2	Recording of ECG EMG and EEG signal	CO 2	Understanding
3	Electrical safety measurements	CO 3	Understanding
4	Measurement of visually evoked potential and Galvanic skin resistance (GSR) measurement	CO 4	Understanding
5	Demonstrate working of Pacemaker simulator and Defibrillator	CO 4	Applying

CYCLE-2

S.No.	Course Content	CO	Bloom's Level
1	Measurement of Respiratory parameters using spirometry	CO 4	Understanding
2	Measurement and Recording of peripheral blood flow using blood flow meter	CO 4	Understanding
3	Measurement of pH and conductivity	CO 4	Understanding
4	Study of heart lung machine model	CO 4	Understanding
5	Study of ventilators	CO 4	Understanding
	Analysis of ECG, EEG and EMG signals	CO 5	Analyzing

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Mapping of Course Outcomes (COs) with Program Outcomes (POs) Program Specific Outcomes (PSO)															
COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3		3								3	3	
2	3	3	3		3								3	3	
3	3	3	3		3								3	3	
4	3	3	3		3								3	3	
5	3	3	3		3								3	3	
	3	High				2	Medium					1	Low		

Assessment based on Continuous and Final Examination			
Bloom's Level	**Continuous Assessment (50 marks) (Attendance – 5 marks)**		**Final Examination [50 marks]**
	Rubric based Continuous Assessment [25 marks]	**Model Examination [20 marks]**	
Remember			
Understand	40	40	40
Apply	60	60	60
Analyze			
Evaluate			
Create			

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Professional Electives (PE)

Stream 1 Biomedical Signal and Image Processing (BSIP)

20BME01	**Physiological Signal Processing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Nature of course	Professional Elective				
Pre requisites	Signals and Systems				

Course Objectives
The course is intended to 1. Study the characteristics of different biomedical signals 2. Impart knowledge about spectral analysis 3. Learn the cardialogical signal processing methods 4. Understand the classification of biosignals using wavelets 5. Study the feauture reduction methods for biosignals

Course Outcomes

On successful completion of the course, students will be able to

CO. No	**Course Outcome**	**Bloom's Level**
CO 1	Examine the basic signal processing for bio-signals	Remembering
CO 2	Analyze biosignals in time domain & to estimate the spectrum.	Analyzing
CO 3	Apply wavelet detection techniques for biosignal processing	Applying
CO 4	Classify biosignals using neural networks and statistical classifiers	Understanding
CO 5	Demonstrate the feature reduction methods for different biosignlas	Analyzing

Course Contents

Unit – I	**Physiological Signal Characteristics**	**9**

Characteristics of dynamic biomedical signals: Electroneurogram (ENG), Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Event-related potentials (ERPs), Electroretinogram (ERG), Electrooculogram (EOG), Electrogastrogram (EGG), Phonocardlogram (PCG), speech signal, Vibroarthrogram (VAG) - Objectives of Biomedical Signal Analysis

Unit – II	**Time Series Analysis And Spectral Estimation**	**9**

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

Unit – III	**Adaptive Filtering And Wavelet Detection**	**9**

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

Unit – IV	**Biosignal Classification And Recognition**	**9**

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

Unit – V	**Time Frequency And Multivariate Analysis**	**9**

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Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA
Total : 45 Periods

Text Books
1. Arnon Cohen, “Bio-Medical Signal Processing Vol I and Vol II”, CRC Press Inc., Boca Rato, Florida, 1999. 2. Rangaraj M Rangayyan, ”Biomedical Signal Analysis A Case Study Approach” John Wiley, 2002
Reference Books
1. Reddy D C, “Biomedical Signal Processing -Principles and Techniques”, The McGraw Hill Publishing Company Limited, New Delhi, 2005. 2. Willis J. Tompkins,”Biomedical Digital Signal Processing”, Prentice Hall of India Publications, 1995. 3. Leif Sornmo, Pablo Laguna, “Bioelectrical Signal Processing in Cardiac & Neurological Applications”, Elsevier, 2005.
Additional / Web References
1. https://physionet.org/about/tutorial/ 2. https://nptel.ac.in/courses/108/105/108105101/Biomedical Signal Processing, “Biomedical Signal Processing”, Prof.Sudipta Mukhopadhyay, IIT Kharagpur

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

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Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME02	Biometric Systems	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Basics of Biomedical Engineering				

Course Objectives

The course is intended to

1. Understand the general principles of design of biometric systems and the underlying
2. Study the technologies of fingerprint, iris, face and speech recognition
3. Study of evaluation of biometrics systems

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Infer knowledge on biometric authentication system and applications of biometric systems	Understanding
CO 2	Explain the functional description of fingerprint enhancement, feature extraction, classification and matching technique	Understanding
CO 3	Discuss about various classifiers, algorithm, feature extraction of face and hand geometry recognition	Understanding
CO 4	Describe about iris recognition	Understanding
CO 5	Identify issues in the voice scan and multimodal biometrics	Understanding

Course Contents

Unit – I	**Introduction to Biometrics**	**9**

Introduction and back ground – biometric technologies –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	**Fingerprint Technology**	**9**

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	**Face Recognition and Hand Geometry**	**9**

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	**Iris Recognition**	**9**

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

Unit – V	**Voice Scan and Multimodal Biometrics**	**9**

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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

Total : 45 Periods

Text Books

1. James Wayman, Anil Jain, DavideMaltoni, Dario Maio, “Biometric Systems, Technology Design and Performance Evaluation”, Springer, 2005.
2. Paul Reid, “Biometrics for Network Security”, Pearson Education, 2004

Reference Books

1. G.R.Sinha, SandeepB.Patel, “Biometrics:Concepts and Applications”, Wiley Publicatios, 1st edition, 2013.
2. Arun A Ross, Karthik Nandakumar and Anil K.Jain, “Handbook of Multibiometics”, Springer,2006.

Additional / Web References

http:// nptel/biometrics- iit-kanpur, “Biometric Systems”, Prof. PhalguniGupt , IIT, khanpur

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME03	Computer Vision And Pattern Recognition For Biological Applications	L	T	P	C
		3	0	0	3
Nature of course	Professional elective				
Pre requisites					

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	**To** introduce student to computer vision algorithms.	
CO 2	To introduce mechanisms used in biological visual systems that inspire design of artificial unit.	
CO 3	Introduction to techniques of image segmentation.	
CO 4	Various techniques for image representation.	
CO 5	To introduce principles of motion analysis and object recognition	

Course Contents

Unit – I	**Digital Image Formation, Depth Estimation and Multi-Camera Views**	**9**

Fundamentals of image formation, transformation: orthogonal, Euclidean, affine, projective, etc; Fourier transform, convolution and filtering, image enhancement, restoration, histogram processing. Perspective, binocular stereopsis: camera and epipolar geometry; homography, rectification, direct linear transform, random sample consensus (RANSAC), 3-D reconstruction framework; auto-calibration.

Unit – II	**Feature Extraction**	**9**

Edges - Canny, Laplacian of Gaussian, difference of Gaussian; line detectors (Hough Transform), corners - Harris and Hessian Affine, orientation histogram, scale invariant feature transform, SURF, histogram of oriented gradients scale-space analysis- image pyramids and Gaussian derivative filters, Gabor Filters and DWT.

Unit – III	**Image Segmentation**	**9**

Region growing, edge based approaches to segmentation, graph-cut, mean-shift, MRFs, texture segmentation; object detection.

Unit – IV	**Shape Representation**	**9**

Deformable curves and surfaces, snakes and active contours, level set representations, Fourier and wavelet descriptors, medial representations, multiresolution analysis.

