HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)

(Approved by AICTE, New Delhi, Accredited by NAAC with 'A' Grade)

Coimbatore - 641 032.

B.E. BIOMEDICAL ENGINEERING

HINDUSTHAN EDUCATIONAL AND CHARITABLE TRUST

HICET

CHOICE BASED CREDIT SYSTEM

Curriculum and Syllabus for the

Academic year 2023-24

VISION AND MISSION OF THE INSTITUTION

VISION

To become a premier institution by producing professionals with strong technical knowledge, innovative research skills and high ethical values.

MISSION

IM1: To provide academic excellence in technical education through novel teaching methods.
IM2: To empower students with creative skills and leadership qualities.
IM3: To produce dedicated professionals with social responsibility.

VISION AND MISSION OF THE DEPARTMENT

VISION

To produce technically aspiring Biomedical Engineers with continuous enrichment in the research and innovation with high ethical standard to ensure quality health care society.

MISSION

M1: To provide a value-based biomedical engineering education utilizing contemporary technologies and equipment.

M2: To Assemble a cohesive group of biomedical engineers to promote technologies via research and development and creativity.

M3: To offer solutions to the healthcare industry that are infused with moral principles and lifelong learning.

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PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

PO 1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

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

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Dean (Academics)
HiCET

PROGRAM SPECIFIC OUTCOMES (PSOs)

Biomedical Engineering Graduates will have ability to:

PSO1: Design and develop biomedical devices to meet the needs of people by applying the Fundamentals of Biomedical Engineering.

PSO2. Understand and implement various software skills for accurate diagnostic and Therapeutic applications.

PSO3. Innovate new ideas and solutions for the healthcare field by integrating various Biomedical Technology.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduate shall create a strong foundation in engineering and biology for solving the existing challenges in the healthcare sector.

PEO2: Graduate shall acquire knowledge in the cutting edge technologies of Biomedical Engineering field and an ability to identify, analyze and solve problems in the field.

PEO3: Graduate shall instill ethical values, communicative skills, teamwork and leadership skills necessary to function productively and professionally**.**

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CURRICULUM

DETAILS OF CHANGES CARRIED OUT IN CURRICULUM & SYLLABUS
CBCS PATTERN UNDERGRADUATE PROGRAMMES
B.E. BIOMEDICAL ENGINEERING (UG)
REGULATION-2022
For the students admitted during the academic year 2023-2024 and onwards

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER I											
Theory											
1.	22MA1101	Matrices and Calculus	BSC	3	1	0	4	4	40	60	100
2.	22ME1201	Engineering Drawing	ESC	1	4	0	3	5	40	60	100
Theory with Lab Component											
3.	22CY1151	Chemistry For Circuit Engineering	BSC	2	0	2	3	4	50	50	100
4.	22HE1151	English for Engineers	HSC	2	0	2	3	4	50	50	100
5.	22IT1151	Python Programming and practices	ESC	2	0	2	3	4	50	50	100
EEC Courses(SE/AE)											
6.	22HE1071	Universal Human Values	AEC	2	0	0	2	3	40	60	100
7.	22HE1072	Entrepreneurship &Innovation	AEC	1	0	0	1	1	100	0	100
Mandatory Courses											
8.	22MC1091/ 22MC1092	Indian Constitution	MC	2	0	0	0	2	0	0	0
		TOTAL		**15**	**5**	**6**	**19**	**26**	**370**	**330**	**700**

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER II **REGULATION-2022** **For the students admitted during the academic year 2023 2024 and onwards**											
Theory											
1.	22MA2105	PARTICAL DIFFERENTIAL EQUATIONS Fourier Series and Transforms	BSC	3	1	0	4	4	40	60	100
2.	22CY2101	Environmental Studies	ESC	2	0	0	2	3	40	60	100
3.	22PH2101	Basics of Material Science	BSC	2	0	0	2	3	40	60	100
Theory with Lab Component											
4.	22PH2151	PHYSICS FOR CIRCUIT ENGINEERING PROGRAMME/PHYSICS FOR ENGINEERS	BSC	2	0	2	3	4	50	50	100

5.	22HE2151	EFFECTIVE TECHNICAL COMMUNICATION	HSC	2	0	2	3	4	50	50	100
6.	22CS2154	ESSENTIALS OF C AND C++ PROGRAMMING	PCC	2	0	2	3	4	50	50	100
Practical											
7.	22ME2001	Engineering Practices	ESC	0	0	4	2	2	60	40	100
EEC Courses(SE/AE)											
8.	22HE2071	DESIGN THINKING (Common to all branches)	AEC	2	0	0	2	2	100	0	100
9.	22HE2072	SOFT SKILLS AND APTITUDE (Common to all branches)	SEC	1	0	0	1	1	100	0	100
Mandatory Courses											
10	22MC2094/ 22MC2095	தமிழரும் தொழில் நுட்பமும்/ TAMILS AND TECHNOLOGY	MC	2	0	0	1	2	40	60	100
11	22MC2093	NCC */NSS / YRC / Sports / Clubs / Society Service –Enrollment (Common)	MC	All students shall enroll, on admission, in anyone of the personality and character development programmes and undergo training for about **100** hours							
		TOTAL		**17**	**1**	**12**	**22**	**30**	**520**	**380**	**900**

S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**CP**	**CIA**	**ESE**	**TOTAL**
SEMESTER III **REGULATION-2022** **For the students admitted during the academic year 2022-2023 and onwards**											
Theory											
1.	22BM3201	Signals and Systems	PCC	3	1	0	4	4	40	60	100
2.	22BM3202	Electron Devices and Circuits	PCC	3	0	0	3	3	40	60	100
3.	22BM3203	Medical Biochemistry	PCC	3	0	0	3	3	40	60	100
4.	22BM3204	Human Anatomy and Physiology	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5.	22MA3151	Statistics and Numerical MethodsWith R Program	BSC	2	0	2	4	4	50	50	100
6.	22BM3251	Digital Electronics	ESC	2	0	2	3	4	50	50	100
Practical											
7.	22BM3001	Biochemistry Lab	PCC	0	0	4	2	4	60	40	100
8.	22BM3002	Electron Devices and Circuits Lab	EEC	0	0	4	2	4	60	40	100
EEC Courses(SE/AE)											
9.	22HE3071	Soft Skills-2	EEC	1	0	0	1	1	100	0	100
Mandatory Course(MC)											
10.	22MC3191	Value education Essence of Indian Traditional Knowledge	MC	2	0	0	0	0	100	0	100
		TOTAL		**19**	**1**	**12**	**25**	**30**	**580**	**420**	**1000**

S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**

SEMESTER IV

REGULATION-2022

For the students admitted during the academic year 2022-2023 and onwards

Theory											
1.	22HE4101	IPR and Start-ups	HSC	2	0	0	2	2	40	60	100
2.	22BM4201	BioSignal Conditioning Circuits	PCC	3	0	0	3	3	40	60	100
3.	22BM4202	Pathology and Microbiology	PCC	3	0	0	3	3	40	60	100
4.	22BM4203	Biosensors and Transducers	ESC	2	0	0	2	3	40	60	100
Theory with Lab Component											
5.	22BM4251	Microprocessors And Microcontrollers Medical application	PCC	2	0	2	4	4	50	50	100
6.	22BM4252	Biomedical Instrumentation	PCC	2	0	2	4	4	50	50	100
Practical											
7.	22BM4001	Human Physiology Laboratory	PCC	0	0	4	2	4	60	40	100
8.	22BM4002	Medical Signal Conditioning Circuits Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses(SE/AE)											
9.	22HE4071	Soft Skills-3	EEC	1	0	0	1	1	100	0	100
			TOTAL	**16**	**1**	**12**	**23**	**28**	**480**	**420**	**900**

S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**

SEMESTER V

REGULATION-2019 with amendments

For the students admitted during the academic year 2021-2022 and onwards

Theory											
1	21BM5201	Biocontrol systems	PC	3	0	0	3	3	25	75	100
2	21BM5202	Biomechanics	PC	3	0	0	3	3	25	75	100
3	21BM5203	Microprocessors and Microcontrollers	PC	3	0	0	3	3	25	75	100
4	21BM520	Biomedical Instrumentation	PC	3	0	0	3	3	25	75	100
5	21BM53XX	Professional Elective-I	PE	3	0	0	3	3	25	75	100
Theory with Lab Component											
6	22BM5251	Virtual Instrumentation for Biomedical Signals using Lab VIEW.	PC	2	0	2	3	2	50	50	100
Practical											
7	21BM5001	Microprocessors and Microcontrollers Lab	PC	0	0	3	1.5	1.5	50	50	100
8	21BM5002	Biomedical Instrumentation Lab	PC	0	0	3	1.5	1.5	50	50	100
MANDATORY COURSES											
9.	22HE5071	Soft Skills-1	EEC	1	0	0	1	2	100	0	100

10	21HE5072	Design Thinking EEC	EEC	1	0	0	1	2	100	0	100
			TOTAL	**21**	**1**	**8**	**24**	**24**	**475**	**475**	**1000**
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER VI **REGULATION-2019 with amendments** **For the students admitted during the academic year 2021-2022 and onwards**											
Theory											
1.	21BM6201	Bio signal processing	PC	3	1	0	4	4	25	75	100
2.	21BM6202	Radiological Equipments and nuclear Medicine	PC	3	0	0	3	3	25	75	100
3.	21BM63XX	Professional Elective-II	PE	3	0	0	3	3	25	75	100
4.	21BM64XX	Open Elective-I	OE	3	0	0	3	3	25	75	100
5.	21BM64XX	Entrepreneurship Development	HS	3	0	0	3	3	25	75	100
Practical											
6.	21BM6001	Bio signal processing lab	PC	0	0	3	1.5	3	50	50	100
Theory with Lab Component											
7.	21BM6251	Diagnostic and therapeutic Equipment lab	PC	3	0	2	3.5	5	50	50	100
MANDATORY COURSES											
8.	21BM6701	Industrial Training*	EEC	0	0	0	1	0	0	100	100
9.	22HE6071	SoftSkills-II	EEC	1	0	0	1	1	0	100	100
10.	21HE6072	Intellectual Property Rights	EEC	1	0	0	1	0	100	0	100
			TOTAL	**18**	**1**	**5**	**24**	**25**	**225**	**475**	**1000**
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**
SEMESTER VII **REGULATION-2019** **For the students admitted during the academic year 2020-2021 and onwards**											
Theory											
1.	19BM7201	Diagnostic and Therapeutic Equipment-II	PC	3	0	0	3	3	25	75	100
2.	19BM7202	Medical Image Processing	PC	3	0	0	3	3	25	75	100
3.	19BM7203	Hospital Management	PE	3	0	0	3	3	25	75	100
4.	19BM73XX	Professional Elective -III	OE	3	0	0	3	3	25	75	100
5.	19XX74XX	Open Elective II	OE	3	0	0	3	3	25	75	100
Practicals											
6.	19BM7001	Image Processing Laboratory	PCC	0	0	3	1.5	3	50	50	100
7.	19BM7002	Diagnostic and Therapeutic Equipment Laboratory	PC	0	0	3	1.5	3	50	50	100
PROJECT WORK											
8.	19BM7901	Project Phase I	EEC	0	0	4	2	4	50	50	100
			TOTAL	**15**	**0**	**10**	**20**	**25**	**300**	**500**	**800**

* - Two weeks internship carries 1 credit and it will be done during Semester VI summer vacation/placement training and same will be evaluated in Semester VII.

S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**TCP**	**CIA**	**ESE**	**TOTAL**

SEMESTER VIII REGULATION-2019 For the students admitted during the academic year 2020-2021 and onwards											
THEORY											
1.	19BM83XX	Professional Elective-IV	PE	3	0	0	3	25	75	100	100
2.	19BM83XX	Professional Elective-V	PE	3	0	0	3	25	75	100	100
PRACTICAL											
3.	19BM8901	Project Work-Phase II	EEC	0	0	16	8	100	100	200	200
			TOTAL	**6**	**0**	**16**	**14**	**150**	**150**	**200**	**200**

Note:

* 1. As per the AICTE guideline, in Semester I, II, III & IV NCC one credit subject is added as Value Added Course with Extra Credit.Further, the students' who enrolled his/her name in HICET NCC and Air Wing are eligible to undergo this subject.The earned extra credits printed in the Consolidated Mark sheetas per the regulation.

2.NCC course level 1& Level 2 will be added in the list of open elective subjects in the appropriate semester.Further, the students' who have opted NCC subjects in Semester I, II, III & IV are eligible to undergo NCC Open Elective Subjects.

3.The above-be admitted in the AcademicYear2021– 22.

PROFESSIONAL ELECTIVE I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	CIA	ESE	TOTAL
1	21BM5301	Medical Physics	PE	3	0	0	3	25	75	100
2	21BM5302	Robotics in Medicine	PE	3	0	0	3	25	75	100
3	21BM5303	Total Quality Management	PE	3	0	0	3	25	75	100
4	21BM5304	Medical Ethics and Standards	PE	3	0	0	3	25	75	100
5	21BM5305	Intellectual Property Rights	PE	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE -II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	CIA	ESE	TOTAL
1	21BM6301	Biomaterials and Artificial Organs	PE	3	0	0	3	25	75	100
2	21BM6302	Embedded System in Medical Devices	PE	3	0	0	3	25	75	100
3	21BM6303	Biomedical Waste Management	PE	3	0	0	3	25	75	100
4	21BM6304	Physiological Modeling	PE	3	0	0	3	25	75	100
5	21BM6305	Artificial Neural Network	PE	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE -III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	CIA	ESE	TOTAL
1	19BM7301	Drug Delivery	PE	3	0	0	3	25	75	100
2	19BM7302	IOT Applications in Healthcare	PE	3	0	0	3	25	75	100
3	19BM7303	Advanced Bio Analytical And Therapeutic Techniques	PE	3	0	0	3	25	75	100
4	19BM7304	Advanced Biosignal Processing	PE	3	0	0	3	25	75	100
5	19BM7305	Ultrasound in Medicine	PE	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE -IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	CIA	ESE	TOTAL
1	21BM8301	Bio fluids and Dynamics	PE	3	0	0	3	25	75	100
2	21BM8302	Artificial Intelligence in Healthcare	PE	3	0	0	3	25	75	100
3	21BM8303	Medical Informatics	PE	3	0	0	3	25	75	100
4	21BM8304	Wearable Medical Devices	PE	3	0	0	3	25	75	100
5	21BM8305	Cardio vascular Engineering	PE	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE -V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	CIA	ESE	TOTAL
1	19BM8306	Rehabilitation Engineering	PE	3	0	0	3	25	75	100
2	19BM8307	Virtual Reality in Medicine	PE	3	0	0	3	25	75	100
3	19BM8308	Bio Photonics	PE	3	0	0	3	25	75	100
4	19BM8309	Telemedicine	PE	3	0	0	3	25	75	100
5	19BM8310	Biometric system	PE	3	0	0	3	25	75	100

OPEN ELECTIVE

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	CIA	ESE	TOTAL
01	21BM6401	Application of Biomedical Engineering	OE	3	0	0	3	25	75	100
02	21BM7401	First Aid and Emergency care	OE	3	0	0	3	25	75	100

Minor Specialization in Biomedical Instrumentation.

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	22BM5601	Basics of Anatomy and Physiology	MDC	3	0	0	3	3
2.	22BM6601	Biosensors and Medical Instrumentation	MDC	3	0	0	3	3
3.	22BM6602	Radiological Equipment's	MDC	3	0	0	3	3
4.	22BM7601	Biomaterials and Artificial Organs	MDC	3	0	0	3	3
5.	22BM7602	Medical Equipment Calibration and Trouble Shooting Laboratory	MDC	3	0	0	3	3
6.	22BM8601	Wearable Devices	MDC	3	0	0	3	3

*MDC–Minor Degree Course

In addition to the above the following additional courses for Minor Degree can also be given to the student's common to all the branches.

B.E (HONS) Biomedical Engineering With Specialization In Advanced Healthcare And Devices

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	TCP	CIA	ESE	TOTAL
1	21BM5205	Modeling of Physiological System	PC	3	0	0	3	3	40	60	100
2	21BM6204	Artificial Intelligence And Machine Learning	PC	3	0	0	3	3	40	60	100
3	21BM6205	Robotics In Medicine	PC	3	0	0	3	3	40	60	100
4	21BM7203	Quality Control &Regulatory Aspects Of Medical Devices	PC	3	0	0	3	3	40	60	100
5	21BM7204	3D Printing	PC	3	0	0	3	3	40	60	100
6	21BM8201	Medical products development and trouble shooting	PC	3	0	0	3	3	40	60	100

SEMESTER WISE CREDIT DISTRIBUTION

B.E./B.TECH.PROGRAMMES									
S.No.	Course Area	Credits per Semester							Total Credits
		I	II	III	IV	V	VI	VII	VIII	
1	HSC	3	3	-	2	-	3	-	-	**11**
2	BSC	7	11	2	-	-	-	-	-	**20**
3	ESC	6	4	3	2	-	-	-	-	**15**
4	PCC	-	3	15	18	12	7	9	-	**64**
5	PEC	-	-	-	-	9	6	3	-	**18**
6	OEC	-	-	-	-	-	6	6	-	**12**
7	EEC	3	3	3	1	1	2	2	10	**25**
8	MC	✔	✔							
Total		**19**	**22**	**25**	**23**	**22**	**24**	**20**	**10**	**165**

Credit Distribution R2019 with amendments

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	20	22	20	21	24	24	20	14	**165**

Credit Distribution R2022

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	19	22	25	23	22	24	20	10	**165**

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SYLLABUS

Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech	**22MA1101**	**MATRICES AND CALCULUS (Common to all Branches)**	3	1	0	4

Course Objective

The learner should be able to

1. Construct the characteristic polynomial of a matrix and use it to identify eigen values and Eigenvectors
2. Impart the knowledge of sequences and series.
3. Analyseanddiscussthemaximaandminimaofthefunctionsofseveralvariables.
4. Evaluate the multiple integrals and apply in solving problems.
5. Apply vector differential operator for vector function and theorems to solve engineering problems.

Unit	Description	Instructional Hours
I	**Matrices** Eigen values and Eigen vectors – Properties of Eigen values and Eigen vectors (without proof) -Cayley - Hamilton Theorem (excluding proof) - Reduction of a quadratic form to canonical form by orthogonal transformation.	12
II	**Single Variate Calculus** Rolle's Theorem–Lagrange's Mean Value Theorem-Maxima and Minima–Taylor's and Maclaurin's Series.	12
III	**Functions of Several Variables** Partial derivatives-Total derivative, Jacobian, Maxima, minima and saddle points; Method of Lagrange multipliers	12
IV	**Integral Calculus** Double integrals in Cartesian coordinates–Area enclosed by plane curves (excluding surface area)– Triple integrals in Cartesian co-ordinates – Volume of solids (Sphere, Ellipsoid , Tetrahedron) using Cartesian co-ordinates.	12
V	**Vector Calculus** Gradient, divergence and curl; Green's theorem, Stoke's and Gauss divergence theorem (statement only) for cubes only.	12
	Total Instructional Hours	**60**

Course Outcome

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

CO1: Compute Eigen values and Eigen vectors of the given matrix and transform given quadratic form into canonical form.

CO2: Apply the concept of differentiation to identify the maximum and minimum values of curve.

CO3: Compute partial derivatives of function of several variables and write Taylor's series for functions with two variables.

CO4: Evaluate multiple integral and its applications in finding area, volume.

CO5: Apply the concept of vector calculus in two and three dimensional spaces.

TEXTBOOKS:

T1:G.B.ThomasandR.L.Finney,"CalculusandAnalyticalGeometry",9th EditionAddisonWesleyPublishing Company,2016.

T2:ErwinKreyszig,"AdvancedEngineeringMathematics",JohnWiley&Sons,2019.

T3:K.P.UmaandS.Padma,"EngineeringMathematicsI(MatricesandCalculus) ",PearsonLtd,2022.

REFERENCEBOOKS:

R1-JerroldE.Marsden,AnthonyTromba,"VectorCalculus",W.H.Freeman,2003

R2-StraussM.J,G.L.BradleyandK.J.Smith,"Multivariablecalculus",PrenticeHall,2002.

R3-VeerarajanT,“EngineeringMathematics”,McGrawHillEducation(India)PvtLtd,NewDelhi,2016.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E/B.Tech	**22CY1151**	**Chemistry for Circuit Engineering (ECE, EEE, EIE, BME,CSE, IT, AIML)**	2	0	2	3

The learner should be able to

Course Objective

1. Acquire knowledge on the concepts of chemistry involved in day today life.
2. Identify the water related problems and water treatment techniques.
3. Enhance the fundamental knowledge on electrochemistry and the mechanism of corrosion and its control.
4. Gain knowledge on the nuclear energy source and batteries.
5. Extend the knowledge on the concepts of spectroscopy and its applications.

Unit	Description	Instructional Hours
I	**CHEMISTRY IN EVERYDAY LIFE** Chemicals in food – Food colors – Artificial sweeteners – Food preservatives. Soaps and Detergents – Soaps – Types of Soap – Detergents – Types of detergents. Drugs – Classification of drugs - Therapeutic Action of Different Classes of Drugs. Chemicals in Cosmetics – Creams – Talcum powders- Deodorants – Perfumes. Plastics – Thermoplastics- Preparation, properties and uses of PVC, Teflon and Thermosetting plastics - Preparation, properties and uses of Polyester and Polyurethane.	6
II	**WATER TECHNOLOGY** Impurities in Water, Hardness of Water, Boiler feed Water – Boiler troubles -Sludge and scale formation, Caustic embrittlement, priming and foaming, boiler corrosion- -Softening Methods (Zeolite & Ion-Exchange Methods)- Desalination of Brackish Water - Reverse Osmosis, Potable water and treatment. **Estimation of total, permanent and temporary hardness of water by EDTA. Determination of Dissolved Oxygen in sewage water by Winkler's method. Estimation of alkalinity of water sample by indicator method.**	6+9
III	**ELECTROCHEMISTRY AND CORROSION** Electrochemical cells – reversible and irreversible cells - EMF- Single electrode potential – Nernst equation (derivation only) – Conductometric titrations. Chemical corrosion – Pilling – Bedworth rule – electrochemical corrosion – different types –galvanic corrosion – differential aeration corrosion – corrosion control – sacrificial anode and impressed cathodic current methods. **Conductometric titration of strong acid vs strong base (HClvsNaOH). Estimation of Ferrous iron by Potentiometry.**	6+6
IV	**ENERGY SOURCES AND STORAGE DEVICES** Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power generator- classification of nuclear reactor- light water reactor- breeder reactor. Batteries and fuel cells: Types of batteries- alkaline battery- lead storage battery- lithium ion battery- fuel cell H_2 -O_2 fuel cell applications.	6
V	**SPECTROSCOPY** Beer-Lambert's law – UV-visible spectroscopy and IR spectroscopy – principles – instrumentation (block diagram only) - applications – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry – atomic absorption spectroscopy – principles – instrumentation (block diagram only) – Estimation of nickel by atomic absorption spectroscopy.	6
	Total Instructional Hours	**45**

Course Outcome

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

CO1: List out the chemicals used in food, soaps and detergents, drugs, cosmetics and plastics

CO2: Differentiate hard and soft water and solve the related problems on water purification in domestic as well as in industries.

CO3: Develop knowledge on the basic principles of electrochemistry and understand the causes of corrosion, its consequences to minimize corrosion to improve industrial design

CO4: Develop knowledge about the renewable energy resources and batteries along with the need of new materials to improve energy storage capabilities

CO5: List out the applications of spectroscopic techniques in various engineering fields.

TEXT BOOKS

T1 - P.C.Jain& Monica Jain, "Engineering Chemistry" DhanpatRai Pub, Co., New Delhi (2018).

T2 -O.G.Palanna, "Engineering chemistry" McGraw Hill Education India (2017).

REFERENCES

R1 - ShikhaAgarwal "Engineering Chemistry -Fundamentals and Applications, Cambridge University Press, Delhi, 2019

R2 - S.S.Dara "A Text book of Engineering Chemistry" S.Chand& Co. Ltd., New Delhi (2018).

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22HE1151	**ENGLISH FOR ENGINEERS (Common to all Branches)**	L	T	P	C
		2	0	2	3

The student should be able

Course Objective

1. To improve the communicative proficiency of learners.
2. To help learners use language effectively in professional writing.
3. To advance the skills of maintaining the suitable one of communication.
4. To introduce the professional life skills.
5. To impart official communication etiquette.

Unit	Description	Instructional Hours
I	**Language Proficiency:** Types of Sentences, Functional Units, Framing question. **Writing:** process description, Writing Checklist.**Vocabulary –** words on environment. **Practical Component: Listening**- Watching short videos and answer the questions, **Speaking**- Self introduction ,formal & semi-formal**,Reading**- Purpose of Reading - Churning & Assimilation, Interpreting Ideas - Interpreting Graphs in Technical Writing.	7+2
II	**Language Proficiency**: Tenses, Adjectives and adverbs. **Writing:** Formal letters (letters conveying positive and negative news), Formal and informal email writing (using emoticons, abbreviations& acronyms), reading comprehension**. Vocabulary–** words on entertainment. **Practical Component: Listening**-Comprehensions based on TED talks**Speaking**- Narrating a short story or an event happened in their life **Reading** - Skimming – Scanning – Reading: Scientific Texts – Literary Texts .	7+2
III	**Language Proficiency:** Prepositions, phrasal verbs. **Writing:** Formal thanks giving, Congratulating, warning and apologizing letters, cloze test. **Vocabulary –** words on tools.**PracticalComponent:Listening**-Listen to songs and answer the questions**Speaking**-Justaminute**Reading**- Reading feature articles (from newspapers and magazines) -Reading to identify point of view and perspective (opinion pieces, editorials etc.)	5+4
IV	**Language Proficiency:** Subject verb concord, Prefixes & suffixes. **Writing:**Preparing agenda &minutes, writing an event report. **Vocabulary–** words on engineering process. **Practical Component: Listening**- Comprehensions based on Talk of orators or interview shows **Speaking**- Presentation on a general topic with ppt. **Reading**- Reading Comprehension - Techniques for Good Comprehension - - Sequencing of Sentences.	5+4
V	**Language Proficiency:** Modal Auxiliaries, Active & passive voice, **Writing:** Project report (proposal & progress) ,sequencing of sentences **Vocabulary –**words on engineering material**Practical Component: Listening**- Listening- Comprehensions based on Nat Geo/Discovery channel videos **Speaking**- Preparing posters and presenting as a team.**Reading**- Biographies,travelogues,technical blogs.	6+3
	Total Instructional Hours	**45**

Course Outcome

After completion of the course the learner will be able

CO1:Tocommunicateinaprofessional forum

CO2:Tospeakorwriteacontentintheproficientlanguage

CO3: To maintain and use appropriate one of the communication.

CO4:To read ,write and present in a professional way.
CO5:To follow the etiquettes in formal communication.

Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech	22ME1201	ENGINEERING DRAWING (AGRI, BME, (CHEM,,AERO, AUTO, CIVIL,MECH, MECT,FT,EEE)	1	4	0	3

Course Objective

The learner should be able

1. To gain the knowledge of Engineer's language of expressing complete details about objects and construction of conics and special curves.
2. To learn about the orthogonal projections of straight lines and planes.
3. To acquire the knowledge of projections of simple solid objects in plan and elevation.
4. To learn about the projection of sections of solids and development of surfaces.
5. To study the isometric projections of different objects.

Unit	Description	Instructional Hours
I	**PLANE CURVES** Importance of engineering drawing; drafting instruments; drawing sheets – layout and folding; Lettering and dimensioning, BIS standards, scales.Geometrical constructions, Engineering Curves Conic sections –Construction of ellipse, parabolaand hyperbola by eccentricity method. Construction of cycloids and involutes of square and circle – Drawing of tangents and normal to the above curves.	12
II	**PROJECTIONS OF POINTS, LINES AND PLANE SURFACES** Introduction to Orthographic projections- Projection of points. Projection of straight lines inclinedto both the planes, Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) inclined to both the planes by rotating object method (First angle projections only).	12
III	**PROJECTIONS OF SOLIDS** Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is perpendicular and inclined to one plane by rotating object method.	12
IV	**SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES** Sectioning of simple solids with their axis in vertical position when the cutting plane is inclined toone 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, cylinder and cone. Development of lateral surfaces of truncated solids.	12
V	**ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS** Isometric views and projections simple and truncated solids such as - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions.Free hand sketching of multiple views from a pictorial drawing. Basics of drafting using AutoCAD software.	12
	Total Instructional Hours	**60**

Course Outcome

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

CO1: Understand and interpret the engineering drawings in order to visualize the objects and draw the conics and special curves.

CO2: Draw the orthogonal projections of straight lines and planes.

CO3: Interpret the projections of simple solid objects in plan and elevation.

CO4: Draw the projections of section of solids and development of surfaces of solids.

CO5: Draw the isometric projections and the perspective views of different objects.

TEXT BOOK:

T1. K.Venugopal, V.Prabu Raja, "Engineering Drawing, AutoCAD, Building Drawings", 5thedition New Age International Publishers, New Delhi 2016.

T2. K.V.Natarajan, "A textbook of Engineering Graphics", Dhanlaksmi Publishers, Chennai 2016.

REFERENCES:

R1. BasantAgrawal and C.M.Agrawal, "Engineering Drawing", Tata McGraw Hill Publishing company Limited,

New Delhi,2013.
R2. N.S. Parthasarathy, Vela Murali, “Engineering Drawing”, Oxford University PRESS, India 2015.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech	22IT1151	**PYTHON PROGRAMMING AND PRACTICES** AGRI, CHEM,FT,AERO, AUTO, CIVIL,MECH, MECT,ECE,BME)	2	0	2	3

Course Objective

The learner should be able

1. To know the basics of algorithmic problem solving
2. To read and write simple Python programs
3. To develop Python programs with conditionals and loops and to define Python functions and call them
4. To use Python data structures –- lists, tuples, dictionaries
5. To do input/output with files in Python

Unit	Description	Instructional Hours
I	**ALGORITHMIC PROBLEM SOLVING** Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). **Illustrative problems: To find the Greatest Common Divisor (GCD)oftwo numbers, Fahrenheit to Celsius, Perform Matrix addition.**	5+4
II	**DATA, STATEMENTS,CONTROL FLOW** Data Types, Operators and precedence of operators, expressions, statements, comments; Conditionals: Boolean values and operators, conditional (if), alternative (if -else), chained conditional (if –elif-else); Iteration: state, while, for, break, continue, pass; **Simple algorithms and programs: Area of the circle, check the given year is Leap year or not, Factorial of a Number.**	5+4
III	**FUNCTIONS, STRINGS** Functions, parameters and arguments; Fruitful functions: return values, local and global scope, function composition, recursive functions. Strings: string slices, immutability, string functions and methods, string module. **Illustrative programs: Perform Linear Search, Selection sort, Sum of all elements in a List, Pattern Programs**	5+4
IV	**LISTS, TUPLES, DICTIONARIES** Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, listparameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations andmethods; advanced list processing - list comprehension. **Illustrative programs: List Manipulation, Finding Maximum in a List, String processing.**	5+4
V	**FILES, MODULES, PACKAGES** Files and exception: text files, reading and writing files, errors and exceptions, handling exceptions, modules, packages **Illustrative programs: Reading writing in a file, word count, Handling Exceptions**	9
	Total Instructional Hours	**45**

Course Outcome

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

CO1: Develop algorithmic solutions to simple computational problems

CO2: Read, write, execute by hand simple Python programs

CO3: Structure simple Python programs for solving problems and Decompose a Python program into functions

CO4: Represent compound data using Python lists, tuples, dictionaries

CO5: Read and write data from/to files in Python Programs.

TEXT BOOKS:

T1: Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python 3.6.2, Shroff Publishers, First edition (2017).

T2:S. Annadurai, S.Shankar, I.Jasmine, M.Revathi, Fundamentals of Python Programming, Mc-Graw Hill Education (India) Private Ltd, 2019.

REFERENCE BOOKS:

R1:CharlesDierbach, ―Introduction to Computer Science using Python: A Computational Problem- Solving Focus, Wiley India Edition,2013.

R2:Timothy A. Budd, ―Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd., 2015

R3:Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016

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	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/	**22HE1071**	**UNIVERSAL HUMAN VALUES (COMMON TO ALL BRANCHES)**	2	0	0	2

Course Objectives

Thestudentshould bemade

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. TofacilitatethedevelopmentofaHolisticperspectiveamongstudentstowardslifeandprofession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implication sofsuchaHolisticunderstanding Interms ofethicalhumanconduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Unit	Description	Instructional Hours
I	**Introduction to Value Education** Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)-Understanding Value Education - Self-exploration as the Process for Value Education - Continuous Happiness and Prosperity – the Basic Human Aspirations - Happiness and Prosperity – Current Scenario - Method to Fulfill the Basic Human Aspirations	6
II	**Harmony in the Human Being and Harmony in the Family** Understanding Human being as the Co-existence of the Self and the Body - Distinguishing between the Needs of the Self and the Body - The Body as an Instrument of the Self - Understanding Harmony in the Self- Harmony of the Self with the Body - Programme to ensure self-regulation and Health	6
III	**Harmony in the Family and Society** Harmony in the Family – the Basic Unit of Human Interaction.Values in Human to Human Relationship'Trust' – the Foundational Value in Relationship Values in Human to Human Relationship'Respect' – as the RightEvaluation Understanding Harmony in the Society	6
IV	**Harmony in the Nature / Existence** Understanding Harmony in the Nature.Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature- Understanding Existence as Co-existence of mutually interacting units in all pervasivespace Realizing Existence as Co-existence at All Levels The Holistic Perception of Harmony in Existence. Vision for the Universal Human Order	6
V	**Implications of the Holistic Understanding – a Look at Professional Ethics** Natural Acceptance of Human Values Definitiveness of (Ethical) Human Conduct A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order-Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical CaseStudiesStrategies for Transition towards Value-based Life and Profession	6

Total Instructional Hours 30

Course Outcome

At the end of the course, the learner will be able

CO1: To become more aware of holistic vision of life - themselves and their surroundings.

CO2: To become more responsible in life, in the Society and in handling problems with sustainable Solutions.

CO3: To sensitive towards their commitment towards what they understood towards environment and Socially responsible behavior.

CO4: To able to apply what have learnt to their own self in different day-to-day settings in real life and In handling problems with sustainable solutions.