Unit – V	**Object Recognition and Motion Analysis**	**9**

Shape correspondence and shape matching, principal component analysis, shape priors for recognition background subtraction and modeling, optical flow, KLT, spatio-temporal analysis, dynamic stereo; motion parameter estimation.

TOTAL: 45

Periods

Text Books

. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag, 2011.
2. D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003.

Reference Books

1. H Richard, Z Andrew, Multiple View Geometry in Computer Vision, Cambridge Press, 2003.
2. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992

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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME04	Speech Processing	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Bio Signal Processing				

Course Objectives

The course is intended to

1. Introduce speech production and related parameters of speech
2. Show the computation and use of techniques such as short time Fourier transform, linear predictive coefficients
3. Understand different speech modeling procedures such as Markov and their implementation issues
4. Introduce speech recognition algorithm
5. Introduce artificial speech of human speech

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Describe the production and classification of speech signal processing using articulatory and acoustic phonetics.	Remembering
CO 2	Analyze the speech signal using feature extracting and pattern comparison techniques.	Analyzing
CO 3	Evaluate the speech processing systems using deterministic and stochastic process models	Evaluating
CO 4	Analyze the continuous speech recognition system using its architecture, acoustic and language models	Analyzing
CO 5	Analyze the speech synthesis using Diaphone Waveform synthesis techniques and evaluation	Analyzing

Course Contents

Unit – I **Basic Concepts** **9**

Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – Acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

Unit – II **Speech Analysis** **9**

Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures– mathematical and perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

Unit – III **Speech Modelling** **9**

Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

Unit – IV **Speech Recognition** **9**

Large Vocabulary Continuous Speech Recognition: Architecture of large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent sub-word units; Applications and present status.

Unit – V **Speech Synthesis** **9**

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Text Normalization – Phonetic Analysis – Prosodic Analysis – Diaphone Waveform synthesis – Unit selection synthesis and Evaluation
Total : 45 Periods

Text Books
1. Lawrence Rabiner, Biing-Hwang Juang and Yegnararayana, “Fundamentals of Speech Recognition”, Pearson Education,First edition, 2008.. 2. Daniel Jurafsky and James H Martin, “Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Pearson Education, second edition 2013
Reference Books
1. Thomas F Quatieri, “Discrete-Time Speech Signal Processing – Principles and Practice”, Pearson Education, 2004. 2. Ben Gold and Nelson Morgan, “Speech and audio signal processing, Processing and Perception of Speech and Music”, Wiley- India Edition, 2006 3. Lawrence R. Rabiner,, Ronald W. Schafer, “Digital Processing of Speech Signals”, Prentice-Hall, 1978.
Additional / Web References
1. http://freevideolectures.com/Course/2504/ELEC9344-Speech-and-Audio-Processing, “Introduction to speech processing”, Prof. E. Ambikairajah, The University of New South Wales

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

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Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME05	Biostatistics	L	T	P	C
		3	0	0	3
Nature of course	Professional elective				
Pre requisites					

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Introduction to measurement & descriptive statistics in medical practices.	
CO 2	Get familiar with statistics software.	
CO 3	Understand basics of sampling.	
CO 4	Study of Hypothesis testing.	
CO 5	Knowledge of regression & correlation	

Course Contents

Unit – I	**Measurements and Descriptive Statistics in Medical Research and Practice**	**9**

Data types and scales of measurement: continuous vs. enumeration data, sampling distributions - normal distribution (continuous data), binomial distribution (proportions, based on enumeration data), measures of central tendency-mean, median, mode, measures of variability-standard deviation and standard error.

Unit – II	**Introduction to R - Software for Statistical Computing**	**9**

Basics of R programming, data entry and exporting data, grouping, loops and conditional execution, functions. Summary statistics, graphics in R, probability and distribution

Unit – III	**Sampling**	**9**

Concept of a source population, random sampling, estimation of population statistics, standard error of a sample mean and of a proportion, and their differences, confidence intervals

Unit – IV	**Inference and Hypothesis Testing**	**9**

Hypothesis generation, null hypothesis, Type I and II errors, statistical power, interpretation of P-values and confidence intervals, statistical and clinical significance. Comparing 2 or more groups: Comparing means of two populations with the t-test (continuous data), comparing proportions of responders in two populations (enumeration data), Chi square with corrections (goodness of fit, test of independence). One - Way ANOVA: F distribution test.

Unit – V	**Regression and Correlation**	**9**

Simple, partial and multiple correlation, simple linear /nonlinear regression, introduction to data mining for patterns, analytics.

TOTAL: 45

Periods

Text Books

1. Rao S, *Introduction to Biostatistics and Research Methods*, PHI, 2012.
2. Chad L., C. Wayne, W. Daniel, *Biostatistics: Basic Concepts and Methodology for the Health Sciences*, Wiley, 2014.

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Reference Books

1. B.K Mahajan, *Methods in Biostatistics*, Jaypee Brothers, 2010.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME07	Medical Image Analysis	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Digital Image Processing				

Course Objectives

The course is intended to

1. Learn debug and test functionality in image processing tools
2. Learn about sources of noise in medical images (i.e. Acquisition noise, low contrast)
3. Understand the design and implement automated medical analysis algorithms on clinical imaging data using Matlab
4. Introduce deep neural network for image analysis
5. Perform research on an image analysis algorithm

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Describe the medical image fundamentals	Remembering
CO 2	Apply image enhancement techniques for processing images	Applying
CO 3	Select the methodologies for image segmentation & recognition	Understanding
CO 4	Outline the deep learning techniques in practical applications	Remembering
CO 5	Attribute image restoration and reconstruction techniques in real time applications	Analyzing

Course Contents

Unit – I	**Introduction to Medical Imaging**	**9**

Introduction to Medical Imaging and Analysis Software, X-ray and Computed Tomography (CT) imaging**,** Magnetic Resonance Imaging (MRI), Ultrasonic Imaging**,** Molecular Imaging, SPECT and PET

Unit – II	**Steps in Image Processing**	**9**

Texture in Medical Images, Region Growing and Clustering, Random Walks for Segmentation, Active Contours for Segmentation, Systematic Evaluation and Validation

Unit – III	**Image Segmentation & Analysis**	**9**

Image Segmentation: Decision Trees for Segmentation and Classification and Random Forests for Segmentation and Classification. Image Analysis: Neural Networks for Segmentation and Classification and Deep Learning for Medical Image Analysis

.

Unit – IV	**Deep Learning for Image Analysis**	**9**

Advanced Computer Vision - Neural Networks for Image Processing – Overview of Deep Neural Networks - Convolutional Neural Networks and Deep Learning for Medical Image Analysis.