CO5: To develop competence and capabilities for maintaining Health and Hygiene.

Reference Books:

R1.A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

R2.Teachers'ManualforAFoundationCourseinHumanValuesandProfessionalEthics,RRGaur, R Asthana,G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93- 87034-53-2

R3.JeevanVidya: EkParichaya, A Nagaraj, JeevanVidyaPrakashan, Amarkantak,1999.

R4.Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

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programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech	22HE1072	**ENTREPRENEURSHIP & INNOVATION** **(Common for all Branches)**	1	0	0	1

Course Objectives

The student should be made

1. To acquire the knowledge and skills needed to manage the development of innovation.
2. To recognize and evaluate potential opportunities to monetize these innovations.
3. To plan specific and detailed method to exploit these opportunities.
4. To acquire the resources necessary to implement these plans.
5. To make students understand organizational performance and its importance.

Module	Description
1	**Entrepreneurial Thinking**
2	**Innovation Management**
3	**Design Thinking**
4	**Opportunity Spotting / Opportunity Evaluation**
5	**Industry and Market Research**
6	**Innovation Strategy and Business Models**
7	**Financial Forecasting**
8	**Business Plans/ Business Model Canvas**
9	**Entrepreneurial Finance**
10	**Pitching to Resources Providers / Pitch Deck**
11	**Negotiating Deals**
12	**New Venture Creation**
13	**Lean Start-ups**
14	**Entrepreneurial Ecosystem**
15	**Velocity Venture**
	TOTAL INSTRUCTIONAL HOURS 15

Course Outcome

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

CO1: Understandthenatureofbusinessopportunities,resources,andindustriesincriticalandcreative aspects.

CO2: Understand the processes by which innovation is fostered, managed, and commercialized.

CO3:Remember effectively and efficiently the potential of new business opportunities.

CO4:Assess the market potential for a new venture, including customer need, competitors, and industry attractiveness..

CO5:Developabusiness model for a new venture, including revenue. Margins, operations,

Working capital, and investment

TEXTBOOKS

T1**:**AryaKumar“Entrepreneurship–CreatingandleadinganEntrepreneurialOrganization”,Pearson,SecondEdition(2012).

T2:EmrahYayici“DesignThinkingMethodology”, Artbiztech,FirstEdition(2016).

REFERENCEBOOKS

R1: Christopher Golis “Enterprise & Venture Capital”, Allen &Unwin Publication, Fourth Edition (2007).
R2: ThomasLockWood&EdgerPapke“InnovationbyDesign”,Career Press.com,SecondEdition(2017).
R3: Jonathan Wilson “Essentials of Business Research”, Sage Publication, FirstEdition(2010).

WEBRESOURCES

W1:https://blof.forgeforward.in/tagged/startup-lessons
W2:https://blof.forgeforward.in/tagged/entrepreurship
W3:https://blof.forgeforward.in/tagged/minimum-viable-product
W4:https://blof.forgeforward.in/tagged/minimum-viable-product
W5:https://blof.forgeforward.in/tagged/innovation

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	22HE1073	**Soft Skills and Aptitude- I**	**0**	**0**	**0**	**1**

Course Objectives:

1. To develop and nurture the soft skills of the students through instruction, knowledge acquisition, demonstration and practice.
2. To enhance the students ability to deal with numerical and quantitative skills.
3. To identify the core skills associated with critical thinking.
4. To develop and integrate the use of English language skills.

Unit	Description	Instructional Hours
I	**Lessons on excellence** Skill introspection, Skill acquisition, consistent practice	2
II	**Logical Reasoning** Problem Solving - Critical Thinking- Lateral Thinking - Coding and Decoding – Series – Analogy - Odd Man Out - Visual Reasoning - Sudoku puzzles - Attention to detail	11
III	**Quantitative Aptitude** Addition and Subtraction of bigger numbers - Square and square roots - Cubes and cube roots - Vedic maths techniques - Multiplication Shortcuts - Multiplication of 3 and higher digit numbers – Simplifications - Comparing fractions - Shortcuts to find HCF and LCM - Divisibility tests shortcuts - Algebra and functions	11
IV	**Recruitment Essentials** Resume Building - Impression Management	2
V	**Verbal Ability** Nouns and Pronouns – Verbs - Subject-Verb Agreement - Pronoun-Antecedent – Agreement - Punctuations	4
	Total Instructional Hours	30

Course Outcome:

CO1:	Students will analyze interpersonal communication skills. public speaking skills.
CO2:	Students will exemplify tautology, contradiction and contingency by logical thinking.
CO3:	Students will be able to develop an appropriate integral form to solve all sorts of quantitative problems.
CO4:	Students can produce a resume that describes their education, skills, experiences and measurable achievements with proper grammar, format and brevity.
CO5:	Students will be developed to acquire the ability to use English language with an error while making optimum use of grammar.

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SECOND SEMESTER

Programme/ sem	Course Code	Name of the Course	L	T	P	C
B.E/ II	22MA2105	PARTIAL DIFFERENTIAL EQUATIONS , FOURIER SERIES AND TRANSFORMS	3	1	0	4

(BME, CIVIL & FT)

The learner should be able to

Course Objective

1. Compute the solution of first order partial differential equations.
2. Analyze Fourier series which is central to many applications in engineering.
3. Apply the effective tools for the solutions of one dimensional boundary value problems.
4. Apply Fourier transform techniques in various situations.
5. Analyze Z transform techniques for discrete time systems.

Unit	Description	Instructional Hours
I	**PARTIAL DIFFERENTIAL EQUATIONS** Formation of partial differential equations by eliminating arbitrary constants and functions – Solution of first order partial differential equations of the form f(p,q)=0, Clairaut's equation – Lagrange's equation.	12
II	**FOURIER SERIES** Dirichlet's conditions- General Fourier Series – Odd and Even Functions – Change of Interval - Parseval's Identity - Harmonic analysis.	12
III	**BOUNDARY VALUE PROBLEMS** Classification of PDE - Solutions of one dimensional wave equation-One dimensional equation of heat conduction (excluding insulated edges).	12
IV	**FOURIER TRANSFORMS** Fourier Transform Pair - Fourier sine and cosine transforms Pair – Properties- Transforms of Simple functions – Convolution Theorem (Statement only).	12
V	**Z - TRANSFORMS** Z- Transforms - Elementary properties – Inverse Z - transform (using partial fraction only) –Solution of difference equations using Z – transform.	12
	Total Instructional Hours	60

Course Outcome

CO1: Compute the solution of first order partial differential equations.
CO2: Understand the principles of Fourier series which helps them to solve physical problems of engineering.
CO3: Employ Fourier series in solving the boundary value problems
CO4: Apply Fourier transform techniques which extend its applications .

CO5: Compute the solution of difference equations using Z – transform.

TEXT BOOKS:

T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi, 2018

T2 - Bali. N.P and Manish Goyal& Watkins, "Advanced Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007

REFERENCE BOOKS :

R1 - Veerarajan. T.,"Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., Second reprint, New Delhi, 2012.

R2 - Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, Delhi,2018.

R3 -Ramana. B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2018.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	-	-	1	2	2	2	1
CO2	3	3	3	2	2	1	1	-	-	1	2	2	2	2
CO3	3	3	3	2	3	1	1	-	-	1	2	2	2	2
CO4	3	3	3	3	3	1	1	-	-	1	2	2	2	3
CO5	3	3	3	3	3	1	1	-	-	1	3	2	1	2
Avg	3	3	3	2.6	2.8	1	1	-	-	1	2.2	2	1.8	2

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
B.E/ II	22CY2101	ENVIRONMENTAL STUDIES (Common to all branches except CSE,IT & AIML)	2	0	0	2

The learner should be able to

Course Objective

1. Grasp the importance and issues related to ecosystem and biodiversity and their protection.
2. Acquire knowledge about environmental pollution – sources, effects and control measures of environmental pollution.
3. Identify the various natural resources, exploitation and its conservation
4. Gain knowledge on the scientific, technological, economic and political solutions to environmental problems.
5. Become aware on the national and international concern for environment and its protection

Unit	Description	
	ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY	
I	Main objectives and scope of environmental studies-Importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – food chain, food web and ecological pyramids - energy flow in the ecosystem – ecological succession processes - Introduction, types, characteristic features, structure and function of the forest and ponds ecosystem – Introduction to biodiversity definition: types and value of biodiversity – hot-spots of biodiversity – threats to biodiversity– endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.	9
	NATURAL RESOURCES	
II	Renewable and Non renewable resources - Forest resources: Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forests and tribal people - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture – Energy resources: Renewable and non renewable energy sources – Solar energy and wind energy - role of an individual in conservation of natural resources.	9
	ENVIRONMENTAL POLLUTION	
III	Definition – causes, effects and control measures of: Air pollution- Water pollution – Water quality parameters- Soil pollution - Noise pollution- Nuclear hazards – role of an individual in prevention of pollution.	9
	SOCIAL ISSUES AND THE ENVIRONMENT	
IV	From unsustainable to sustainable development – urban problems related to energy- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- Municipal solid waste management. Global issues – Climatic change, acid rain, greenhouse effect and ozone layer depletion – Disaster Management – Tsunami and cyclones.	9

HUMAN POPULATION AND THE ENVIRONMENT

V	Population growth, variation among nations – population explosion – family welfare programme – environment and human health – effect of heavy metals – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- GIS-remote sensing-role of information technology in environment and human health.	9
	Total Instructional Hours	**45**

Course Outcome

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

CO1: Discuss the importance of ecosystem and biodiversity for maintaining ecological balance.
CO2: Identify the causes of environmental pollution and hazards due to manmade activities.
CO3: Develop an understanding of different natural resources including renewable resources.
CO4: Demonstrate an appreciation for need for sustainable development and understand the various social issues and solutions to solve the issues.
CO5: Describe about the importance of women and child education, existing technology to protect environment.

TEXT BOOKS:

T1 – S.Annadurai and P.N. Magudeswaran, "Environmental studies", Cengage Learning India Pvt.Ltd, Delhi, 2020
T2 - Anubha Kaushik and C. P. Kaushik, "Perspectives in Environmental studies", Sixth edition, New Age International Publishers,
New Delhi, 2019.

REFERENCE BOOKS:

R1 - ErachBharucha, "Textbook of environmental studies" University Press (I) Pvt.ltd, Hyderabad, 2015
R2 - G.Tyler Miller, Jr and Scott E. Spoolman"Environmental Science" Thirteenth Edition, Cengage Learning, 2010.
R3 – Gilbert M. Masters and Wendell P. Ela "Introduction to Environmental Engineering and Science", 3rd edition, Pearson
Education, 2013.

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO2	PSO3
CO1	3	2	2	-	2	1	1	-	-	-	-	1	1	1
CO2	3	2	2	-	2	1	-	-	-	-	-	1	1	1
CO3	3	2	2	-	2	1	1	-	-	-	-	1	1	1
CO4	3	2	2	2	2	1	-	-	-	-	-	1	1	1
CO5	3	2	2	-	2	1	-	-	-	-	-	1	1	1
Avg	3	2	2	2	2	1	1	-	-	-	-	1	1	1

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
BE/B.Tech II	22PH2101	BASICS OF MATERIAL SCIENCE (Common to all branches except MCT)	2	0	0	2

Course Objective

The student should be able to

1.Gain knowledge about Crystal systems and crystal structures
2. Understand the knowledge about electrical properties of materials
3. Enhance the fundamental knowledge in semiconducting materials.
4. Gain knowledge about magnetic materials
5. Acquire fundamental knowledge new engineering materials which is related to the engineering program

Unit	Description	Instructional Hours
	CRYSTAL PHYSICS	
I	Crystal systems - Bravais lattice - Lattice planes - Miller indices – Inter planar spacing in cubic lattice - Atomic radius, Coordination number and Packing factor for SC, BCC and FCC crystal structures.	6
	ELECTRICAL PROPERTIES OF MATERIALS	6
II	Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression – Widemann - Franz law – Success and failures - – Fermi- Dirac statistics – Density of energy states .	
	SEMICONDUCTING MATERIALS	
III	Introduction – Compound and elemental semiconductor - direct and indirect band gap of semiconductors. Intrinsic semiconductor — electrical conductivity – band gap determination. - Extrinsic semiconductor – n type and p type semiconductor – Light Emitting Diode.	6
	MAGNETIC MATERIALS	
IV	Origin of magnetic moment – Bohr magnetron – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – anti ferromagnetic materials – Ferrites and its applications.	6
	NEW ENGINEERING MATERIALS	
V	Metallic glasses: melt spinning process, Preparation and applications - shape memory alloys: phases, shape memory effect - Characteristics of SMA : Pseudoelastic effect, Super elasticity and Hystersis. Applications of SMA.	6

Nanomaterials preparation (bottom up and top down approaches) – various techniques - pulsed laser deposition - Chemical vapor deposition

Total Instructional Hours 30

Course Outcome

After completion of the course the learner will be able to

CO1: Understand the Crystal systems and crystal structures in the field of Engineering
CO2: Illustrate the fundamental of electrical properties of materials
CO3: Discuss concept of acceptor or donor levels and the band gap of a semiconducting materials
CO4: Develop the technology of the magnetic materials and its applications in engineering field
CO5: Understand the advanced technology of new engineering materials in the field of Engineering

TEXT BOOKS:

T1 - Rajendran V, "Materials Science", Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.

T2- M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., New Delhi 2022

REFERENCE BOOKS:

R1 – Charles Kittel "Introduction to Solid State Physics". Wiley., New Delhi 2017

R2 - Dr. M.Arumugam "Materials Science " Anuradha publications., 2019

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	-	1	-	2	3		
CO2	3	3	1	1	2	-	-	-	1	-	2	2		
CO3	3	2	1	2	2	-	-	-	1	-	1	2		
CO4	3	3	1	2	2	1	-	-	1	-	1	2		
CO5	3	2	2	3	2	1	2	-	1	-	2	2		
Avg	3	2.4	1.2	1.8	1.8	1	1.5	-	1	-	2	3		

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Programme / Sem	Course Code	Name of the Course	L	T	P	C
BE/B.Tech/ II	22PH2151	PHYSICS FOR CIRCUIT ENGINEERING PROGRAMME/ PHYSICS FOR ENGINEERS	2	0	2	3

(AIML,CSE,ECE,EEE,EIE,IT & BME)

The student should be able to

Course Objective

1. Gain knowledge about laser, their applications , become conversant with principles of optical fiber and its applications
2. Enhance his fundamental knowledge about properties of matter
3. Understand the concept of wave optics
4. Gain knowledge about quantum mechanics to explore the behavior of sub atomic particles
5. Acquire fundamental knowledge of Ultrasonics and their applications.

Unit	Description	Instructional Theory Hours
I	**LASER AND FIBER OPTICS** Spontaneous emission and stimulated emission –Type of lasers – Nd:YAG laser - Laser Applications – Holography – Construction and reconstruction of images. Principle and propagation of light through optical fibers – Derivation of numerical aperture and acceptance angle – Classification of optical fibers (based on refractive index and modes) – Fiber optical communication link.	6
II	**Determination of Wavelength and particle size using Laser** **PROPERTIES OF MATTER** Elasticity – Hooke's law – Poisson's ratio – Bending moment – Depression of a cantilever – Determination of Young's modulus of the material of the beam by Uniform bending theory and experiment. Twisting couple - torsion pendulum: theory and experiment **Determination of Young's modulus by uniform bending method**	6
III	**Determination of Rigidity modulus – Torsion pendulum** **WAVE OPTICS** Interference of light – air wedge –Thickness of thin paper(Testing of thickness of surface) - Michelson interferometer - Diffraction of light –Fraunhofer diffraction at single slit – Diffraction grating - Plane Diffraction grating – Rayleigh's criterion of resolution power - resolving power of grating. **Determination of wavelength of mercury spectrum – spectrometer grating**	6
IV	**Determination of thickness of a thin wire – Air wedge method** **QUANTUM PHYSICS** Black body radiation –Compton effect: theory and experimental verification – wave particle duality –concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box .	6
V	**ULTRASONICS** Production – Piezoelectric generator – Properties of Ultrasonic waves. Determination of velocity using acoustic grating – Cavitation. Industrial applications – Drilling and welding – Non destructive testing (pulse echo system). Medical applications – Ultrasound Scanner – A –	6

mode – B- mode and C –mode.

Total Instructional Hours	**30**
Total Lab Instructional Hours	**30**

Course Outcome

After completion of the course the learner will be able to

CO1: Understand the advanced technology of LASER and optical communication in the field of engineering
CO2: Illustrate the fundamental properties of matter
CO3: Discuss the Oscillatory motions of particles
CO4: Understand the dual nature of matter and the Necessity of quantum mechanics.
CO5: Develop the Ultrasonics technology and its applications in NDT.

TEXT BOOKS:

T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.
T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2015.