Unit – V	**Applications**	**9**

Retinal Vessel Segmentation, Vessel Segmentation in Lung CT Image, Lesion Segmentation in Brain MR

Total : 45 Periods

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Text Books
1. Wolfgang Birkfellner, “Applied medical Image Processing- A basic course”, Second Edition, CRC Press, 2014 2. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018
Reference Books
1. A. P. Dhawan, H.K. Huang, and D. SH. Kim,” Principles and Advanced Methods in Medical Imaging and Image Analysis”, 2008 2. Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011 3. William K. Pratt, “Introduction to Digital Image Processing”, CRC Press, 2013. 4. Reiner Salzer, “Biomedical Imaging: Principles and Applications”, 2012, 1st Edition, Wiley, New Jersey
Additional / Web References
https://nptel.ac.in/courses/108/105/108105091/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME012	Machine Learning for Healthcare	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Linear algebra and Probability theory				

Course Objectives

The course is intended to

1. Learn the various types of machine learning and fundamental mathematical concepts
2. Understand the supervised Learning techniques like regression, classification tree
3. Understand the neural network based Classification and Clustering techniques
4. Familiar with various classifications and clustering algorithms
5. Understand the various concepts of learning techniques and its medical application

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Apply the basic mathematical foundation for various Machine learning techniques	Applying
CO 2	Implement supervised learning techniques for various data sets.	Analyzing
CO 3	Implement and analyse data sets for clustering	Analyzing
CO 4	Apply various reinforcement learning algorithms on data sets	Applying
CO 5	Explain the learning techniques and its medical application	Understanding

Course Contents

Unit – I **Introduction** **9**

Definition and Need for Machine Learning–Type–Supervised–Unsupervised Learning–Reinforcement–Basics Maths and Background–Probability–Linear Algebra–Statistical Decision Support Theory–Bayesian–Data set–Training–Testing–Validation–Models–Evaluation

Unit – II **Supervised Learning** **9**

Regression–Linear–Ridge–Lasso–Logistic regression–Regularizations; Classification algorithms: K–Nearest Neighbour–Decision Trees–Support Vector Machine–Kernel trick–Artificial Neural Networks–Feedforward–Back propagation–Case study on various classification applications

Unit – III **Unsupervised Learning** **9**

Clustering algorithms– K-Means–K-Medoids–DBSCAN –Hierarchical clustering – Spectral Clustering– Cluster Analysis – Objective Functions – Case study on various clustering applications

Unit – IV **Reinforcement Learning** **9**

Markov Decision process model–Policy–value–optimal–evaluation– Planning algorithms – value iteration–policy iteration–linear programming– Learning algorithms – Stochastic approximation – Q-Learning – SARSA – Case study on various reinforcement applications

Unit – V **APPLICATIONS OF MACHINE LEARNING IN MEDICAL FIELD** **9**

Study of Neuro marketing With EEG Signals and Machine Learning Techniques, Deep Learning on Symptoms in Disease Prediction, Deep Learning in Mining Biological Data, Prediction of protein structure using ML, Medical Image data classification and segmentation

Total : 45 Periods

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Text Books
1. Mohri Mehryar, Afshin Rostamizadeh, and Ameet Talwalkar. “Foundations of machine learning”, MIT press, 2018 2. Sachi Nandan Mohanty, G. Nalinipriya, Om Prakash Jena, Achyuth Sarkar, "Machine Learning for Healthcare Applications" ISBN: 978-1-119-79181-2, Wiley Scrivener Publishing, 2021 3. Müller Andreas C. and Sarah Guido. “Introduction to Machine Learning with Python: A Guide for Data Scientists”, O’Reilly, 2016
Reference Books
1. Christopher M. Bishop. “Pattern Recognition and Machine Learning”, Springer, 2013 2. Ethem A Ipaydin. “Introduction to Machine Learning” Second Edition, PHI Learning,2012
Additional / Web References
https://nptel.ac.in/courses/106/106/106106236/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

BME14	Real Time Embedded Systems	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Microcontrollers				

Course Objectives

The course is intended to

1. Study the architecture and programming of ARM processors
2. Understand the computing platform in memory
3. Understand the program validation and testing
4. Introduce the basic concepts of hard real time multiprocessing
5. Introduce the analytical concepts for effective programming

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Design and develop ARM processor based systems	Applying
CO 2	Comprehend and appreciate the significance and role of microcontrollers in embedded systems.	Understanding
CO 3	Analyze and demonstrate program design and optimization and proper scheduling of the process	Analyzing
CO 4	Apply the concept of process, multiprocessing and operating systems in embedded system	Analyzing
CO 5	Implement various communication protocols in distributed embedded computing platform	Analyzing

Course Contents

Unit – I	**Introduction to Embedded Computing and ARM Processors**	**9**

Complex systems and microprocessors–Embedded system design process–Formalism for system design– Design example: Model train controller- ARM Processor Fundamentals-Instruction Set and Programming using ARM Processor

Unit – II	**Computing Platform**	**9**

CPU: Programming input and output–Supervisor mode, exception and traps–Coprocessor–Memory system mechanism–CPU performance–CPU power consumption- CPU buses–Memory devices–I/O devices–Component interfacing-System Level Performance Analysis-Parallelism. Design Example: Data Compressor

Unit – III	**Program Design and Analysis**	**9**

Program design–Model of programs–Assembly and Linking–Basic compilation techniques– Program Optimization-Analysis and optimization of execution time, power, energy, program size–Program validation and testing- Example: Software Modem

Unit – IV	**Process and Operating Systems**	**9**

Multiple tasks and Multi processes–Processes–Context Switching–Operating Systems–Priority based Scheduling- RMS and EDF- Inter Process Communication mechanisms–Evaluating operating system performance–Power optimization strategies for processes

Unit – V	**Hardware Accelerators and Networks**	**9**

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Multiprocessors-CPUs and Accelerators–Performance Analysis- Distributed Embedded Architecture–Networks for Embedded Systems: I2C, CAN Bus, Ethernet, Myrinet–Network based design–Internet enabled systems. Design Example: Elevator Controller.

Total : 45 Periods

Text Books

1. Wayne Wolf, "Computers as Components - Principles of Embedded Computing System Design", Morgan Kaufmann Publisher (An imprint of Elsevier), 3rd Edition, 2008.
2. Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developer‘s Guide-Designing and Optimizing System Software", Elsevier/Morgan Kaufmann Publisher, 2008

Reference Books

1. David E-Simon, "An Embedded Software Prime", Pearson Education, 2010.
2. K.V.K.K.Prasad, "Embedded Real-Time Systems: Concepts, Design & Programming", Dreamtech press, 2005.
3. Jane. W. S. Liu, "Real-Time Systems", Pearson Education Asia, 2011.

Additional / Web References

https://nptel.ac.in/courses/106/105/106105193/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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Stream -2 Health Care Systems (HCS)

20BME22	Robotics in Medicine	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites	Sensors and Measurements				

Course Objectives

1. To provide basic understanding of robotics and their applications.
2. To demonstrate the need for various sensors and drives in robotics.
3. To provide knowledge about the robot kinematics, path planning and different trajectories.
4. To make students understand the basics of programming of robots, contemporary use and design of robots in practice and research.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand the necessity of robots in various applications and the working of basic electric, electronic and other types of drives required in robots.	Understand
CO 2	Identify a suitable sensor for a specific robot.	Apply
CO 3	Derive the mathematical model of robotic systems and analyze its kinematic behavior.	Apply
CO 4	Design robots for diverse environments encompassing all types of motions and paths and the ideas for performing various robotic tasks with the application of programming skills.	Analyze
CO 5	Design of different types of robots for various applications.	Understand

Course Contents

Unit – I	**Introduction to Robotics and Drives for Robotics**	**9**

Robots: Basics, Types-Application, Mobility, Terrain, components classification, performance characteristics. Drives: Electric, hydraulic and pneumatic drives

Unit – II	**Sensors for Robots**	**9**

Tactile sensors - Proximity and range sensors - Acoustic sensors - Vision sensor systems -Image processing and analysis - Image data reduction – Segmentation – Feature extraction -Object recognition.

Unit – III	**Robot Kinematics and Dynamics**	**9**

Kinematics of manipulators, rotational, translation and transformation, Homogeneous, Transformations, Denavat – Hartenberg Representation, Inverse Kinematics. Linearization of Robot Dynamics – State variable continuous and discrete models.

Unit – IV	**Path Planning and Programming of Robots**	**9**

Types of trajectories, trajectory planning and avoidance of obstacles, path planning, skew motion, joint integrated motion and straight line motion. Robot programming: languages and software packages-MATLAB/Simulink, OpenRDK, Adams.

Unit – V	**Application of Robots**	**9**

Applications in Biomedical Engineering–Bio Engineering Biologically Inspired Robots,Neural Engineering, Application in Rehabilitation–Interactive Therapy, Bionic Arm, Clinical and Surgical–Gynaecology, Orthopaedics, Neurosurgery.

Total : 45 Periods

Text Books

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1. P. Groover, “Industrial Robotics: Technology, Programming and Applications”, 2nd Edition, McGraw-Hill Publishers, 2012
2. John J. Craig, “Introduction to Robotics, Mechanics and Control”, 3rd Edition, Pearson Education, 2010

Reference Books

1. Robert Schilling, “Fundamentals of Robotics-Analysis and control”, Prentice Hall, 2003
2. W. Spong and M. Vidyasagar, “Robot Dynamics and Control,” 2012, 2nd Edition, John Wiley & Sons, New York.
3. Lorenzo Sciavicco Bruno Siciliano , “Modelling and Control of Robot Manipulators”, 2012, 1st Edition, Springer Science & Business Media, Berlin.
4. Peter Corke, “Robotics, Vision and Control: Fundamental Algorithms in MATLAB”, Reprint 2013, 1 st Edition, Springer-Verlag Berlin Heidelberg.

Additional / Web References

9. Additional / web Reference 01
10. Additional / web Reference 02
11. Additional / web Reference 03

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME23	Medical Device Design And Prototyping	L	T	P	C
		3	0	0	3
Nature of course	Profession Elective				
Pre requisites	Introduction to basic medical Science for engineers				

Course Objectives

1. Provides an overview of design and manufacturing technique for medical devices development.
2. Define the equipments, instrumentations and control systems used in bio manufacturing.
3. Explain standard design and manufacturing programs, validation practices and regulatory requirement used in biomedical industry.

Course Contents

Unit – I		**9**

Generating Ideas and Concepts, Design Process versus Design Control, Implementation of Design Procedures, Material selection and Biocompatibility, Design Specification, Quality in Design, Detailed Design (hardware/ Software design), Computer-Aided Design, Design Evaluation (Validation and Verification), Obtaining Regulatory Approval to Market.

Unit – II		**9**

Introduction to Finite Element Method, Finite element modelling of cells, tissues and organs Medical device design and prototyping, Customized and universal design of Implants and prosthesis.

Unit – III		**9**

Design of orthopaedic Implants, orthoses and Assistive devices.

Unit – IV		**9**

Additive manufacturing processes; Machining, forming, electro-discharge machining (EDM) and electrochemical machining (ECM), laser-based processing, casting and molding, and others.

Unit – V		**9**

Machines and equipment including tooling, fixturing, sensors systems, and control; Metrology, material handling, joining, and assembly; Implants, Prostheses and orthoses manufacturing; Assistive technology

Total : 45 Periods

Text Books

1.Design and Manufacture of Medical Devices by Paulo Davim, Woodhead Publishing,2012
2. Medical Device Design: Innovation from Concept to Market, by Peter J. Ogrodnik, Academic Press is an imprint of Elsevier
3. Handbook of Medical Device Design by Richard C. Fries, CRC Press
4. Introduction to Bio manufacturing, Margaret Bryans, Northeast Bio manufacturingceter

Reference Books

Additional / Web References

1. Additional / web Reference 01
2. Additional / web Reference 02
3. Additional / web Reference 03

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Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)															
COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME25	Telemedicine	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites	Sensors and Measurements				

Course Objectives
1.To impart the key principle of telemedicine and healthcare. 2. Expound element of tele-radiology systems like image acquisition system, display system and communication networks. 3. Demonstrate the methods and techniques used in virtual instrumentation

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	To teach the key principles of telemedicine-health and its technology	Understand
CO 2	To make the student understand tele-medical technology.	Apply
CO 3	To introduce the students with the knowledge of mobile telemedicine and its applications.	Apply
CO 4	To study the need for digital imaging and picture archiving and communication systems in telemedicine application.	Analyze

Course Contents

Unit – I	**Telemedicine and Health**	**9**

History and Evolution of telemedicine - Tele health - Tele care - Organs of telemedicine - Global and Indian scenario. Ethical and legal aspects of Telemedicine - Social and legal issues - Safety and regulatory issues - Advances in Telemedicine.

Unit – II	**Telemedical Technology**	**9**

Principles of Multimedia - Text, Audio, Video, data - Data communications and networks - PSTN – POTS – ANT – ISDN – Internet - Air/ wireless communications: GSM satellite - and Micro wave - Modulation techniques, Types of Antenna - Integration and operational issues - Communication infrastructure for telemedicine – LAN and WAN technology - Satellite communication. Mobile hand held devices and mobile communication - Internet technology and telemedicine using world wide web (www) - Video and audio conferencing - Clinical data – Local and centralized.

Unit – III	**Mobile Telemedicine**	**9**

Tele radiology: Definition, Basic parts of tele radiology system - Image Acquisition system - Display system - Tele pathology - Multimedia databases - Color images of sufficient resolution - Dynamic range - Spatial resolution - Compression methods - Interactive control of color.

Unit – IV	**Information System**	**9**

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 – V	**Telemedical Applications**	**9**

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 – health education and self-care - Business aspects - Project planning and costing - Usage of telemedicine.

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Total : 45 Periods

Text Books
1. Sherry Emery, Telemedicine in Hospitals: Issues in Implementation, 2015, 1st edition, Routledge, Tayor and Francis Group, New York.

Reference Books
1. Bernard Fong, A.C.M. Fong, C.K. Li, Telemedicine Technologies: Information Technologies in Medicine and Telehealth, 2011, 1st edition, John Wiley & Sons Ltd, New York

Additional / Web References
12. Additional / web Reference 01 13. Additional / web Reference 02 14. Additional / web Reference 03

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME26	Wearable Systems	L	T	P	C
		3	0	0	3
Nature of course	Professional Electives				
Pre requisites	Sensors and Instrumentation				

Course Objectives

The course is intended to

1. Know the sensor and signal processing requirement of wearable systems
2. Understand the level of energy involvement in wearable systems
3. Understand the communication and security aspects
4. Educate the wearability issues related to Body Sensor Networks
5. Learn the applications of wearable systems

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Identify the wearable sensors and its need for wearable systems	Understanding
CO 2	Interpret the energy requirement for wearable system	Applying
CO 3	Express the need for wireless communication techniques	Understanding
CO 4	Predict the wearability issues related to Body Sensor Networks	Applying
CO 5	Illustrate the applications of wearable systems	Understanding

Course Contents

Unit – I **Introduction to Sensors** **9**

Need for wearable systems, Characteristics of wearable systems, Sensors for wearable systems-Biomechanical Sensors -Inertia movement sensors, Physiological Sign Sensors-Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Pulse Oximetry, Radiant thermal sensor, Gas Sensor, Bio compatibility.