REFERENCE BOOKS:

R1 - M.N Avadhanulu and PG Kshirsagar"A Text Book of Engineering physics"S.Chand and Company ltd., NewDelhi 2016

R2 - Dr. G. Senthilkumar "Engineering Physics – I" VRB publishers Pvt Ltd., 2021

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	1	1	-	1	-	2	3		
CO2	3	3	2	2	1	1	1	-	1	-	2	2		
CO3	3	3	2	2	2	1	1	-	1	-	1	2		
CO4	3	2	3	1	3	1	1	-	1	-	1	2		
CO5	3	2	3	1	2	1	1	-	1	-	2	2		
Avg	3	2.6	2.6	1.6	2.2	1	1	-	1	-	1.6	2.2		

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Programme/Sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/ II	22HE2151	EFFECTIVE TECHNICAL COMMUNICATION (Common to all Branches)	2	0	2	3

Course Objective

The learner should be able

1. To improve essential business communication skills.
2. To enrich employability knowledge.
3. To acquire the crucial organizing ability in official forum.
4. To impart important business writings.
5. To make effective presentation with essential etiquette.

Unit	Description	Instructional Hours
I	Language Proficiency: Types of sentences in English according to structure Writing: writing definitions, Describing product, work place and service (purpose, appearance, function) Vocabulary – words on nature **Practical Component: Listening- Watching and interpreting advertisements/short films Speaking- Extempore speech**	9
II	Language Proficiency: Direct and Indirect speech. Writing: Formal memos, Job application and resume preparation Vocabulary - words on offense and ethics **Practical Component: Listening- Comprehensions based on telephonic conversation Speaking- Vote of thanks& welcome address**	9
III	Language Proficiency: Homophones and Homonyms, Writing: Preparing a detail plan for an official visit, schedule and Itinerary, reading comprehension, Vocabulary– words on society **Practical Component: Listening- Listening- paraphrasing the listened content Speaking- Group Discussion with preparation**	9
IV	Language Proficiency: Idioms Writing: Report writing (marketing, investigating) Vocabulary-words involved in business **Practical Component: Listening- Watching technical discussions and preparing MoM Speaking- On the spot Group Discussion**	9
V	Language Proficiency: spotting errors Writing: making /interpreting chart, sequencing of sentences Vocabulary- words involved in finance **Practical Component: Listening- Comprehensions based on announcements Speaking- Presentation on a technical topic with ppt.**	9
	Total Instructional Hours	**45**

Course Outcome

At the end of the course, learners will be able

CO1: To the business procedure and promotion skills.
CO2: To make oral and written presentation in corporate forum.
CO3: To schedule official events and participate in official discussions without reluctance.
CO4: To take an effective role and manage in an organizational sector.
CO5:To prepare and demonstrate a professional presentation

TEXT BOOKS:

T1 - NormanWhitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press, 2016.

T2- Ian Wood and Anne Willams. "Pass Cambridge BEC Preliminary", Cengage Learning press 2015.

REFERENCE BOOKS :

R1 -Michael Mc Carthy, "Grammar for Business", Cambridge University Press, 2009.

R2- Bill Mascull, "Business Vocabulary in use: Advanced 2nd Edition", Cambridge University Press, 2009.

R3-Frederick T. Wood, "Remedial English Grammar For Foreign Students", Macmillan publishers, 2001.

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO 1	PSO 2
CO1	1	-	2	-	-	1	-	1	3	-	1	2	1
CO2	2	1	-	-	-	2	2	2	3	-	2	1	1
CO3	2	-	1	-	-	2	-	1	3	-	2	1	1
CO4	1	2	-	-	-	1	-	1	3	-	1	1	1
CO5	1	-	-	2	-	1	-	1	3	-	2	1	1
Avg	1.4	1.5	1.5	1	-	1.4	1	1.2	3	1.6	1.6	1.2	1

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
B.E. / II	22CS2154	ESSENTIALS OF C AND C++ PROGRAMMING (BME)	2	0	2	3

The student should be able to

Course Objective

1. Learn and develop basics of C programming.
2. understand Object Oriented Programming concepts and basic characteristics of C++.
3. Be familiar with the constructors and operator overloading.
4. understand the concepts of inheritance, polymorphism and virtual function.
5. learn and define concept of templates and exception handling.

Unit	Description	Instructional Hours
I	**BASICS OF 'C' PROGRAMMING** Fundamentals of ' C' programming – Structure of a 'C' program – Constants - Variables – Data Types – Expressions using operators in 'C' – Managing Input and Output operations- Branching and Looping - Arrays – One dimensional and Two dimensional arrays. **Programs: 1. Write a C program to calculate sum of individual digits of a given number.** **2. Write a C program to count no. of positive numbers, negative numbers and zeros in the array. 3. Write a C program to find sum of two numbers using functions with arguments and without return type.**	3+6
II	**BASICS OF 'C++' PROGRAMMING** Introduction to C++ – structures and unions- Object oriented programming concepts–Defining a Class – creating objects - access specifiers – Function in C++ - function and data members default arguments – function overloading – Inline functions - friend functions – constant with class – static member of a class – nested classes – local classes. **Program: Write a C++ program to accept the student detail such as name and 3 different marks by get_data() method and display the name and average of marks using display() method. Define a friend class for calculating the average of marks using the method mark_avg().**	6+3
III	**CONSTRUCTOR AND OPERATOR OVERLOADING** Constructors - Default, Copy, Parameterized, Dynamic constructors, Default argument – Destructor. - Function overloading- Operator overloading-Unary, Binary - Binary operators using friend function. **Program: Write a C++ program to calculate the volume of different geometric shapes like cube, cylinder and sphere and hence implement the concept of Function Overloading.**	7+2
IV	**INHERITANCE AND POLYMORPHISM** Inheritance – Public, Private and Protected derivations– Single– Multiple– Multilevel– Hybrid– Hierarchical - Virtual base class – abstract class – composite objects- Runtime polymorphism – virtual functions – pure virtual functions. **Program: Demonstrate Simple Inheritance concept by creating a base class FATHER with data members Sur Name and Bank Balance and creating a derived class SON, which inherits Sur Name and Bank Balance feature from base class but provides its own feature First Name and DOB. Create and initialize F1 andS1 objects with appropriate constructors and display the Father & Son details. (Hint : While creating S1 object, call Father base class parameterized constructor through derived class by sending values).**	7+2

V	**TEMPLATES AND EXCEPTION HANDLING** Function and class templates - Exception handling – try-catch-throw paradigm – exception specification – terminate and Unexpected functions – Uncaught exception. **Program: Write a C++ program to create a template function for Bubble Sort and demonstrate sorting of integers and doubles.**	7+2
	TOTAL INSTRUCTIONAL HOURS	**45**

Course Outcome

At the end of the course, the learner will be able to
CO1:Develop simple applications in C using basic constructs.
CO2:Apply solutions to real world problems using basic characteristics of C++.
CO3:Write object-oriented programs using operator overloading, constructors and destructors.
CO4:Develop programs with the concepts of inheritance and polymorphism.
CO5:Understand and define solutions with C++ advanced features such as templates and exception handling.

TEXT BOOKS:

T1 - E.Balagurusamy, "Programming in ANSI C", 7th Edition, McGraw Hill Publication, 2016.
T2 - E.Balagurusamy, "Object Oriented Programming with C++", 7th Edition, McGraw Hill Publication, 2017.

REFERENCE BOOKS:

R1 - Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011.
R2 - RohitKhurana, "Object Oriented Programming with C++", Vikas Publishing, 2nd Edition, 2016.
R3 - B. Trivedi, "Programming with ANSI C++", Oxford University Press, 2007.

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	2	-	-	-	-	-	3	-	-	-	-	2	-
CO2	2	2	3	-	-	-	-	-	3	-	-	-	-	2	-
CO3	3	-	-	-	-	-	-	-	3	-	-	-	-	2	-
CO4	3	-	-	-	-	-	-	-	3	-	-	-	-	3	-
CO5	3	-	-	-	-	-	-	-	3	-	-	-	1	-	-
Avg	3	1	1	-	-	-	-	-	3	-	-	-	-	2	-

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Programme	Course Code	Name of the Course	L	T	P	C
B.E/B.Tech	22ME2001	ENGINEERING PRACTICES	0	0	4	2

(Common to all branches)

Course Objective: To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical and Electrical Engineering.

Unit **Description of the Experiments**

GROUP A (CIVIL AND MECHANICAL)

1. Preparation of Single pipe line and Double pipe line connection by using valves, taps, couplings, unions, reducers and elbows.
2. Arrangement of bricks using English Bond for one brick thick wall for right angle corner junction and T- junction
3. Arrangement of bricks using English Bond for one and a half brick thick wall for right angle corner and T- junction
4. Preparation of arc welding of Butt joints, Lap joints and Tee joints.
5. Practice on sheet metal Models– Trays and funnels
6. Hands-on-exercise in wood work, joints by sawing, planning and cutting.
7. Practice on simple step turning, taper turning and drilling.
8. Demonstration on Smithy operation.
9. Demonstration on Foundry operation.
10. Demonstration on Power tools.

GROUP B (ELECTRICAL ENGINEERING)

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring.
4. Measurement of Electrical quantities – voltage, current, power & power factor in single phase circuits.
5. Measurement of energy using single phase energy meter.
6. Soldering practice using general purpose PCB.
7. Measurement of Time, Frequency and Peak Value of an Alternating Quantity using CRO and Function Generator.
8. Study of Energy Efficient Equipment's and Measuring Instruments.

Total Instructional Hours 45

Course Outcome

- Fabricate wooden components and pipe connections including plumbing works.
- Fabricate simple weld joints.
- Fabricate different electrical wiring circuits and understand the AC Circuits.

Course Code & Name: 22ME2001 Engineering Practices

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	3	-	3	-	1	-	1	-	-	-	1	2	1
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Avg	3	-	3	-	3	-	-	-	1	-	-	-	1	2	1

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
BE/B.TECH II	22HE2071	DESIGN THINKING	2	0	0	2

The student should be able to

Course Objective

1. To expose students to the design process
2. To develop and test innovative ideas through a rapid iteration cycle.
3. To provide an authentic opportunity for students to develop teamwork and leadership skills

Unit	Description	Instructional Hours
I	**DESIGN ABILITY** Asking Designers about what they Do – Deconstructing what Designers Do – Watching what Designers Do – Thinking about what Designers Do – The Natural Intelligence of Design Sources	6
II	**DESIGNING TO WIN** Formula One Designing – Radical Innovations – City Car Design – Learning From Failures – Design Process and Working Methods	5
III	**DESIGN TO PLEASE AND DESIGNING TOGETHER** Background – Product Innovations – Teamwork versus Individual work – Roles and Responsibilities – Avoiding and Resolving Conflicts.	6
IV	**DESIGN EXPERTISE** Design Process – Creative Design - Design Intelligence – Development of Expertise – Novice to Expert. Critical Thinking – Case studies: Brief history of Albert Einstein, Isaac Newton and Nikola Tesla.	6
V	**DESIGN THINKING TOOLS AND METHODS** Purposeful Use of Tools and Alignment with Process - Journey Mapping - Value Chain Analysis - Mind Mapping – Brainstorming - Design Thinking Application: Design Thinking Applied to Product Development	7
	Total Instructional Hours	**30**

Course Outcome

After completion of the course the learner will be able to

CO1: Develop a strong understanding of the Design Process
CO2: Learn to develop and test innovative ideas through a rapid iteration cycle.
CO3: Develop teamwork and leadership skills

TEXT BOOKS:

T1 - 1. Nigel Cross, "Design Thinking", Kindle Edition.

REFERENCE BOOKS:

R1 - Tom Kelley, "Creative Confidence", 2013.

R2 - 3. Tim Brown, "Change by Design", 2009.

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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
BE/B.TECH II	22HE2072	SOFT SKILLS AND APTITUDE	1	0	0	1

Course Objective

The student should be able to

1. To develop and nurture the soft skills of the students through instruction, knowledge acquisition demonstration and practice.
2. To enhance the students ability to deal with numerical and quantitative skills.
3. To identify the core skills associated with critical thinking.
4. To develop and integrate the use of English language skills

Unit	Description	Instructional Hours
I	**Lessons on excellence** Skill introspection, Skill acquisition, consistent practice	2
II	**Logical Reasoning** Problem Solving - Critical Thinking- Lateral Thinking - Coding and Decoding – Series – Analogy - Odd Man Out - Visual Reasoning - Sudoku puzzles - Attention to detail	11
III	**Quantitative Aptitude** Addition and Subtraction of bigger numbers - Square and square roots - Cubes and cube roots - Vedic maths techniques - Multiplication Shortcuts - Multiplication of 3 and higher digit numbers – Simplifications - Comparing fractions - Shortcuts to find HCF and LCM - Divisibility tests shortcuts - Algebra and functions	11
IV	**Recruitment Essentials** Resume Building - Impression Management	4
V	**Verbal Ability** Nouns and Pronouns – Verbs - Subject-Verb Agreement - Pronoun-Antecedent – Agreement - Punctuations	4
	Total Instructional Hours	30

Course Outcome

After completion of the course the learner will be able to

CO1: Students will analyze interpersonal communication skills. public speaking skills.
CO2: Students will exemplify tautology, contradiction and contingency by logical thinking.
CO3: Students will be able to develop an appropriate integral form to solve all sorts of quantitative problems.
CO4:Students can produce a resume that describes their education, skills, experiences and measurable achievements with proper grammar, format and brevity
CO5: Students will be developed to acquire the ability to use English language with an error while making optimum use of grammar

REFERENCE BOOKS:

R1 - Quantitative Aptitude – Dr. R S Agarwal
R2 -Speed Mathematics: Secret Skills for Quick Calculation - Bill Handley
R3 -Verbal and Non – Verbal Reasoning – Dr. R S Agarwal
R4- Objective General English – S.P.Bakshi

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செம்	பாடநெறி குறியீடு	பாடத்தின் பெயர்	L	T	P	C
பி.இ/ க	22MC2094/ 2095	தமிழரும்தொழில்நுட்பமும் (முதலாம் ஆண்டு பி.இ பொது பாடப்பிரிவு)	2	0	0	0

பாடத்தின் நோக்கம்	கற்றவர்இயலவேண்டும் சங்க காலத்தில் தொழில்துறை பற்றிய அறிவைப் பெறுதல். சங்க காலத்தில் வீட்டின் பொருள் ,சிற்பங்கள் மற்றும் கோவில்கள் வடிவமைப்பு பற்றி கூட்டு கற்றல் வரலாறு மற்றும் தொல்லியல் சான்றுகளின் ஆதாரமாக உலோகவியல் ஆய்வுகளில் அறிவை வளர்த்துக் கொள்ளுங்கள். வேளாண்மை மற்றும் வேளாண் செயலாக்கத்தில் பயன்படுத்தப்படும் பண்டைய நுட்பங்களைப் பற்றிய அறிவைப் பெறுதல். தமிழ் மொழியின் மென்பொருள் பற்றி அறிதல்

அலகு	விளக்கம்	பயிற்சி நேரம்
I	நெசவுமற்றும்பானைத்தொழில்நுட்பம் சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம்- கருப்பு சிவப்பு பாண்டங்கள் -பாண்டங்களில் கீறல் குறியீடுகள்.	3
II	வடிவமைப்புமற்றும்கட்டிடத்தொழில்நுட்பம் சங்க இலக்கியத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் மற்றும்சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும்- சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் - சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிப்பாடுத் தளங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டி நாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோச்செனிக் கட்டிடக் கலை.	3
III	உற்பத்தி தொழில்நுட்பம் கப்பல் கட்டும் கலை- உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருகுதல் எஃகு - வரலாற்றுசாலை சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள் , கண்ணாடிமணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின்வகைகள்.	3

IV	வேளாண்மைமற்றும்நீர்பாசனத்தொழில்நுட்பம் அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் - கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்க பட்ட கிணறுகள் - வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்.	3
V	அறிவியல்தமிழ்மற்றும்கணித்தமிழ் அறிவியல் தமிழின் வளர்ச்சி - கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணைய கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.	3
மொத்தபயிற்றுவிக்கும்நேரம்		15
பாடத்தின் முடிவு	பாடநெறியின்முடிவில்கற்றவர்கற்றபின் பா மு1: பண்டைய தொழில்நுப்பதை அடையாளம் கொள்ள தெரியும் பா மு2: சங்க கால.கட்டுமானப் பொருட்கள்- சிற்ப வகைகளை வேறுபடுத்த முடியும் பா மு3: வரலாறு மற்றும் தொல்லியல் சான்றுகளின் ஆதாரமாக உலோகவியல் ஆய்வுகளில் பட்டியலிட்டு அடையாளம் காண முடியும் பா மு4: விவசாயம் மற்றும் வேளாண் செயலாக்கத்தில் பயன்படுத்தப்படும் பழங்கால நுட்பங்களைப் பற்றி விளக்கத்துடன் நிரூபிக்க முடியும் பா மு5: தமிழ் மொழியின் புதிய மென்பொருள் பற்றி உருவாக்கக் கூடிய திறன் மேம்படுத்துதல்.	

உரைபுத்தகங்கள்

உ1- தமிழக வரலாறு - மக்களும் பண்பாடும் - கே .கே பிள்ளை (வெளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)

உ2- எஸ்.கே. சிங், இடைக்கால இந்தியாவின் வரலாறு. புது தில்லி: ஆக்சிஸ் புக்ஸ் பிரைவேட் லிமிடெட், 2013.

குறிப்புகள்

கு1- கணிதத்தமிழ் -முனைவர் இல. சுந்தரம் .(விகடன் பிரசுரம்)

கு2- கீழடி வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு.