Unit – II **Energy Harvesting for Self-Powered Wearable Devices** **9**

Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles

Unit – III **Wireless Health Systems** **9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges-System security and reliability, BAN Architecture–Introduction, Wireless communication techniques

Unit – IV **Ergonomics for Wearable Body Sensor Networks** **9**

Wearability issues-physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, Rejection of irrelevant information, Data mining

Unit – V **Applications of Wearable Systems** **9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics

Total : 45 Periods

Text Books

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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

Reference Books

1. Hang,Yuan-Ting,"wearable medical sensors and systems",Springer-2013
2. Mehmet R. Yuce,Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt.Ltd, Singapore, 2012

Additional / Web References

https://www.youtube.com/watch?v=P7YWJuhVM1Q, „Wearable Electronic Textiles",Prof. Volakis, Chair Professor of Electrical Engineering at Ohio State University

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME27	Body Area Networks	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. To know the hardware requirement of BAN
2. To understand the communication and security aspects in the BAN
3. To know the applications of BAN in the field of medicine

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Discuss the introduction of BAN	Understanding
CO 2	Design a BAN for appropriate application in medicine	Applying
CO 3	Assess the efficiency of communication and the security parameters	Evaluating
CO 4	Illustrate the need for medical device regulation and regulations followed in various regions	Understanding
CO 5	Extend the concepts of BAN for medical applications	Understanding

Course Contents

Unit – I	**Introduction**	**9**

Definition, BAN and Healthcare, Technical Challenges-Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BAN Architecture–Introduction

Unit – II	**Hardware For BAN**	**9**

Processor-Low Power MCUs, Mobile Computing MCUs ,Integrated processor with radio transceiver, Memory, Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes

Unit – III	**Wireless Communication and Network**	**9**

RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1,IEEE P802.15.13, IEEE 802.15.14, Zigbee

Unit – IV	**Coexistence Issues With BAN**	**9**

Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self-protection-Bacterial attacks, Virus infection, Secured protocols, Self-protection

Unit – V	**Applications of BAN**	**9**

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill

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Total : 45 Periods

Text Books
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.
Reference Books
1. Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems'',Springer, 2013. 2. Guang-Zhong Yang(Ed.), "Body Sensor Networks'',Springer, 2006. 4. Mehmet R. Yuce, Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation, and Applications", Pan Stanford Publishing Pte.Ltd., Singapore, 2012
Additional / Web References

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME29	Data Communication and Networking	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Focus on information sharing and networks
2. Understand the MAC layer protocols
3. Study the IP addressing and routing protocols in network layer
4. Know the congestion control and resource allocation techniques
5. Educate the services provided by the application layer protocol

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Interpret the importance of layering, addressing and annotate the protocol stack of OSI and TCP/IP model	Understanding
CO 2	Annotate MAC protocols (Ethernet, Token Ring and Wi-Fi) supported by Data Link layer to ensure hop-to-hop reliable communication	Understanding
CO 3	Explain IP addressing and routing protocols to find shortest route to achieve reliable network-layer data transmission	Applying
CO 4	Classify the transport layer protocols and explain the congest ion control or congestion avoidance techniques to ensure quality of service	Understanding
CO 5	Analyze the functions and services provided by the application layer protocols (HTTP, SMTP and DNS).	Analyzing

Course Contents

Unit – I	**Data Communications**	**9**

Data Communication–Networks–The OSI Model– Layers in the OSI Model – TCP/IP Protocol Suite – Addressing–Transmission Media

Unit – II	**Data Link Layer**	**9**

Framing–Error Detection and Correction– IEEE Standards (802.3,802.5,802.11)-MAC protocols and types

Unit – III	**Network Layer**	**9**

Internetworking: Switching and Bridging–Basic Internetworking-IPv4-IPv6–Routing Techniques: Distance vector (RIP)–Link state (OSPF)-Interdomain Routing (BGP)

Unit – IV	**Transport Layer**	**9**

Congestion Control and Resource Allocation: TCP Congestion Control–Congestion Avoidance Mechanisms–Quality of Service: Integrated Services–Differentiated Services

Unit – V	**Application Layer**	**9**

Domain Name System-File Transfer-Web Services and SNMP-HTTP-Electronic Mail (SMTP, POP3, IMAP, MIME)

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Total : 45 Periods

Text Books
6. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Fifth Edition, Morgan Kaufmann Publishers, 2011 **7.** Behrouz A. Forouzan, "Data Communications and Networking", Fourth Edition, Tata McGraw Hill, Reprint 2012
Reference Books
6. William Stallings, "Data Communication and Networks", Pearson Education, Tenth edition, 2014. **7.** James .F. Kurouse & W. Rouse, "Computer Networking: A Top down Approach Featuring", Sixth edition, Pearson Education, 2013.
Additional / Web References
http://www.nptel.ac.in/downloads/106105080, Computer Networks, Prof.Sujoy Ghosh, IIT Kharagpur

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	**Pos**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME30	Internet Of Things in Medicine	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	microcontroller				

Course Objectives

The course is intended to

1. Understand Smart Objects and IoT Architectures
2. Learn about various IOT-related protocols
3. Study the healthcare challenges in IoT
4. Understand the domain specific applications of IoT in healthcare
5. Study the IoT in medicine for popular applications

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Describe the concepts of Internet of Things	Understanding
CO 2	Interpret basic protocols in wireless sensor network	Understanding
CO 3	Illustrate the need and challenges of IoT	Understanding
CO 4	Relate IoT applications in Industry domain and analyze their performance	Analyzing
CO 5	Compute the health care applications through IoT tools and Embedded systems	Applying

Course Contents

Unit – I	**IoT and M2M**	**9**

Defining IoT-Characteristics of IoT-Physical design of IoT-Logical design of IoT–Functional blocks of IoT-Communication models & APIs-Machine to Machine-Difference between IoT and M2M-Software define network

Unit – II	**Network and Communication Aspects**	**9**

Wireless medium access issues-MAC protocol survey-Survey routing protocols– Sensor deployment & Node discovery-Data aggregation & dissemination

Unit – III	**Challenges in IoT**	**9**

Design challenges-Development challenges-Security challenges–Health care challenges.

Unit – IV	**Domain Specific Applications of IoT**	**9**

Home automation-Industry applications-Surveillance applications-Other IoT applications in health care

Unit – V	**Developing IoT Applications in Healthcare**	**9**

Introduction to Python-Introduction to different IoT tools-Developing applications through IoT tools-Developing sensor based application through embedded system platform-Implementing IoT concepts with python

Total : 45 Periods

Text Books

1. Vijay Madisetti, Arshdeep Bahga, “Internet of Things: A Hands-On Approach”, Universities Press, 2015.

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2. Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat, “Internet of Things and Personalized Healthcare Systems”, Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019.

Reference Books

1. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice".
2. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.

Additional / Web References

https://nptel.ac.in › courses, “Internet of Things” – Prof.Sudip Misra, IIT Kharagpur

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME32	Medical Informatics	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites					

Course Objectives

1. Introduce the basic concepts in Biomedical Informatics.
2. Understand the applications of an electronic medical record system and medical standards.
3. Acquaint the students to clinical decision support systems.
4. Introduce the basics of bioinformatics, resources in the field and explore the various databases.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand the basic concepts in Biomedical Informatics	Understand
CO 2	Comprehend the applications of an electronic medical record system.	Apply
CO 3	Apply the various aspects of health informatics and medical standards.	Apply
CO 4	Design and develop clinical decision support systems.	Analyze
CO 5	Understand the basics of bioinformatics and the resources in the field.	Understand

Course Contents

Unit – I	**Introduction to Biomedical Informatics**	**9**

The Science and the Pragmatics - Biomedical Data - Their Acquisition, Storage, and Use - Computer Architectures for Health Care and Biomedicine - Overview of hospital information system - Patient history taking mechanisms - Patient data processing - Database Management - Communication of medical data across different hospital units - Networking and Integration of patient data.

Unit – II	**Computer Architectures and Software Engineering for Health Care and Biomedicine**	**9**

Computer Architectures and Software Engineering for Health Care and Biomedicine 6 hours
Data from patients - Patient Record, Coding and classification – Standards - Natural Language Processing - Biomedical Imaging Informatics - Biosignal Analysis - Electronic Health Record Systems - PatientCentered Care Systems - Primary care - Clinical Departmental Systems - Nursing Information Systems

Unit – III	**Electronic Patient Record and Standards**	**9**

Electronic Patient Record - Medical data formats – Medical Standards – HL7 – DICOM - LOINC - PACS - Medical Standards for Vocabulary - ICD 10 – DRG - MeSH, UMLS, SNOMED - Healthcare Standards - JCAHO, HIPAA.

Unit – IV	**Biomedical Decision Making**	**9**

Probabilistic Clinical Reasoning - Medical Knowledge and Decision Support - Methods for decision support - Clinical decision-support systems - Strategies for medical knowledge acquisition - Predictive tools for clinical decision support.

Unit – V	**Bioinformatics**	**9**

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Introduction to Bioinformatics- Biological information resources - Genome sequence acquisition and analysis - Retrieval of biological data - Data acquisition – databases - structure and annotation - Data mining and data characteristics.
Total : 45 Periods

Text Books
1.Edward H. Shortliffe and James J. Cimino, “Biomedical Informatics: Computer Applications in Health Care and Biomedicine (Health Informatics)”, 2014, 4th edition, Springer, New York.
Reference Books
1.Rastogi, “Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery”, 2013, 1st edition, Prentice Hall, New Delhi.
Additional / Web References
1. Additional / web Reference 01 2. Additional / web Reference 02 3. Additional / web Reference 03

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME34	Bioinformatics and Drug Design	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites					

Course Objectives

1.Apply basic knowledge of various computational algorithms on areas of applications in bioinformatics.
2. Analyze common problems in bioinformatics, alignment techniques, ethical issues, public data sources and evolutionary modelling.
3. Discover the practical use of tools for specific bioinformatic areas.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Evaluate the main databases at the NCBI and EMBL-EBI resources.	Understand
CO 2	Compare the databases, tools, repositories and be able to use each one to extract specific information.	Apply
CO 3	Demonstrate the selected tools at NCBI and EBI to run simple analyses on genomic sequences. 4. Apply knowledge of bioinformatics in a practical project.	Apply
CO 4	Develop the ability for critical assessment of scientific research publications in bioinformatics.	Analyze
CO 5	Evaluate the main databases at the NCBI and EMBL-EBI resources.	Understand

Course Contents

Unit – I	**Introduction to Bioinformatics**	**9**

Scope and applications of bioinformatics, Evolutionary Basis - Sequence Homology, Sequence Identity, Sequence Similarity, Biological databases – File formats.

Unit – II	**Sequence Alignment**	**9**

Alignment of pairs of sequences, Introduction - Definition of sequence alignment, Methods - Dot matrix sequence comparison. Similarity Searches on Sequence Databases - FASTA and BLAST.

Unit – III	**Pairwise Sequence Alignment**	**9**

Dynamic programming algorithm for sequence alignment – Global Alignment: Needleman- Wunsch, Local Alignment: Smith-Waterman, Gap penalty, Assessing the significance of an Alignment.

Unit – IV	**Multiple Sequence Alignment**	**9**

Dynamic programming, progressive methods, Iterative methods, MSA using CLUSTAL W, PILEUP and CLUSTAL X, purpose and applications of multiple sequence alignment, phylogenetic trees.

Unit – V	**Scoring Matrices**	**9**

Similarity searches - PAM and BLOSUM matrix, Dayhoff mutation matrix, construction of PAM and BLOSUM matrix. Differences between PAM & BLOSUM.

Total : 45 Periods

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Text Books
1. Bioinformatics and Functional Genomics by Pevsner J, 3rd Ed., 2019. 2. Introduction to Bioinformatics by Arthur M. Lesk, 2014
Reference Books
1. Artificial Neural Networks: Methods and Applications (Methods in Molecular Biology) by David J. Livingstone, 2011.
Additional / Web References
1. Additional / web Reference 01 2. Additional / web Reference 02 3. Additional / web Reference 03

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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Stream-3 Bio Engineering (BE)

20BME42	**Rehabilitation Engineering**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Nature of course	Professional Elective				
Pre requisites					

Course Outcomes		
On successful completion of the course, students will be able to		
CO. No	**Course Outcome**	**Bloom's Level**
CO 1	Understand need and concepts of rehabilitation engineering in general.	Understand
CO 2	Understand the concept of mobility and functioning of sensory augmentation.	Apply
CO 3	Identify the key components and design of universal accessibility.	Apply
CO 4	Analyse the design of orthotics and prosthetics of upper and lower extremities.	Analyze
CO 5	Design manual and power wheelchair	Understand

Course Contents

Unit – I	**Engineering Concepts in Rehabilitation Engineering**	**9**

Anthropometry: methods for static and dynamic measurements. Area measurements-measurement of characteristics and movement, measurement of muscular strength and capabilities. Measurement tools and processes in rehabilitation engineering: fundamental principles, structure, function. Measurement systems for performance and behaviour.

Unit – II	**Sensory Rehabilitation Engineering**	**9**

Sensory augmentation and substitution, visual system, visual augmentation, tactual vision substitution, and auditory vision substitution. Auditory system: auditory augmentation, audiometer, hearing aids, cochlear implantation, visual auditory substitution, tactual auditory substitution. Tactual system: tactual augmentation, tactual substitution.

Unit – III	**Universal Design and Accessibility**	**9**

Design Considerations, Total Quality Management in Rehabilitation Engineering, Steel as a Structural Material, Aluminium for Assistive Technology Design, Use of Composites for Assistive Technology Design, Design with Engineering Materials, Fabrication, Basic Electric Circuits. Barrier-Free Design, Elemental Resource Model, Factors Affecting Barrier-Free Design, Interior Space Design, Design for People with Disabilities, Accessible Transportation

Unit – IV	**Orthopaedic Prosthetics and Orthotics**	**9**

Upper-Extremity Prostheses, Upper-Extremity Orthoses, Lower-Extremity Prostheses, Lower-Extremity Orthoses, Functional Neuromuscular Stimulation, Ambulation Aids, Aids to Daily Living

Unit – V	**Wheel chair Safety Standards and Testing**	**9**

Categories of wheel chairs, wheel chair structure and component design – materials, frame design, wheels and casters. Ergonomics- wheel chair propulsion- kinetics, kinematics, net joined forces and movements, power wheel chair electrical systems- user interface, integrated control, power systems. Electromagnetic compatibility, Personal transportation- vehicle selection,lift mechanisms, wheel chair restraint mechanisms, hands controls

Total : 45 Periods

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Text Books

1. Bronzino, Joseph, “Handbook of Biomedical Engineering”, 2nd ed., CRC Press, 2006.
2. Robinson C.J, Rehabilitation Engineering, CRC press, 1995.
3. Rory A Cooper, An introduction to Rehabilitation Engineering, Taylor & Francis, CRC Press, 2006)

Reference Books

1. H N Teodorecu, L.C.Jain, Intelligent Systems and Technologies in Rehabilitation Engineering, CRC, 2000.
2. Etienne Grandjean, H. Oldroyd, Fitting the task to the man, Taylor & Francis, 1988

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME43	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites					

Course Objectives
1. To learn the fundamentals of tissue engineering and tissue repairing 2.To acquire knowledge on clinical applications of tissue engineering 3.To understand the basic concept behind tissue engineering focusing on the stem cells, biomaterials and its applications

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Multidisciplinary aspects in tissue engineering to solve healthcare problems	Understand
CO 2	Identify sources of cells, bioactive molecules and materials	Apply
CO 3	Design and develop scaffolds using conventional and advanced fabrication methods	Apply
CO 4	Evaluate biological outcomes of tissue engineering strategies	Analyze
CO 5	Describe the regulatory aspects to commercialize products	Understand

Course Contents

Unit – I	**Introduction and History**	**9**

Introduction to tissue engineering:Basic definition; current scope of development; Tissue and organ banking; limitations of banking; types of tissues; organ and tissue culture invitro; origin of tissue engineering; history (with respect to artificial skin);

Unit – II	**Tissue Architecture**	**9**

Tissue types and Tissue components,Tissue repair,Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors.scopesuse in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, numberviability,motility and functions. Measurement of tissue characteristics, appearance, cellular component,ECM component, mechanical measurements and physical properties.