SEMESTER III

Programme	Course Code	Name of the Course	L	T	P	C
BE	**22BM3202**	**Electron Devices and Circuits**	**3**	**0**	**0**	**3**

Course Objective

To be familiar with the theory, construction, and operation of Semi conductor diodes
To impart knowledge on the configurations and operation of transistors and **amplifiers**
To give an insight of the operation of **multistage, differential and feedback amplifiers**
To be familiar with the concept of **power supplies and oscillators.**
To impart knowledge on fundamentals of communication engineering

Unit	Description	Instructional Hours
I	**SEMICONDUCTOR DIODES** PN junction and Zener diodes – structure, operation and V-I characteristics, Rectifiers - Half and Fu ll Wave, Zener diode as regulator, Display devices – LED and Laser diodes.	9
II	**TRANSISTORS AND AMPLIFIERS** BJT, JFET, MOSFET and IGBT - structure, operation and characteristics. CE amplifier ,Power amplifiers - class A - Class B - Class AB - Class C.	9
III	**MULTI STAGE, DIFFERENTIAL AND FEEDBACK AMPLIFIERS** BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis - Gain and frequency response. Feed back-Positive and Negative, Types-Voltage/current series and shunt feedback amplifiers.	9
IV	**POWER SUPPLIES AND OSCILLATORS** Fixed and Variable power supply, Linear and Switched Mode Power Supply, Regulated power supply, Online and Off line Uninterrupted power supply (Block Diagram Approach only) Oscillators– condition for oscillations, RC Oscillator - Phase shift, LC Oscillators - Hartley oscillators.	9
V	**FUNDAMENTALS OF COMMUNICATION ENGINEERING** Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations – Radar, Modem, Satellite and Optical Fibre communications, 4G,5G (Block Diagram Approach only).	9
	Total Instructional Hours	**45**

Course Outcome

CO1	Ability to explain the theory, construction, and operation of Semiconductor diodes
CO2	Ability to demonstrate the structure, operation and characteristics of transistors and amplifiers.
CO3	To understand the working of **multistage, differential and feedback amplifiers**.
CO4	To understand the working of **power supplies and oscillators**.
CO5	To understand the fundamentals of communication engineering

TEXT BOOKS:

T1 Gupta J. B. "Electronic Devices and Circuits", Fifth edition, S K Kataria and Sons, 2013 edition.

T2 Sedra and smith, "Microelectronic Circuits", Seventh Edition, Oxford University Press, 2017.

REFERENCE BOOKS:

R1 Floyd, "Electron Devices", 9th edition, Pearson Education India, 2015.

R2 Robert L. Boylestad, "Electronic Devices and Circuit theory", 11th Edition, Pearson Education India, 2015.

R3 Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", 2nd Edition, CRC Press, 2017.

R4 Robert A. Mammano,"Fundamentals of Power Supply Design", 2017.

R5 S.K. Kataria & Sons., "Fundamentals of Communication Engineering 1st Edition, : S.K. Kataria& Sons, 2011

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Programme	Course Code	Name of the Course	L	T	P	C
BE	**22BM3202**	**MEDICAL BIOCHEMISTRY**	3	0	0	3

Course Objective

1. To study the basic fundamentals of biochemistry
2. To study structural and functional properties of carbohydrates
3. To study structural and functional properties of lipids.
4. To study structural and functional properties of proteins ,and nucleic acids
5. To emphasize the role of enzymes in human body.

Unit	Description	Instructional Hours
I	**INTRODUCTIONTOBIOCHEMISTRY** Introduction to Biochemistry, water as a biological solvent,weak acidand bases, pH,buffers,Handerson-Hassel balchequation,physiological buffers in living systems, Energy in living organism .Properties of water and their applications in biological systems. Clinical application of Electrolytes and radioisotopes.	9
II	**METABOLISM OF CARBOHYDRATES** Introduction to meta bolism-Classification of carbohydrates -Digestion and absorption of carbohydrates-Metabolic pathways and bio energetics–Glycolysis, glycol genesis, glycol genolysis and its hormonal regulation. TCA cycle and electron transport chain - Biochemical aspect of Diabetes mellitus and Glycogen storage Disease.	9
III	**METABOLISM OF LIPIDS** Classification of lipids- simple, compound and derived lipids. Nomenclatureof fatty acid, physical and chemical properties of fat. Metabolic pathways:synthesis and degradation of fatty acid (beta oxidation), hormonal regulation offatty acid meta bolism ,ketogenesis, Biosynthesis of Cholesterol .Disorders of lipidmetabolism	9
IV	**NUCLEIC ACID & PROTEIN** Nucleic acid: Biosynthesis of purine and pyrimidines - Disorder of purine and pyrimidines metabolism.Classification structure and properties of proteins, structura lorganization of proteins, classification and properties of amino acids.Separation of protein,In born Meta bolicerror of amino acid metabolism.	9
V	**ENZYME AND ITS CLINICAL APPLICATION** Classification of enzymes,apoenzyme,coenzyme,holoenzyme and co factors.Kinetics of enzymes-Michaelis-Mentenequation.Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration.Inhibitors of enzyme action:Competitive,non-competitive,irreversible-Clinical Application of enzyme- ELISA	9
	Total Instructional Hours	**45**

Course Outcome

CO1	Explain the fundamentals of biochemistry
CO2	Explain structural and functional properties of carbohydrates
CO3	Explain structural and functional properties of lipids
CO4	Explain structural and functional properties of proteins, and nucleic acids
CO5	Discuss the role of enzymes in human body.

TEXT BOOKS:

T1 RAFIMD—Text book of biochemistry for Medical Student, Fourth Edition ,University Press, Orient Blackswan Private Limited , New Delhi, 2021

T2 Peter J. Kennelly, Kathleen M. Botham, Owen McGuinness, Victor W. Rodwell, P. Anthony Weil, Harper's Illustrated Biochemistry, Thirty-Second Edition, MC Graw Hill Lange,2022

REFERENCE BOOKS:

R1 Keith Wilson & John Walker, ―Practical Biochemistry - Principles & Techniques‖, Seventh Edition, Oxford University Press, 2010.

R2 David L. Nelson, Michael M. Cox, Aaron A. Hoskins, Lehninger Principles of Biochemistry, Eighth, Edition, 2021

R3 Pamela.C.Champe & Richard.A.Harvey, "Lippincott Biochemistry Lippincott's Illustrated Reviews", Raven publishers,1994

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Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM3204	HUMAN ANATOMY AND PHYSIOLOGY	3	0	0	3

Course Objective

1. Students would be understand the basic structural and functional elements of human body.
2. Learn about the structure and functions of the skeletal ,muscular and respiratory systems.
3. Students would have knowledge on Skeletal and muscular systems.
4. Students would be able to comprehend circulatory and nervous systems and their components.
5. Students would study importance of digestive and urinary systems in Human body.

Unit	Description	Instructional Hours
I	**CELL AND TISSUE STRUCTURE** Structure of Cell – structure and functions of sub organelles – Cell Membrane –Transport of Across Cell Membrane - Action Potential – Cell to Cell Signaling –Cell Division. Types of Specialized tissues–Functions -The Integumentary System: Structure of the Skin, Accessory Structures of the Skin, Types of Skin, Functions of the Skin Cell Division.	9
II	**SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS** **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	9
III	**CARDIO VASCULAR AND LYMPHATIC SYSTEMS** **Cardio vascular:** Components of Blood and functions.-Blood Groups and importance – Structure of Heart – Conducting System of Heart – Properties of Cardiac Muscle-Cardiac Cycle–Types of Blood vessel–Regulation of Heart rate and Blood pressure. **Lymphatic:** Parts and Functions of Lymphatic systems –Types of Lymphatic organs and vessels	9
IV	**NERVOUS , ENDOCRINE SYSTEMS AND SENSEORGANS** Nervous system: Types and Structure of Neuron – Mechanism of Nerve Impulse - Structure and Parts of Brain. Sensory organ: Eye and Ear - **Endocrine - Pituitary** and thyroid gland.	9
V	**DIGESTIVE AND URINARY SYSTEMS** 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	9
	Total Instructional Hours	**45**

Course Outcome

CO1	To learn the basic components of formation of systems
CO2	To understand structure and functions of the various types of systems of human body.
CO3	To identify all the organelles of an animal cell and their function.
CO4	To demonstrate their knowledge of importance of anatomical features and physiology of human systems
CO5	To understand structure and functions of the digestive and

urinary systems.

TEXT BOOKS:

T1 PrabhjotKaur. Text Book of Anatomy and Physiology. Lotus Publishers. 2014.

T2 Elaine.N. Marieb , "Essential of Human Anatomy and Physiology", Eight Edition, Pearson Education, New Delhi 2007.

REFERENCE BOOKS:

R1 Ross and Wilson, "Anatomy and Physiology ",13th edition,2018

R2 Khurana , "Textbook of Anatomy And Physiology",Cbs Nursing,2020.

R3 PrabhjotKaur ,"Textbook Of Anatomy Physiology 2ed", Lotus Publication, 2019

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	22MA3151	STATISTICS AND NUMERICAL METHODS WITH R PROGRAMMING (BME)	2	0	2	4

Course Objective

The learner should be able to

1. Illustrate the relation between two random variables by using correlation concepts along with R studio
2. Employ some basic concepts of statistical methods for testing the hypothesis together with R studio.
3. Analyze the design of experiment techniques to solve various engineering problems accompanying with R studio
4. Apply various methods to find the inter mediate values for the given data
5. Explain concepts of numerical differentiation and numerical integration of the unknown functions.

Unit	Description	Instructional Hours
I	**CORRELATION AND REGRESSION** Correlation – Karl Pearson's correlation coefficient – Spearman's Rank Correlation – Regression lines (problems based on Raw data only). **R-Lab : Introduction to R programming, Correlation and Regression**	12
II	**HYPOTHESIS TESTING** Large sample test based on Normal distribution – test of significance for single mean and difference of means - Tests based on t (for single mean and difference of means) - F distribution – for testing difference of variance, Chi – Square test for Contingency table (Test for Independency) – Goodness of fit **R-Lab : t -test, F test , Chi – square test**	12
III	**ANALYSIS OF VARIANCE** Introduction, analysis of variance, completely randomized design, randomized block design, Latin square design. **R-Lab : Completely randomized design, randomized block design**	12
IV	**INTERPOLATION** Interpolation: Newton's forward and backward difference formulae Lagrangian interpolation for unequal intervals – Divided differences- Newton's divided difference formula.	12
V	**NUMERICAL DIFFERENTIATION AND INTEGRATION** Differentiation using interpolation formula – Newton's forward and backward interpolation formulae for equal intervals – Newton's divided difference formula for unequal intervals - Numerical integration by Trapezoidal and Simpson's 1/3 rules.	12
		60
	Total Instructional Hours	

Course Outcome

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

CO1: Compute correlation and predict unknown values using regression together with R studio.
CO2: Understand the concepts of statistical methods for testing the hypothesis along with R studio.
CO3: Apply Design of Experiment techniques to solve various engineering problems in addition with R studio.
CO4: Understand the concept of interpolation in both cases of equal and unequal intervals.
CO5: Identify various methods to perform numerical differentiation and integration.

TEXT BOOKS:

T1 - Erwin Kreyszig, “Advanced Engineering Mathematics”, 10th Edition, Wiley India Private Ltd., New Delhi, 2018.

T2 - Medhi J,” stochastic Processes”, New Age International Publishers,New Delhi,2014

REFERENCE BOOKS :

R1 - Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers And Scientists", 8th Edition, Pearson Education, Asia, 2007.

R2 - Grewal B.S. and Grewal J.S. “Numerical Methods in Engineering and Science “, 6th Edition , Khanna Publishers, New Delhi 2004.

R3 - S.K.Gupta, Numerical Methods for Engineers”, New Age International Pvt.Ltd Publishers, 2015.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	22BM3251	Digital Electronics	2	0	2	3

Course Objective

To understand the number systems and simplification of Boolean functions
To Confer the basic principles combinational circuits
To learn synchronous sequential circuits
To recognize asynchronous sequential circuits
To know about Memory devices and fundamentals of HDL.

Unit	Description	Instructional Hours
I	**NUMBER SYSTEMS AND MINIMIZATION TECHNIQUES** Number systems: Decimal, Binary, Octal, Hexadecimal-Number-Base conversion-Complements of Numbers: 1's and 2's complements- Boolean algebra and laws-De-organ's Theorem-Minimization of Boolean expressions – Midterm – Maxterm – Sum of Products (SOP) – Product of Sums (POS) – Karnaugh map Minimization– Don't care conditions (2-variable,3-variable & 4-variable)-Tabulation method	9
II	**COMBINATIONAL CIRCUITS** Adder-Half adder, Full adder; Subtractor- Half subtractor, Full subtractor: Code converters: Binary to Gray, Gray to Binary, BCD to Excess-3 and Excess-3 to BCD; Magnitude comparator- Decoders, Encoders,-Multiplexers, De multiplexers, Experimental **Design and implementation of Adders and Subtractors.** **Experimental Design and implementation of Binary to Gray and Gray to Binary Conversion.** **Experimental Design and implementation of Decoder and Encoder**	9
III	**SYNCHRONOUS SEQUENTIAL CIRCUITS** Flip flops: SR, JK, D, T - Design of synchronous sequential circuits: State diagram - State table, – State minimization - State assignment. Shift registers: SISO, SIPO, PIPO, PISO– Counters: BCD, Up down counter and modulo counter. **Experimental Design and implementation of Shift registers, Synchronous and Asynchronous Counters**	9
IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS** Stable and Unstable states– Cycles and Races-Reduction of state and flow tables – Race-free state assignment – Hazards-Design of Hazard free circuits	9
V	**MEMORY DEVICES AND HDL** ROM-PROM-EPROM-EEPROM-RAM-FPGA-Programmable Logic Devices-Introduction to Hardware Description Language (HDL)- HDL for combinational circuits- Half adder, Full adder, Multiplexer, De-multiplexer, Counters.. **Coding Combinational/Sequential circuits using HDL.**	9
	Total Instructional Hours	**45**

Course Outcome

CO1 Simplify Boolean functions
CO2 Analyze, design and implement combinational logic circuits.
CO3 Evaluate, design and implement Synchronous sequential logic circuits
CO4 Interpret, design and implement Asynchronous sequential logic circuits
CO5 Simulate and implement combinational and sequential circuits using HDL.

TEXT BOOKS:

T1 Morris Mano M. and Michael D. Ciletti, “Digital Design”, IV Edition, Pearson Education,2008

T2 S. Salivahanan and S. Arivazhagan, “Digital Circuits and Design”, Second Edition, VikasPublishing House Pvt. Ltd, New Delhi, 2010.

REFERENCE BOOKS:

R1 Thomas L. Floyd, “Digital Fundamentals”, Pearson Education, Inc, New Delhi, 2013

R2 Kharate G.K “Digital Electronics” Oxford, First edition-2018

R3 Singh B.T “Digital Electronics” Dhanpatrai and Co, First Edition 1987

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Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM3002	Electron Devices and Circuits Lab	0	0	3	2

Course Objective

To learn the characteristics of PN junction diode.
To understand the characteristics of Zener diode.
To learn the characteristics of Transistors and frequency response of amplifiers.
To learn the working of oscillators.
To learn the basic laws and network reduction theorems.

S. No	Description of the Experiments
1	PN Junction Diode Characteristics
2	Zener Diode Characteristics
3	Common Emitter transistor - Input and Output Characteristics
4	SCR Characteristics
5	Verification of KVL & KCL
6	Verification of Super Position Theorem
7	Verification Of Thevenin's Theorem
8	Verification Of Norton's Theorem
9	RC Phase shift oscillator characteristics
10	Transient analysis of RL and RC circuits

Total Instructional Hours 45

Course Outcome

CO1 To understand the characteristics of PN junction diode, Zener diode and transistors.
CO2 To understand the concept of amplifiers and Oscillators.
CO3 Apply the concept of basic laws and network reduction theorems.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	22BM3001	BIOCHEMISTRY LABORATORY	0	0	3	2

Course Objective

1. To learn about Estimation and quantification of bio molecules.
2. To learn about Separation of macromolecules.
3. To learn about Estimation and interpretation of bio chemical parameter.

Description of Experiments

Study Exp 01	General Instructions For Lab Safety
Study Exp 02	Units, Volume, Weight Measurements And Concentrations, Units
3	Preparation Of Buffer
4 A.	Qualitative Analysis Of Carbohydrates
4.B	Quantitative Analysis For Carbohydrates
5	Spectroscopy: Determination Of Absorption Maxima Of A Given Solution
6	Estimation Of Blood Glucose By Anthrone Method
7	Estimation Of Haemoglobin By Sahli's Method
8	Estimation Of Creatinine
9	Estimation Of Urea
10	Estimation Of Cholesterol By Zak's Method
11	Enzymatic Activity Of Salivary Amylase On Starch
12	Effect Of Temperature On The Activity Of Salivary Amylase
13	Separation Of Amino Acids By Thin Layer Chromatograpghy (Demo)

Course Outcome

CO1: Understand the Biochemistry laboratory functional components
CO2: Understand

the basics principle of preparation of buffers.
CO3: Understand the qualitative test for different bio molecules
CO4: Understand the basics knowledge of Biochemical parameter and their inter pretation in Blood sample.
CO5: Understand the separation technology of proteins and amino acids.