Unit – III	**Morphogenesis &Cell source**	**9**

Morphogenesis and organ development in human; repair and regeneration; cell sources; stem cells and its types; Differentiation, differentiation and trans-differentiation; Intercellular communication-gap junctional and microvescular; Cell aggregation; adhesion dependence; Role of ECM in term of decellularizedallo-/xeno-genic tissues in tissue engineering

Unit – IV	**Scaffolds and bioreactors**	**9**

Classification of scaffold materials, criteria for ideal scaffold, various types of scaffolds, various types of bioreactor configurations for cell cultures and advantages/disadvantages of the same. Definition, 3- dimentionality; porosity and pore-size; fabrication technology: conventional (such as Solvent-casting particulate-leaching Gas foaming, electrospinning, fiber meshes/ fiber bonding, phase separation, freeze drying, solution casting) and solid free form technology (such as stereolithography, 3D printing, fused deposition modeling, phase-change jet printing)

Unit – V	**Biomaterials and Transplantation of Engineered Cells and Tissues**	**9**

Definition, ideal properties and types; biomimetics; Properties like -- mechanical property, wetability, biodegradability and surface property; Types -- polymeric (natural and synthetic), nano-materials, ceramic, composites, hydrogels and metallic

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Total : 45 Periods

Text Books

1. Principles of Tissue Engineering, 4th Edition Robert Lanza, Robert Langer, Joseph P. Vacanti, Academic Press; 4 edition (2015)
2. 3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine Lijie Grace Zhang John Fisher Kam Leong, 1st Edition Academic Press (2015)

Reference Books

1. Ravi Birla, (2014) Introduction to Tissue Engineering: Applications and Challenges, WileyIEEE Press.
2. Robert A. Brown, (2012) Extreme Tissue Engineering: Concepts and Strategies for tissue fabrication, Wiley Blackwell

Additional / Web References

4. Additional / web Reference 01
5. Additional / web Reference 02
6. Additional / web Reference 03

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

CHAIRMAN - BOARD OF STUDIES

20BME49	Biomems And Lab-On-Chip	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites					

Course Objectives

1. Introduce and discuss the historical background of evolution of MEMS and Microsystems and their applications and highlight the scaling effects in miniaturizing devices.
2. Educate on the rudiments of various materials and fundamental concepts used in MEMS and microfluidics fabrication
3. Comprehend various fluidic systems in LoC devices and identify their usage in development of various electrochemical biosensors, paper based microfluidics and chemical analysis.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Introduced the historical background of evolution of MEMS and Microsystems as well as discussed the scaling effects on different Physical domains to the students.	Understand
CO 2	Rudiments of silicon and various polymer materials for MEMS fabrication was discussed with students.	Apply
CO 3	Comprehensive understanding of basic microfluidic theory and its fabrication techniques were provided to the students.	Apply
CO 4	Highlighted the students with various Fluidic systems for complete microfluidic device development.	Analyze
CO 5	Acquainted the students with various techniques of developing electrochemical LoC biosensors	Understand

Course Contents

Unit – I	**Introduction to MEMS**	**9**

Historical background of Micro Electro Mechanical Systems-Types of MEMS devices-Applications of MEMS in healthcare industry, Microsystems and Miniaturization.

Unit – II	**Scaling Laws in MEMS**	**9**

Introduction to Scaling, Scaling in Geometry-Scaling in Rigid, Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces, Scaling in Heat Transfer, Scaling in Fluid Mechanics/ Microfluidics.

Unit – III	**Materials for MEMS and Microfabrication Technology**	**9**

Substrates and wafers, Silicon and Silicon compounds, Polymers (SU8, PDMS), Thin film coating: PVD, CVD, Photolithography, Lift-off technique, Etching, Bulk micro machining, Surface micro machining, LIGA process.

Unit – IV	**Microfluidics: Theory and Fabrication**	**9**

Basic Microfluidics Theory: Fluidic parameters, Equation of motion, Transport modes in microfluidic systems; Micromachining of silicon, glass, rigid and soft polymers for micro total analysis systems, SoftLithography: Molding Technology. Surface chemistry in polymer microfluidic system.

Unit – V	**Fluidic Systems of Lab-on-Chip devices**	**9**

Lab-On-a-Chip Platforms and Components – Fluidic Platforms-Pressure driven, Capillary flow, Segmented flow, Electrokinetics, Electrowetting on Dielectrics (EWOD), Centrifugal Microfluidics; Components of LoC Systems- Microvalves, Micropumps-mechanical (membrane type) and nonmechanical (electrical-electroosmosis, electrophoretic, DEP, EHD), Micromixers, Filters, Sensors.

Total : 45 Periods

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Text Books

1. Tai-Ran Hsu, “MEMS & Microsystem, Design and manufacture”, 2017, 1st Edition, McGraw Hill, New York
2. Marc J. Madou, “Fundamentals of Microfabrication: The Science of Miniaturization”, 2012, 2nd edition, CRC Press, Florida, USA.
3. Jaime Castillo-León, Winnie E. Svendsen (eds.) “Lab-on-a-Chip Devices and Micro-Total Analysis Systems_ A Practical Guide”, 2015, Springer International Publishing

Reference Books

1. Gary S. May and Simon Sze, “Fundamentals of semiconductor fabrication”, 2010, 1st edition John Wiley & Sons, New Jersey, USA.
2. Francis E. H. Tay, “Microfluidics and Biomems application”, 2013, 1st Edition, Springer, Berlin.
3. Albert Folch, “Introduction to Biomems”,2016, 1st Edition, CRC Press, Florida.
4. Edwin Oosterbroek and Albert van den Berg, “Lab-on-a-Chip: Miniaturized Systems for (Bio) Chemical Analysis and Synthesis”, 2011, 1st edition, Elsevier Science, Amsterdam, Netherlands.

Additional / Web References

1. Additional / web Reference 01
2. Additional / web Reference 02

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

CHAIRMAN - BOARD OF STUDIES

20BME51	Physiological System Modeling	L	T	P	C
		3	0	0	3
Nature of course	Professional Core				
Pre requisites					

Course Objectives

. To introduce the basic system concepts and differences between an engineering and physiological control systems.
2. To acquaint students with different mathematical techniques applied in analysing a system and the various types of nonlinear modelling approaches.
3. To teach neuronal membrane dynamics and to understand the procedures for testing, validation and interpretation of physiological models.
4. To study the cardiovascular model and apply the modelling methods to multi input and multi output systems.

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Understand the basic system concepts and differences between an engineering and physiological control systems.	Understand
CO 2	Apply different mathematical techniques to analyze a system.	Apply
CO 3	Comprehend the various nonlinear modelling approaches.	Apply
CO 4	Understand the neuronal membrane dynamics.	Analyze
CO 5	Apply the procedures for testing, validation and interpretation of physiological models.	Understand

Course Contents

Unit – I **System Modeling in Physiology** **9**

The problem of system modeling in physiology - Need for modeling - Conceptual and mathematical models – Modeling - experiments and simulation - Feedback control systems - Difference between engineering and physiological control systems.

Unit – II **Physiological Modeling** **9**

Deductive and Inductive modeling - Characteristics of a reliable physiological model - Modeling a simple reflex - Mathematical modeling.

Unit – III **Nonlinear Modeling** **9**

System Identification, Model Specification, Model estimation. Types of nonlinear modeling approaches. Non parametric modeling. Volterra and Wiener models. Volterra Kernels. Modeling the vertebrate retina. Analysis of estimation errors.

Unit – IV **Modeling of Neuronal Systems** **9**

A general model of the nerve membrane - Action potential and synaptic dynamics - Functional integration in the single neuron -Neuronal systems with point process inputs - Conduction in nerve fibres - Voltage clamp experiment - Hodgkin Huxley (H-H) model - Circuit analog of the H-H nerve membrane model.

Unit – V **Systems Identification in Physiology** **9**

System characteristics -System parameters - System functional properties -Input characteristics - Experimental considerations -Data preparation -Data consolidation -Model specification and estimation tasks - Model validation and interpretation.

Total : 45 Periods

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Text Books

1. Michael C.K. Khoo, "Physiological Control Systems: Analysis, Simulation and Estimation,"2011, 1st edition, Prentice Hall of India, New Delhi.

Reference Books

1. Suresh Devasahayam, "Signal Processing and Physiological Systems Modeling", 2013, 1st edition, Springer, New York.
2. Joseph D. Bronzino and Donald R. Peterson, "The Biomedical Engineering Handbook", 2015, 4 thedition, CRC Press, Florida.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom's Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME52	Virtual Instrumentation	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Nil				

Course Objectives

The course is intended to

1. Introduce virtual instrumentation concepts and applications
2. Understand the programming principles in virtual instrumentation using LabVIEW
3. Train to program virtual instrumentation software for biomedical applications

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Explain the graphical programming and textural programming in virtual instrumentation using LabVIEW environment	Understanding
CO 2	Demonstrate the programming principles in virtual instrumentation using LabVIEW	Analyzing
CO 3	Develop the programming in LabVIEW using loops and structures	Applying
CO 4	Develop the configuration of data acquisition system using the Analog and digital hardwares.	Applying
CO 5	Apply virtual instrumentation concept for signal processing, image processing, mechanical and embedded system applications	Applying

Course Contents

Unit – I	**Basics of Virtual Instrumentation**	**9**

Introduction- Virtual Instrument versus Traditional Instrument, Advantages, Comparison of Graphical Programming and Textual Programming-LabVIEW environment: Front Panel, Block Diagram, Data Flow techniques

Unit – II	**Programming Principles**	**9**

Creating simple VI- Data types-Numeric, String, Boolean-Mechanical Operation of Boolean, Arrays, Clusters, Waveforms graphs and waveform charts - Array Functions- Cluster Functions- Debugging Techniques, Documentation, Context Help Window-Sub VI-Creation

Unit – III	**Loops and Structures**	**9**

FOR – WHILE loop - Case, Sequence, event structures- Formula nodes- local and global variables

Unit – IV	**Data Acquisition System**	**9**

Instrument control – GPIB – VISA – instrument drivers-serial port communication. Data Acquisition: Review of Transducer and Signal conditioning, DAQ hardware- Analog inputs – Analog outputs- Digital I/O- DAQ assistant and configurations

Unit – V	**Applications of Virtual Instrumentation**	**9**

Signal Processing and Analysis, Image acquisition and processing–Biomedical Startup Kit–Motion control–Control Design and Simulation Tools –Simulation Interface Toolkit –Embedded Module –GSD Applications

Total : 45 Periods

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Text Books
4. Jovitha Jerome “Virtual Instrumentation using labview” Prentice Hall of India, NewDelhi, 2010. 5. Sanjay Gupta and Joseph john “ Virtual Instrumentation using labview principles and practices of graphical programming”Tata McGraw Hill Education Private Limited, Second Edition 2017.
Reference Books
1. Gary W.Johnson and Richard Jennings, “LabVIEW Graphical Programming”, McGraw Hill, 4th Edition, New York, 2011. 2. Jeffrey Travis and Jim Kring, “LabVIEW for everyone”, 3rd edition, Dorling Kindersley, 2009. 3. John Essick “Hands-On Introduction to LabVIEW for Scientists and Engineers” illustrated, OUP USA, 2018. 4. Lisa K. Wells “ LabVIEW: User's Guide”, Prentice-Hall 1995
Additional / Web References
http://www.ni.com/academic/students/learn-labview/

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3	2	2	2										2	
CO2	3	2	2	2										2	
CO3	3	3	2	2										3	
CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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20BME53	Medical Optics	L	T	P	C
		3	0	0	3
Nature of course	Professional Elective				
Pre requisites	Medical Physics				

Course Objectives

The course is intended to

1. Understand the basic concept of photonics
2. Acquire knowledge about the impact and interaction of light with biological tissue
3. Understand practical applications of optics related to medicine

Course Outcomes

On successful completion of the course, students will be able to

CO. No	Course Outcome	Bloom's Level
CO 1	Explain the basic properties of light source	Understanding
CO 2	Demonstrate knowledge of the fundamentals of optical properties of tissues	Analyzing
CO 3	Describe surgical applications of laser	Understanding
CO 4	Describe photonics and its therapeutic applications	Understanding
CO 5	Apply the concepts of laser and light to understand the laser safety procedures	Applying

Course Contents

Unit – I	**Instrumentation in Photonics**	**9**

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	**Optical Properties of the Tissues**	**9**

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

Unit – III	**Surgical Applications of Lasers**	**9**

Lasers in ophthalmology-Dermatology–Dentistry-Urology-Otolaryngology-Tissue welding

Unit – IV	**Non Thermal Diagnostic Applications**	**9**

Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, FLIM Raman Spectroscopy and Imaging, FLIM–Holographic and speckle application of lasers in biology and medicine

Unit – V	**Therapeutic Applications**	**9**

Phototherapy, Photodynamic therapy (PDT)-Principle and mechanism-Oncological and non oncological applications of PDT - Biostimulation effect – applications-Laser Safety Procedures

Total : 45 Periods

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Text Books

1. Markolf H.Niemz, “Laser-Tissue Interaction Fundamentals and Applications”, Springer, 2007.
2. Paras N. Prasad, “Introduction to Bio photonics”, A. John Wiley and sons, Inc. Publications, 2003.

Reference Books

1. Tuan Vo Dinh, “Biomedical photonics – Handbook”, CRC Press LLC, 2003.
2. Mark E. Brezinski, “Optical Coherence Tomography: Principles and Applications”, Academic Press, 2006.
3. R. Splinter and B.A. Hooper, “An Introduction to Biomedical Optics”, Taylor and Francis, 2007.
4. Helena Jelinkova, “Lasers for Medical Applications: Diagnostics, Therapy and Surgery’’, Woodhead Publishing, 1st Edition, 2013.

Additional / Web References

Mapping of Course Outcomes (COs) with Programme Outcomes (POs) Programme Specific Outcomes (PSOs)

COs	Pos												PSOs		
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CO4	3	3	2	2										3	
CO5	3	3	2	2										3	
	3	High				2	Medium					1	Low		

Formative assessment			
Bloom’s Level	**Assessment Component**	**Marks**	**Total marks**
Analyze	Classroom or Online Quiz	5	20
Understand	Assignment	15	

Summative Assessment				
Bloom’s Category	**Continuous Assessment Tests**			**Terminal Examination (60)**
	IAE-1 (7.5)	**IAE-2 (7.5)**	**IAE-3 (10)**	
Remember	5	5	5	10
Understand	5	5	5	20
Apply	20	20	20	30
Analyze	20	20	20	40
Evaluate	0	0	0	0
Create	0	0	0	0

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