PO& PSO	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	-	3	-	--	-	3	-	-	2	3	-	-
CO2	3	3	3	-	3	-	-	-	3	--	-	2	3	-	--
CO3	3	3	3	--	3	--	--	--	3	-	--	2	3	--	-
CO4	3	3	3	-	3	-	-	-	3	-	-	2	3	-	--
CO5	3	3	3	-	3	-	--	-	3	-	-	2	3	--	-
AVG	3	3	3	--	3	-	-	-	3	-	--	2	3	-	-

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Programme	Course Code	Course Title	L	T	P	C
BE	22HE3071	Soft Skills and Aptitude- II	0	0	0	1

Course Objectives:

1. Solve Logical Reasoning questions of easy to intermediate level
2. Solve Quantitative Aptitude questions of easy to intermediate level
3. Solve Verbal Ability questions of easy to intermediate level
4. Display good writing skills while dealing with essays

Unit	Description	Instructional Hours
	Logical Reasoning	
I	Clocks - Calendars - Direction Sense - Cubes - Data Interpretation: Tables, Pie Chart, Bar Graph - Data Sufficiency	9
	Quantitative Aptitude	
II	Time and work: Work with different efficiencies, Pipes and cisterns, Work equivalence, Division of wages - Time, Speed and Distance: Basics of time, speed and distance, Relative speed, Problems based on trains, Problems based on boats and streams, - Profit and loss, Basic terminologies in profit and loss - Averages - Weighted average	12
	Verbal Ability	
III	Sentence Correction: Subject-Verb Agreement, Modifiers, Parallelism, Pronoun-Antecedent Agreement, Verb Time Sequences, Comparisons, Prepositions, Determiners - Sentence Completion and Para-jumbles: Pro-active thinking, Reactive thinking (signpost words, root words, prefix suffix, sentence structure clues), Fixed jumbles, Anchored jumbles.	7
	Writing skills for placements	
IV	Essay writing: Idea generation for topics, Best practices, Practice and feedback	2
	Total Instructional Hours	30

Course Outcome:

CO1:	Students will avoid the various fallacies that can arise through the misuse of logic.
CO2:	Students would opt for alternate methods to solve the problems rather than conventional methods.
CO3:	Students will heighten their awareness of correct usage of English grammar in writing and speaking
CO4:	Students will be concise and clear, using professional language for placements.

REFERENCE BOOKS:

R1: A New Approach To Reasoning Verbal & Non-Verbal By B.S. Sijwali

R2: How to prepare for data interpretation for CAT by Arun Sharma.

R3: How to Crack TEST OF REASONING in all competitive examinations by Jaikishan and Premkishan.

R4: Quantitative Aptitude for Competitive Examinations -Dr. R.S. Aggarwal, S. Chand

R5: Word Power Made Easy by Norman Lewis

R:6 Six weeks to words of power by Wilfred Funk

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E	22BM3191	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2	0	0	0

Course Objective

1. To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyze it and apply it to their day to day life.
3. To impart basic principles of thought process, Itihas and Dharma Shastra and connecting society and nature.
4. To understand the concept of Intellectual and intellectual property rights with special Reference.
5. The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific world-view and basic principles of Yoga and Indian philosophy.

Unit	Description	Instructional Hours
I	**Introduction to traditional knowledge:** Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vs indigenous knowledge, traditional knowledge vs western knowledge	6
II	**Protection of traditional knowledge:** The need for protecting traditional knowledge, Significance of TK Protection, value of TK in global economy, Role of Government to harness TK	6
III	**Itihas and Dharma-Shastra Itihas:** The Mahabharata - The Puranas - The Ramayana Dharma-Shastra**:** **Manu Needhi - The Tirukkural – Thiru Arutpa**	6
IV	**Traditional knowledge and intellectual property:** Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge	6
V	**Indian philosophy** Jain – Buddhist – Charvaka – Samkhya - Yoga - Nyaya - Vaisheshika - Saiva Siddhanta	6

Course Outcome

1. Identify the concept of Traditional knowledge and its importance.
2. Explain the need and importance of protecting traditional knowledge.
3. Explain the need and importance of Itihas and Dharma Shastra.
4. Interpret the concepts of Intellectual property to protect the traditional knowledge.
5. Interpret the concepts of indian philosophy to protect the traditional knowledge.

REFERENCES

1. Traditional Knowledge System in India, by Amit Jha, 2009.
2. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
3. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.

4. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014.
5. V N Jha (Eng. Trans,), Tarkasangraha of Annam Bhatta, Inernational Chinmay Foundation, Velliarnad, Amaku,am.

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FOURTH SEMESTER

Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM4201	BIOSIGNAL CONDITIONING CIRCUITS	3	0	0	3

The student should be able

Course Objective

1. To introduce the basics of operational amplifiers and its applications in biomedical.
2. To gain knowledge about the various types of filters and isolation amplifiers.
3. To learn the theory of ADC,DAC and comparators.
4. To learn the working of analog circuits and PLL.
5. To introduce the concepts of waveform generation and various safety standards .

Unit	Description	Instructional Hours
I	**Operational Amplifiers and Its Biomedical Applications** Operational Amplifiers-Basic opamps parameters, Ideal and practical opamp, application of opamp in biomedicine- Adder, subtractor, analog integrator, differentiator, preamplifiers, Transimpedence circuits.	9
II	**Basic Filters and Isolation Circuits** Active filters and Medical Isolation Amplifiers: First order and second order active filters, Instrumentation amplifier, Types of isolation amplifiers and optocouplers.	9
III	**Biosignal Data Acquisition Systems** Comparators, Comparator applications, Multivibrators,555 timers, Astable and monostable, Pacemaker circuits, Aliasing and sampling, Analog to Digital, Digital to Analog conversion.	9
IV	**Special Analog Circuits** Special analog circuits and systems used in biomedical transmission, Phase Detectors-Analog and Digital, Voltage Controlled Oscillators, Various VCO ICS, Phase locked loops.	9
V	**Advanced Biomedical Instrumentation and Safety Standards** Modulation and demodulation of biosignals, IC thermometers and advanced biomedical instrumentation systems, Electrical Interface problems and Safety Standards in Bio Potential Measurements.	9
	Total Instructional Hours	45

Course Outcome

CO1	Apply the signal conditioning circuits for biomedical field.
CO2	Analyze and design bio filters and isolation circuits used in medical signal conditioning.
CO3	Interface the bioelectric signals with analog and digital circuits for data acquisition
CO4	Create the various circuits for designing medical equipments using different ICs
CO5	Recommend the various safety standards in biomedical instrumentation

TEXT BOOK:

T1 Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRC Press, II Edition, New York, 2017

T2 Sergio Franco, "Design with Operational Amplifier and Analog Integrated Circuits", TMH, 3rd Edition, 2009.

REFERENCES:

R1 Myer Kutz, "Biomedical Engineering and Design Handbook", II Edition, Volume 1, McGraw Hill Professional,2011

R2 Robert F. Coughlin, Frederick F. Driscoll, "Operational Amplifiers & Linear Integrated Circuits", Prentice-Hall, 6th Edition,2004.

R3 Milman&Hallkias, "Integrated Electronics-Analog and Digital Circuit", McGraw Hill, II Edition,2011

R4 Roy Choudhury and Shail Jain, "Linear integrated circuits", Wiley Eastern Ltd,2002

ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
CO2	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
CO3	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
CO4	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
CO5	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
AVG	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-

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Program	Course code	Name of the course	L	T	P	C
me B.E	22BM4202	PATHOLOGY AND MICROBIOLOGY	2	0	0	3

The student should be able

Course Objective

1. To understand and gain knowledge on the structural and functional a3 ects of living organisms
2. To learn the medical aspects of bacteriology, virology, mycology and parasitological
3. To compare different clinical manifestations of different types of pathogens
4. To analyze how disease processes can result in specific clinical signs and symptoms
5. Empower the importance of public health.

Unit	Description	Instructional Hours
I	**Introduction to Pathology**: Pathology-- Cellular adaptation- atrophy, hypertrophy. Cellinjury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification, cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumour, carcinogenesis, spread of tumours. Autopsy and biopsy. Tumor markers.	9
II	**Systematic Pathology:** Fluid and Hemodynamic derrangements- Edema, normal homeostasis, thrombosis, disseminated Intravascular coagulation, embolism, infarction, shock. Hematological disorders- Bleeding disorders, Leukemia's, Lymphomas	9
III	**Basics of Microbiology:** Organization and function of prokaryotic and eukaryotic cells;Structure and function of cell organelles surface structure, special organelles, cellular reserve materials; Microscopy- Light microscope – Bright field, Dark field, Phase contrast, Fluorescence, Electron microscope (TEM & SEM). Preparation of samples forclectron microscope. Staining methods – simple, gram staining and AFB staining.	9
IV	**Microbial Cultures:** Morphological features and structural organization of bacteria: Bacterial Staining- Gram; Cultivation-Types, Media for growth; pure culture concept and cultural characteristics; Control of microorganisms by physical and chemical agents	9
V	**Immunology:** Basic principles of immunity immunobiology: lymphoid organs andtissues. Antigen, Antibodies, antigen and antibody reactions with relevance to pathogenesis and serological diagnosis, Immunological techniques: Immune diffusion, Immuno Electrophoresis, RIA and ELISA, monoclonal antibodies. Disease caused bybacteria, fungi, Protozoal, virus and helminthes	9
	Total Instructional Hours	45

Course Outcome

CO1	Analyze the structural and functional aspects of living organisms.CO2
	Infer and recall different forms of disease formation
CO3	Infer and explain the function of microscopesCO4
	Knowing the methods for bacterial cultures
CO5	Analyze structural and functional aspects of immunology

TEXT BOOK:

T1 V Kumar, AK. Abbas and JC Aster, (2015), Robbins & Cotran Pathologic Basis of Disease, 9th Edition, Elsevier.

T2 Ramzi S Cotran, Vinay Kumar and Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB SaundersCo. 2010

REFERENCES:

R1 Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000

Ananthanarayanan & Panicker, "Microbiology" Orientblackswan, 2005.

ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
CO2	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
CO3	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
CO4	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
CO5	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
AVG	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3

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Programme	Course code	Name of the course	L	T	P	C
B.E	22BM4203	BIOSENSORS AND TRANSDUCERS	2	0	0	2

The student should be able

Course Objective

1 To gain knowledge in basic requirements to fabricate a sensor for a given application.
2 To understand different methods for attaching recognition molecule on the sensor surface.
3 To identify the interaction between the surface attached molecule and target molecule
4 To understand the working principles of electronic and optical sensor devices.
5 To understand the role of affinity sensors in disease diagnosis.

Unit	Description	Instructional Hours
I	**BASICS OF BIOSENSORS:** Biosensor – definition - Historical perspective; Sensor characteristics - calibration, dynamic Range, signal to noise, sensitivity, selectivity, interference- examples - applications –Problems.	9
II	**TYPES OF TRANSDUCERS:** Transducer – definition- types – optical, electrochemical, Electrochemical transducers (Amperometric, potentiometric, conductimetric); - thermal, Mass – piezoelectric – acoustic wave with examples.	9
III	**BIORECOGNITION SYSTEMS**– Enzymes; Microorganism based biosensor, immobilization of microorganism - botanical biosensors-Biosensors using cultured cells intact tissues-receptor elements..	9
IV	**DNA ELECTRONIC APPLICATIONS-** Molecular wires and switches Biomolecular computer, molecular arrays as memory stores, DNA for molecular devices - molecules between nanofabricated electrodes.	9
V	**GLUCOSE SENSORS-** Definition- Historical developments – generations of glucose sensing -types of glucose monitoring – invasive and non-invasive – sensor marketIndian status.	9
	Total Instructional Hours	45

Course Outcome

CO1 Become knowledge able in the field of biosensors.
CO2 Understand the role of transducer in sensor and its types.
CO3 Understand bio recognition system to detect particular type of analytes.
CO4 Become familiar with the DNA sensors.
CO5 Gain knowledge on the history and recent development of glucose sensors..

TEXT BOOK:

T1 Zhang X. ZuH. Wang J. (2018). Electrochemical Sensors, Biosensors and their Biomedical applications. Elsevier Science and Technology Books.
T2 Cooper J. Cass T. (2004).Biosensors. 3- Biotechnology Advances.

REFERENCES:

R1 2. Cooper J.M. Cooper J. Cass A.E.G. (2004). Biosensors. Oxford University Press.
R2 Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall of India, 1st edition, 2016.

ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
CO2	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
CO3	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
CO4	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
CO5	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
AVG	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3

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Programme	Course code	Name of the course	L	T	P	C
B.E	22BM4251	Microprocessors and Micro controllers in Medical Applications	2	0	2	4

Course Objective

The student should be able

1. To study the architecture of 8085 micro processor with medical application
2. To understand the basic programming concepts of 8085 micro processor with medical application
3. To know the architecture of 8086 microprocessor with medical application
4. To gain knowledge about 8051 microcontroller with medical application.
5. To learn the Assembly programming and instruction of 8051 micro controllers with medical application

Unit	Description	Instructional Hours
I	8085 Microprocessor: Introduction to Microprocessor: Microprocessor architecture and its operations, Memory, Input & output devices, The 8085 MPU- architecture, Pins and signals, Timing Diagrams, Logic devices for interfacing, Memory interfacing, Interfacing output displays, Interfacing input devices, Memory mapped I/O.– Programming exercise - Measurement of heart rate monitoring	9+3
II	Basic Programming concepts: Flow chart symbols, Data Transfer operations, Arithmetic operations, Logic Operations, Branch operation, Writing assembly language programs, Programming techniques: looping, counting and indexing. Additional data transfer and 16 bit arithmetic instruction, Logic operation: rotate, compare, counter and time delays, 8085 Interrupts. A/D Interfacing. & D/A Interfacing. Using 8085 Programming exercise MRI scanning Exp1:Simple arithmetic operations: addition / subtraction using 8085 Exp 2.Traffic light controller. Using 8085	9+3
III	8086 Microprocessor 16-bit Microprocessors - 8086 Architecture, Pin Description, Physical address, segmentation, memory organization, Addressing modes. Peripheral Devices: 8237 DMA Controller, 8255 programmable peripheral interface, 8253/8254 programmable timer/counter, 8259 programmable interrupt controller, 8251 USART and RS232C.– Programming exercise - Patient Monitoring in Intensive Care Unit. Exp3: Simple arithmetic operations: multiplication / division using 8086 Exp4:A/D Interfacing. & D/A Interfacing. Using 8086	9+3
IV	8051 Microcontroller Inside the Computer, Microcontrollers and Embedded Processors, Block Diagram of 8051, PSW and Flag Bits, 8051 Register Banks and Stack, Internal Memory Organization of 8051, IO Port Usage in 8051, Types of Special Function Registers and their uses in 8051, Pins Of 8051. Memory Address Decoding, 8031/51 Interfacing With External ROM And RAM. 8051 Addressing Modes.– Programming Exercise - Drug delivery system Exp5: Programming I/O Port 8051	9+3
V	Assembly programming and instruction of 8051: Introduction to 8051 assembly programming, Assembling and running an 8051 program, Data types and Assembler directives, Arithmetic, logic instructions and programs, Jump, loop and call instructions, IO port programming. Programming 8051 Timers. Serial Port Programming, Interrupts Programming, Interfacing: LCD & Keyboard Interfacing, ADC, DAC & Sensor Interfacing, External Memory Interface, Stepper Motor and Waveform generation. Programming Exercise: Blood Glucose Monitor Exp 6: Stepper Motor Interfacing using 8051	9+3
	Total Instructional Hours	60

Course Outcome

CO1	Interpret architecture of 8085 Microprocessor with medical application
CO2	Remember the basic programming concepts of 8085 Microprocessor with medical application
CO3	Recognize the architecture of 8086 Micro processor with medical applications
CO4	Iinterpret the Architecture of 80581 micro controller with medical application
CO5	Infer the structure of assembly programming and instruction of 8051 Micro controller.

TEXT BOOK:

T1 Ramesh Gaonkar "Microprocessor Architecture, Programming and Applications with the 8085" Penram International Publishing, 6th edition, October 2013

T2 B.Ram,"fundamentals of Microprocessors and Microcontrollers",8th Edition, DhanpatRai publications Pvt.Ltd.,2015.

T2 N.SenthilKumar,M.Saravanan,S.Jeevananthan,"Microprocessors and Microcontrollers",Oxford University Press,2000.

REFERENCES:

R1 Kenneth L. Short, "Microprocessors and programmed Logic", 2nd Ed, Pearson Education Inc.,2003

R2 Barry B. Brey, "The Intel Microprocessors, 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, PentiumPro Processor, PentiumII, PentiumIII, Pentium IV, Architecture, Programming & Interfacing", Eighth Edition, Pearson Prentice Hall, 2009

R3 Shah Satish, "8051 Microcontrollers MCS 51 Family and its variants", Oxford,2010

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ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
CO2	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
CO3	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
CO4	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
CO5	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
AVG	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3

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Programme	Course code	Name of the course	L	T	P	C
B.E	22BM4252	Biomedical Instrumentation	2	0	2	4

The student should be able

Course Objective

1. To Illustrate origin of bio potentials and its propagations.
2. To understand the different types of electrodes and its placement for various recordings.
3. To design bio amplifier for various physiological recordings.
4. To learn the different measurement techniques for non-Electrical parameters.
5. To Summarize different biochemical measurements.

Unit	Description	Instructional Hours
I	**Biopotential Electrodes:** Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half-cell potential, Contact impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - motion artifacts, measurement with two electrodes.	9
II	**Biopotential Measurements:** Bio signals characteristics – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system, Principles of vector cardiography.EEG – 10-20 electrode system, unipolar, bipolar and average mode. EMG– unipolar and bipolar mode. Recording of ERG, EOG . **Lab Experiment** 1. Acquisition of ECG, signals 2. Acquisition of EEG signals 3. Acquisition of EMG signals	9+6
III	**Signal Conditioning Circuits** Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier, Power line interference, Right leg driven ECG amplifier, Band pass filtering	9
IV	**Measurement of non-Electrical Parameters:** Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers, Systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement. **Lab Experiment** 4.Measurement of pulse-rate using Photo transducer 5. Measurement of blood pressure using sphygmomanometer. 6.Measurement and recording of peripheral blood flow using PPG	9+6
V	**Biochemical Measurement And Biosensors:** Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET), Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers - colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description) – Bio Sensors – Principles – amperometric and voltometric techniques **Lab Experiment** 7. Measurement of pH and conductivity	9+3
	Total Instructional Hours	45+15=60

Course Outcome

CO1	Demonstrate origin of bio potentials and its propagations.
CO2	Classify different types of electrodes and its placement for various recordings.
CO3	Design bio amplifier for various physiological recordings
CO4	Explain various technique for non-electrical physiogical measurements
CO5	Demonstrate different biochemical measurement techniques.

TEXT BOOK:

T1 John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2009.

T2 Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw, New Delhi, 2004.

REFERENCES:

R1 Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007.

R2 Myer Kutz, "Biomedical Engineering and Design Handbook", II Edition, Volume 1, McGraw Hill Professional,2009.

Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2008

ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
CO2	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
CO3	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
CO4	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
CO5	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
AVG	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	22BM4001	HUMAN PHYSIOLOGY LABORATORY	0	0	4	2

Description of Experiments

1. Study of parts of compound microscope
2. Peripheral smear study
3. Estimation of RBC count.
4. Estimation of WBC count.
5. Hemoglobin estimation.
6. Blood grouping.
7. Bleeding time/ clotting time.
8. Hearing test using Audiometer.
9. Visual Acuity Test
10. Respiratory parameter measurement.
11. Measurement of vital parameters.
12. Virtual anatomy lab experiments
    - i) Hematocrit Lab Simulation
    - ii) Cardiac Cycle Simulation
    - iii) Urinalysis Lab Simulation

Total Practical Hours: 45

REFERENCES:

1. Ghai C L, —Textbook of Practical Physiology, Eight edition, Jaypee Brothers, Medical Publisher's Pvt. Ltd., New York, 2013.
2. Stuart Ira Fox, —Laboratory Guide to Human Physiology, Tata McGraw Hill, 2002.
3. Richard G P Flanzer, —Experimental and Applied Physiology Laboratory Manual, Tata McGraw Hill, Columbus, 2005.
4. https://www.humanbiomedia.org/lab-simulations/

Course Outcome

CO1	Identification and enumeration of blood cells
CO2	Enumeration of hematological parameters.
CO3	To understand the human anatomy and physiology virtually.

ENTRY MAPPING OF COs and POs:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO-1	PSO-2	PSO-3
CO1	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
CO2	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
CO3	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
CO4	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
CO5	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
AVG	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3

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Programme	Course Code	Name of the Course	L.	T	P	C
B.E.	22BM4002	BioSignal Conditioning Circuits Laboratory	0	0	4	2

Description of Experiments

1. Study of basic digital logic used in biosignal conditioning
2. Study of biosignal data acquisition system
3. Design of basic op-amp circuits for biosignal processing
4. Design and analysis of biological pre amplifiers
5. Design of wave shaping circuits
6. Design of Instrumentation amplifier for ECG amplification
7. Design of active filters for biosignal acquisition (PPG Signal Acquisition)
8. Design of pacemaker circuit
9. Design of medical isolation amplifier
10. Design of constant current source and transimpedence circuits

Total Practical Hours: 45

REFERENCES:

T1 D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt.Ltd., 2021, Sixth Edition.

T2 Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 4thEdition, Tata Mc Graw-Hill, 2016

Course Outcome

CO1	Identify and apply the amplifiers and various signal conditioning circuits for biosignals acquisition.
CO2	Demonstrate the basic concepts for filtering of bio signals
CO3	Select suitable circuits to design various biomedical devices

Course Code & Name: 22BM4002& BioSignal Conditioning Circuits Laboratory

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	3	-	-	2	-	3	1
CO2	2	-	2	-	-	-	-	-	3	-	-	2	-	3	1
CO3	3	-	3	2	-	-	-	-	3	-	-	-	-	3	1
CO4	3	-	-	-	2	-	-	-	3	-	-	-	-	2	1
CO5	3	-	-	2	-	-	-	-	3	-	-	2	1	3	1
Avg	3	0	1	1	0	-	-	-	3	-	-	1	0	3	1

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	22HE4072	Soft Skills and Aptitude III	0	0	0	1

Course Objectives:

1. Solve Logical Reasoning questions of easy to intermediate level
2. Solve Quantitative Aptitude questions of easy to intermediate level
3. Solve Verbal Ability questions of easy to intermediate level
4. Display good writing skills while dealing with essays

Unit	Description	Instructional Hours
	Logical Reasoning	
I	Clocks - Calendars - Direction Sense - Cubes - Data Interpretation: Tables, Pie Chart, Bar Graph - Data Sufficiency - Syllogism	10
	Quantitative Aptitude	
II	Time and work: Work with different efficiencies, Pipes and cisterns, Work equivalence, Division of wages - Time, Speed and Distance: Basics of time, speed and distance, Relative speed, Problems based on trains, Problems based on boats and streams, Problems based on races - Profit and loss, Partnerships and averages: Basic terminologies in profit and loss - Partnership - Averages - Weighted average Permutation, Combination: Fundamental Counting Principle, Permutation and Combination, Computation of Permutation, Circular Permutations, Computation of Combination - Probability	12
	Verbal Ability	
III	Sentence Correction: Subject-Verb Agreement, Modifiers, Parallelism, Pronoun-Antecedent Agreement, Verb Time Sequences, Comparisons, - Sentence Completion and Para-jumbles- Critical Reasoning: Argument – Identifying the Different Parts (Premise, assumption, conclusion), Strengthening statement, Weakening statement, Mimic the pattern	6
	Recruitment Essentials	
IV	Cracking interviews - demonstration through a few mocks - Sample mock interviews to demonstrate how to crack the: HR interview, MR interview, Technical interview - Cracking other kinds of interviews: Skype/ Telephonic interviews, Panel interviews, Stress interviews - Resume building – workshop: A workshop to make students write an accurate resume- Essay Writing	2
	Total Instructional Hours	30

Course Outcome:

CO1: Students will avoid the various fallacies that can arise through the misuse of logic.

CO2: Students would opt for alternate methods to solve the problems rather than conventional methods.

CO3: Students will heighten their awareness of correct usage of English grammar in writing and speaking

CO4: Students will be concise and clear, using professional language for placements.

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22HE4101	IPR AND START-UPS	2	0	0	2

The student should be able

Course Objective

The main objective of the IPR is to make the students aware of their rights for the protection of their invention done in their project work.

To get registration in our country and foreign countries of their invention, designs and thesis or theory written by the students during their project work and for this they must have knowledge of patents, copy right,

To learn about the trademarks and geographical indications (GI) in our country and foreign countries of their invention.

To gain the knowledge about designs and layout design Act-2000.

To learn about the technology transfer to product and Start-up knowledge.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO IPR** Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights Introduction to Trade-Related of Intellectual Property Rights (TRIPS) and World Trade Organization (WTO). - Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.	6
II	**PATENT RIGHTS AND COPY RIGHTS** Origin, Meaning of Patent, Types, Procedure to follow the methods of IP agents, Inventions, which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties, IT Act- introduction. COPY RIGHT- Origin, Definition &Types of Copy Right, Patent Ethics, Registration procedure, Assignment & license, Terms of Copy Right, Piracy, Infringement, Remedies,	6
III	**TRADE MARKS AND GEOGRAPHICAL INDICATION** Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing off, Penalties. GEOGRAPHICAL INDICATION – International Protection, plant varieties, Infringement of GI, licensing, legal issues.	6
IV	**DESIGN** Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor Integrated circuits and layout design Act-2000.	6
V	**START-UPS** Process of Innovation, Monetizing Ideas, Technology transfer to product, Funding Options for Start-up, Start-up Models, Preparation of Project Report, Start up to MNC, Start-up Audit.	6
	Total Instructional Hours	30

Course Outcome

Upon completion of the course, the students will be able to:
CO1: Understand IPR and aware the invention rights.
CO2: Get awareness of acquiring the patent for their project ideas
CO3: Learn obtaining copyright for their innovative works
CO4: Understand the designs and layout design Act-2000.

CO5: Understand the concept of start-ups, identify the required strategic resources.

TEXT BOOK:

T1. Intellectual Property Rights (IPR) by M.K Bhandari 2021
T2. Law relating to Intellectual Property Rights, by V.K Ahuja 2017
T3. Intellectual Property Rights (IPR) for Start-ups by Vinay Vaish 2016
T4. Intellectual Property - Patents, Copyright, Trade Marks and Allied Rights (South Asian Edition) by W Cornish and D Llewelyn and T Pain 8th South Asian Edition, 2016.
T5 Peter Thiel & Blake Masters, Zero to One: Notes on Start Ups, or How to Build the Future, Random House, 2014.

Course Code & Name: **22HE4101 IPR AND START-UPS**

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	3	-	-	3	-	-	-	-	-	3	2	2
CO2	3	-	3	-	-	3	-	-	-	-	-	3	2	2
CO3	3	-	3	-	-	3	-	-	-	-	-	3	2	2
CO4	3	-	3	-	-	3	-	-	-	-	-	3	2	2
CO5	3	-	3	-	-	3	-	-	-	-	-	3	2	2
Avg.	3	-	3	-	-	3	-	-	-	-	-	3	2	2

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SEMESTER V

Programme	Course Code	Name of the Course	L	T	P	C
B.E	21BM5201	BIOCONTROL SYSTEMS	3	1	0	4

Course Objectives

1. To understand the concept behind feedback and continuum in various systems and subsystems.
2. To analyse the systems in time and frequency domain and to understand the concept of stability.
3. To apply mathematical modelling principles in understanding the various fundamental biological systems.
4. To understand biological system models.
5. To analyse biological control systems.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Open and Closed loop Systems, Block diagram and signal flow graph representation of systems, reduction of block diagram and signal flowgraph.	12
II	**TIME RESPONSE ANALYSIS** Standard test signals,time response of first order and second order systems, time domain specifications,steady State errors.	12
III	**FREQUENCY RESPONSE ANALYSIS** Determination of closed loop response from open loop response,Bodeplot, Nichol'schart,Polarplot.	12
IV	**STABILITYANALYSIS** Characteristic equation,Location of rootsins-plane for stability,Routh Hurwitz criterion,Root locus techniques-Construction,Gain margin and phasemargin,Nyquist stability criterion.	12
V	**PHYSIOLOGICAL CONTROL SYSTEM ANALYSIS** Difference between engineering and physiological control system-Model development of Cardio vascular system-Heart model-circulatory model - Simplemodels of muscle stretch reflexaction-Stability analysis of Pupillary lightreflex-Regulation of cardiac output,Regulation of ventilation.	12
	Total Instructional Hours	**60**

Cours Outcomes

CO1: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.
CO2:Analyze the timer esponse of various systems and discuss the concept of systemst ability
CO3:Analyze the frequency response characteristics of various systems using different charts
CO4:Understand the concept of modeling basic physiological systems.
CO5:Comprehend the application aspects of time and frequency response analysis in physiological control systems.

TEXTBOOKS:

T1. I.J. Nagarath and M. Gopal ―Control Systems Engineering", Fifth Edition, AnshanPublishers,2008.(UNIT
T2.MichaelCKKhoo,

―PhysiologicalControlSystems‖,IEEEPress,PrenticeHallofIndia,2005

REFERENCES:

R1.BenjaminC. Kuo,―AutomaticControlSystems‖,PrenticeHallofIndia,1995.
R2. John Enderle Susan Blanchard, Joseph Bronzino ―Introduction to BiomedicalEngineering‖,secondedition,AcademicPress,2005.
R3.RichardC.Dorf, RobertH.Bishop,―Moderncontrolsystems‖, Pearson,2004.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	**21BM5202**	**BIOMECHANICS**	3	0	0	3

CourseObjectives

Up on completion of this course,the students will be familiar with

1. Explain the principles of mechanics.
2. Discuss the mechanics of physiological systems.
3. Explain the mechanics of joints.
4. Illustrate the mathematical models used in the analysis of biomechanical systems.
5. Describe biomechanics of joints.

Unit	Description	Instructional Hours
	INTRODUCTION	
I	Scope of mechanics in medicine, mechanics of bone structure, determination ofin-vivoelasticmodulus.Biofluidmechanics,flowpropertiesofblood.Anthropometry.	9
	MECHANICSOFPHYSIOLOGICALSYSTEMS	
II	Heartvalves, power developed by the heart,prosthetic valves.Constitutive quations for soft tissues, dynamics of fluid flow in cardiovascular system andeffectofvibration-shearstressesinextra-corporealcircuits..	9
	ORTHOPAEDICMECHANICS	
III	Mechanical properties of cartilage, diffusion properties of articular cartilage,mechanical properties of bone,kinetics and kinematics of joints,Lubrication of joints.	9
	MATHEMATICAL MODELS	
IV	Introduction to Finite Element Analysis, Mathematical models-pulse wave velocitiesinarteries,determinationofin-vivoelasticityofblood vessel, dynamics offluidfilledcatheters..	9
	ORTHOPAEDIC APPLICATIONS	
V	Dynamics and analysis of human locomotion-Gait analysis(determinationof Instantaneous joint reaction analysis),occupant response to vehicular ibration. Mechanics of knee joint during standing and walking..	9
	Instructional Hours Total	**45**

Course Outcomes

Upon completion of this course,the students will be able to

CO1: Understand the use of mechanics in medicine.
CO2:Understand the mechanics of physiological systems.
CO3: Distinguish the reason for abnormal patterns.
CO4:Analyze the biomechanical systems using mathematical models.
CO5:Design and develop the models specific to orthopedic applications.

TEXTBOOKS:

1.Y.C.Fung,―Bio-Mechanics,"MechanicalPropertiesofTissues'',Springer-Verilog,1998.
2.C.RossEtherandCraigA.Simmons,
"IntroductoryBiomechanicsfromcellstoorganisms",CambridgeUniversityPres
s,NewDelhi, 2009.

REFERENCE:

1.SusanJHall,"Basics of Biomechanics'',McGraw Hill
Publishing.co.NewYork,5thEdition,2007.
2.DhanjooN.Ghista,"OrthopaedicMechanics",AcademicPress,1999
3.JosephD.Bronzino, "BiomedicalEngineeringFundamentals",Taylor&Francis, 2006.
4.JohnEnderle,Susanblanchard,JosephBronzino,"Introduction to Biomedical
Engineering'',Elsevier,2005

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Programme	Course Code	Name of the Course	L	T	P	C
BE	**21BM5203**	**MICROPROCESSORAND MICROCONTROLLERS**	**3**	**0**	**0**	**3**

Course Objective

1. Demonstrate the Architecture of 8086 microprocessor.
2. Interpret the system bus structure and Multiprocessor configuration of 8086microprocessor.
3. Apply the design aspects of I/O and Memory Interfacing circuits.
4. Examine theArchitecture of 8051microcontroller.
5. Practice the design aspect of interfacing circuits with 8051microcontroller.

Unit	Description	Instructional Hours
I	**8086 MICROPROCESSOR** Introductionto8086–Microprocessorarchitecture–Addressingmodes-Instruction set– Assemblylanguageprogramming–ModularProgramming-Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interruptserviceroutines.	9
II	**8086 SYSTEM BUS STRUCTURE AND MULTIPROCESSOR CONFIGURATIONS** Basic8086configurations–Systembustiming–BusStandards–Multiprocessorconfigurations–Coprocessor,CloselycoupledandlooselyCoupledconfigurations –Introductiontoadvancedprocessors.	9
III	**PERIPHERAL DEVICES AND THEIR INTERFACING** Addressspace portioning-Memory InterfacingandI/O interfacing-Parallelcommunicationinterface–Serialcommunicationinterface-D/Aand A/DInterface -Timer -Keyboard/displaycontroller –Interruptcontroller –DMAcontroller	9
IV	**8051 MICROCONTROLLER** Over view of 8051 family-Architecture of 8051 –I/O Pins Ports Circuits and I/OPortProgramming - Instruction set- Addressingmodes - Assembly languageprogramming.	9
V	**8051MICROCONTROLLER INTERFACING WITH PERIPHERAL DEVICE** 8051 Timers Programming - Serial Port Programming - Interrupts Programming – LCD&Keyboard Interfacing-ADC,DAC&Sensor Interfacing-ExternalMemory Interface- Interfacing with 8255- Stepper Motor Interfacing, Practical applications-Water level indicator and Zigbee interfacing.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Write Assembly Language programs using 8086microprocessor.
CO2: Pointout System Bus Structure and Multiprocessor Configuration.
CO3: Analyze the various peripheral devices interfacing with8086microprocessor.
CO4: Modeland implement8051microcontrollerbasedsystems.
CO5: Experiment programson8051 microcontroller for interfacing various peripheral devices.

TEXTBOOKS:

T1 Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family -Architecture, Programming and Design",Second Edition, PrenticeHallofIndia,2007.

T2 MohamedAliMazidi,JaniceGillispieMazidi,RolinMcKinlay,"The8051MicrocontrollerandEmbedded Systems: Using Assembly andC",Second Edition,Pearsoneducation,2011

REFERENCEBOOKS:

R1 DoughlasV.Hall,"Microprocessors and Interfacing, Programming and Hardware,TMH,2012

R2 A.K.Ray,K.M.Bhurchandi,"Advanced Microprocessors and Peripherals"3rd edition,Tata McGraw Hill,2012

R3 N.SenthilKumar,M.Saravanan,S.Jeevananthan,"Microprocessors and Microcontrollers",Oxford University Press,2000.

R4 B.Ram,"Microprocessors and Microcontrollers",8th Edition, DhanpatRai Publications Pvt.Ltd.,2015.

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Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM5204	BIOMEDICAL INSTRUMENTATION	3	0	0	3

Course Objective

I. To Illustrate about the measurement systems.

II. To design bio amplifier for various physiological recordings.

III. Detection of physiological parameters using impedance techniques.

IV. To learn the different measurement techniques form on-physiological parameters.

V. To Summarize different patient safety procedures.

Unit	Description	Instructional Hours
I	**BIOPOTENTIAL ELECTRODES** Origin of biopotential and its propagation.Electrode-electrolyte interface,electrode– skin interface, half-cell potential,impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle andmicro electrodes and their equivalent circuits. Recording problems – measurement with two electrodes.	9
II	**BIOPOTENTIAL MEASUREMENT** Bio signal characteristics– frequency and amplitude ranges. ECG – Einthoven‘striangle, standard 12 lead system, block diagram. Measurements of heart sounds -PCG.EEG–10-20electrode system,unipolar,bipolar and averagemode,Functional block diagram. EMG – unipolar and bipolar mode, blockdiagram,EOG and ERG.	9
III	**BIOPOTENTIAL AMPLIFIER** Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier.Bandpass filtering,isolation amplifiers–transformer and opticalisolation-isolated DC amplifier and AC carrier amplifier. Artifacts and removal.	9
IV	**NONELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT** Temperature,respiration rate and pulserate measurements,Plethysmography,Pulse oximetry, Blood Pressure: direct methods - Pressure amplifiers - systolic,diastolic,mean detector circuit,indirect methods-auscultatory method,oscillometric method,ultrasonic method.Bloodflow-Electromagnetic and ultrasound bloodflow measurement.Cardiac output measurement-Indicator dilution, dyedilution and thermodilution method.	9

V	**BIOCHEMICALMEASUREMENT** Biochemical sensors - pH, pO2 and pCO2, Ion selective Field Effect Transistor(ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors – Blood gas analyzers, colorimeter,flame photometer,spectro photometer,bloodcell counter,auto analyzer.	9
	Total Instructional Hours	**45**

Course Outcome

CO1:To understand the various concepts of measurement systems.
CO2: To understand the method of designing bio amplifiers.
CO3:To understand about the Detection of physiological parameters using impedance techniques.
CO4: To understand about measurement of non electric parameter.
CO5:To understand about Patient safety and electromedical equipment.

TEXTBOOKS:

T1-JosephJ.CarrandJohnM. Brown,"Introduction to Biomedical Equipment Technology",Pearson Education India,Delhi,2004

T2-.Cromwell,"Biomedical Instrumentation and Measurements",Prentice Hall of India,New Delhi,2007.

REFERENCE BOOKS:

R1- Khandpur .R.S., "Handbook of Biomedical Instrumentation ",Prentice Hall of India, New Delhi,2003.

R2- Jacobson Band Webster J G Medical and Clinical Engineering–Prentice Hall of India New

R3- John.G.Webster. "Medical Instrumentation, Application and Design "Fourth Edition. Wiley & sons, Inc, New York.2011.

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Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM5251	VIRTUAL INSTRUMENTATIONUSING LabVIEW	2	0	2	3

Course Objective

Understand the fundamentals of Virtual Instrumentation.

1. Idea behind the software used inVirtual Instrumentation and its functions
2. To familiarize with the basic programming and working concept in LabVIEW.
3. Acquire biological data and develop applications using LabVIEW.

UNIT	Description	Instructional Hours
I	**INTRODUCTION** Virtual Instrumentation Architecture,Conventional Virtua lInstruments, Distributed Virtual Instruments, Virtual instruments Vs Traditional Instruments,Advantages of VI,Evolution LabVIEW.	9
II	**INTRODUCTION TO LabVIEW AND ITS PROGRAMMING MODES** Front Panel and Block Diagram of LabVIEW, LabVIEW environment and itsMenus,PalletsofLabVIEW,CreatingVIusingLabVIEW,Loops,Arrays,Clusters,Strings,Registers,Structures,Nodes,ControlsandIndicators for clusters and strings, Waveform chart and Graph types and File I/O.**Experiments:** *1. Basic operations,controls and Indicators.* *2. Simple programming structures and Timing Issues.*	6+(3)P
III	**HARDWARE INSTRUMENT CONTROLS** Virtual Instruments Software Architecture (VISA), Digital I/O techniques,Data Acquisition in LabVIEW, DAQ Hardware Installation and configuration, DAQ Hardware Sampling and Grounding Techniques, Analog and DigitalI/O,Counter/Timer,Network data acquisition techniques. **Experiments:** *1.Data Acquisition using Virtual instrumentation from temperature/vibration Transducer.*	6+(3)P
IV	**I TOOLKITS** Biomedical toolkit, Signal Processing Tools-Fourier Transform, Power Spectrum,Correlation,Windowing,Filters,Digital Filter Design Toolkit,	6+(3)P

Control System DesignToolkit, Communication DesignToolkit, Vision And MotionTools,Image processingToolkit.

Experiments:

1. *Computerized data logging of ECG signal and find the heart beat rate using LabVIEW*
2. *Acquisition of PCG,EMG Signal*

V **BIOMEDICALAPPLICATIONUSINGLabVIEW** 9

Case study: Process Control and Automation Application, Biomedical application,robotics application,IoT application using LabVIEW,Real Time acquisition of ECG,EMG,PCG and EEG signals.

Total Instructional Hours 45

CO1	Analyze Virtual Instruments in Healthcare Domain
CO2	Explain Virtual Instruments process and software.
CO3	Illustrate concepts of LabVIEW in Realtime application.
CO4	Use DAQ for data acquisition and VI Toolkits for analysis.
CO5	Outline various research applications using LabVIEW.

TEXTBOOKS:

1. John Essick,"Hands-On Introduction to LabVIEW for Scientists and Engineers",Oxford University Press,Fourth edition,2018.
2. Sanjay Gupta, Joesph John,"Virtual Instruments using LabVIEW", TATA Mc Graw Hill, New Delhi,2017.

REFERENCES:

1. Ronald W.Larsen,"LabVIEW for Engineers",Pearson,First edition,2010.
2. Robert H.Bishop,"Learning with LabVIEW",Pearson, First edition, 2014.

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Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM5001	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	0	0	3	1.5

Description of the Experiments

1. Simple arithmetic operations: addition/subtraction/multiplication/division.
2. Programming with control instructions:
(i) Ascending/Descending order, Maximum/Minimum of numbers.
(ii) Programs using Rotate instructions.
(iii) Hex/ASCII/BCD code conversions.
3. Interface Experiments:with8085
(i)A/D Interfacing. & D/A Interfacing.
4. Traffic light controller.
5. I/O Port /Serial communication
6. ProgrammingPracticeswithSimulators/Emulators/opensource
7. Readakey,interface display
8. Demonstration of basic instructions with 8051Microcontroller execution,including:
(i)Conditional jumps, looping
(ii)Calling sub routines.
9. Programming I/O Port8051
(i)study on interface with A/D&D/A
(ii)study on interface with DC & AC motor.
10. Miniproject development with processors.

Practical Hours:45

Course Outcome

CO1: understand the basic arithmetic operations in8085.
CO2: Ability to understand and analyze, about 8085microprocessor
CO3: understanding of various interfacing techniques in microcontrollers
CO4: understand the basic arithmetic operations in 8051
CO5: Analyze and demonstrate an mini project using microcontroller.

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BE	**21BM5002**	**BIOMEDICAL INSTRUMENTATION LABORATORY**	**0**	**0**	**3**	**1.5**

Description of the Experiments

1.To study the different types of electrodes.

2.To study the Electrocardiogram System.

3.Bedside monitor

4.Evoked Potential Monitoring System(With Auditory,Photic and Electric Stimulus)

5.Measurement of pulse-rate using Photo transducer.

6.Measurement of pH and conductivity.

7.Surgical diathermy.

8.GSR Measurement setup with Software and Accessories(PC based)-Without PC Workstation.

9.Ultrasound DopplerBlood FlowMonitor.

10.TostudyPlethysmographSystem.

11.TostudyPhonocardiographSystem.

12. To study X-ray produced by X-raymachine.

Practical Hours:45

Course Outcome

CO1: Identify various Bio-potential and their specifications interms of amplitude and frequency.

CO2: Understand principle and working of various Biomedical Instruments for vital parameter monitoring.

CO3: Decide the applications of therapeutic instruments for treatment purpose.

CO4: Understand applications of imaging instruments and the modalities involved in each technique.

CO5: Understand applications of imaging instruments and the modalities involved in each technique.

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SEMESTER VI

Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM6201	BIO SIGNAL PROCESSING	3	1	0	4

Course Objective

1. To introduce the concept of analyzing discrete time signals and systems in the time and frequency domain through mathematical representation.
2. To study various time to frequency domain transformation techniques
3. To Understand the implementation of the DFT in terms of the FFT, as well as some of its applications (computation of convolution sums, spectral analysis).
4. To learn the basic design and structure of FIR and IIR filters with desired frequency responses and design digital filters.
5. To learn ECG and EEG signal processing.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO DIGITAL SIGNAL PROCESSING** Classification of signals - Basic concepts of digital signal processing - Digital signal processing applications - Representation of discrete-time signals - Elementary discrete-time signals - Classifications of discrete-time signals - Basic operations on signals - Classification of discrete-time systems: static - causal - linear - time-invariant - Review of sampling and reconstruction – Anti-aliasing filtering.	9
I	**Z-TRANSFORM** Definition - Properties of the Z-Transform - Inverse Z-Transform - Partial Fraction Expansion - Difference Equations using Z-Transform	9
III	**DISCRETE AND FAST FOURIER TRANSFORMS** Discrete Fourier Transforms (DFT) - Properties of DFT - Linear Convolution of Sequences using DFT - Computation of DFT - Over-lap Add Method - Over-lap Save Method. Fast Fourier Transforms (FFT) - Radix-2 Decimation-in-Time and Decimation-in-Frequency FFT Algorithms.	9
IV	**IIR AND FIR DIGITAL FILTERS** IIR Digital Filters: Analog Filter Approximations - Butterworth and Chebyshev - Design of IIR Digital filters from Analog Filters - Bilinear Transformation Method. FIR Digital Filters: Design of FIR Filters using Window Techniques - Comparison of IIR & FIR filters.	9
V	**CARDIOLOGICAL AND NEUROLOGICAL SIGNAL PROCESSING** Cardiological signal processing: ECG signal characteristics (parameters and their estimation) - Analog filters - ECG amplifier - and QRS detector - Portable arrhythmia monitor. Neurological signal processing: EEG signal and its characteristics (EEG rhythms, waves, and transients) – Correlation - Analysis of EEG channels - Detection of EEG rhythms.	9
	Total Instructional Hours	45

Course Outcome

CO1	Ability to understand signals and systems by their mathematical representation.
CO2	Ability to do system representation using transforms.

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CO3 Understand the significance of various filter structures and effects of rounding errors.
CO4 Design a digital filter for a given specification.
CO5 Understand the ECG and EEG signal processing.

TEXT BOOKS:

T1 D. C Reddy, "Biomedical Signal Processing, Principles and Techniques", Tata McGraw Hill Publishing Company Limited, First Edition, 2005

T2 John G Proakis & Dimitris G Manolakis: Digital Signal Processing – Principles, Algorithms and Applications, Prentice Hall of India, 2005.

REFERENCE BOOKS:

R1 Andreas Antonion: Digital Filters Analysis & Design, Prentice Hall of India, 2002.

R2 P. Ramesh Babu: Digital Signal Processing, Scitech Publications,India 2004.

R3 Alan V. Oppenheim & Ronald W Schafer: Digital Signal Processing, Prentice Hall of India, 2004.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
CO2	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
CO3	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
CO4	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
CO5	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
AVG	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-

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Programme/Sem B.E./B.Tech./VI	Course Code	Name of the Course	L	T	P	C
	21BM6202	RADIOLOGICAL EQUIPMENTS AND NUCLEAR MEDICINE	3	0	0	3

Course Objective

Understand generation of x-rays and its uses in imaging.
Learn different types of radio diagnostic techniques.
Know techniques used for visualizing different sections of the body.
Understanding about different nuclear imaging techniques.
Learn radiation therapy methodologies and the radiation safety.

Unit	Description	Instructional Hours
I	**MEDICAL X-RAY EQUIPMENT** Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Digital Radiography- discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, cineAngiography. Digital subtraction Angiography. Mammography.	9
II	**COMPUTED TOMOGRAPHY** Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors-Viewing systems- spiral CT scanning – Ultra fast CT scanners. Image reconstruction techniques- back projection and iterative method.	9
III	**MAGNETIC RESONANCE IMAGING** 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- system magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.	9
IV	**NUCLEAR MEDICINE SYSTEM** Radio Isotopes- alpha, beta, and gamma radiations. Radio Pharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GMcounter and scintillation Detectors, Gamma camera- Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit, pulse height analyzer.Principles of SPECT and PET.	9
V	**RADIATION THERAPY AND RADIATION SAFETY** Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT,-Recent Techniques in radiation therapy - 3DCRT – IMRT – IGRT and Cyber knife- radiation measuring instruments-Dosimeter, film badges, Thermo Luminescentdosimeters- electronic dosimeter- Radiation protection in medicine- radiation protection principles	9
	Total Instructional Hours	45

Course Outcome

CO1: Understand the fundamentals and applications of Radiological Equipments such as X-Ray machine.
CO2: Understand the fundamentals and applications of Radiological Equipments such as CT.
CO3: Understand the fundamentals and applications of Radiological Equipments such as MRI.
CO4: Develop technical knowledge of Radiology so that he/she will be able to assist a Radiologist in every Aspect of Radiological Imaging.
CO5: Understand the fundamentals and applications of Radiation therapy and radiation safety.

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TEXT BOOKS:

T1 Steve Webb, The Physics of Medical Imaging, Adam Hilger, Philadelpia, 2008 (Units I, II, III &IV).

T2 R.Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss,2002.

REFERENCE BOOKS

R1 Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine"- Third edition Springer, 2006.

R2 B.H.Brown, PV Lawford, R H Small wood, D R Hose, D C Barber, "Medical physics and biomedical Engineering", - CRC Press, 1999.

R3 Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.

R4 P.Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	2	2	-	-	3	3	-	-	-	-	2	3	3	3
CO2	3	2	2	-	-	3	3	-	-	-	-	2	3	3	3
CO3	3	2	2	-	-	3	3	-	-	-	-	2	3	3	3
CO4	3	2	2	-	-	3	3	-	-	-	-	2	3	3	3
CO5	3	2	2	-	-	3	3	-	-	-		2	3	3	3
AVG	3	2	2	-	-	3	3	-	-	-	-	2	3	3	3

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Programme/Sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech./VI	21HE6203	ENTREPRENEURSHIP DEVELOPMENT	3	0	0	3

Course Objective

To become familiar entrepreneurship development
To learn concepts of creativity and innovation.
To learn steps in developing business model.
To studyabout appraisal of projects.
To become familiar different forms ofbusiness organisations

Unit	Description	
I	**INTRODUCTION TO ENTREPRENEURSHIP** Definition – Characteristics and Functions of an Entrepreneur – Common mythsabout entrepreneurs – Importance or Entrepreneurship. Seminar in R5 & R6.	6
II	**CREATIVITY AND INNOVATION:** The role of creativity – The innovation Process – Sources of New Ideas – Methods of Generating Ideas – Creative Problem Solving – Entrepreneurial Process.	6
III	**DEVELOPING AN EFFECTIVE BUSINESS MODEL:** The Importance of a Business Model – Starting a small scale industry -Components of an Effective Business Model.	6
IV	**APPRAISAL OF PROJECTS:** Importance of Evaluating Various options and future investments-Entrepreneurship incentives and subsidies – Appraisal Techniques.	6
V	**FORMS OF BUSINESS ORGANIZATION::** Sole Proprietorship – Partnership – Limited liability partnership - Joint StockCompanies and Cooperatives..	6
	Total Instructional Hours	45

Course Outcome

CO1: Know and understand the basics of entrepreneurship development.CO2: Understand the role of creativity in entrepreneurship development. CO3: Understand the concepts of developing an effective business model.CO4: Learn the basics of appraisal of projects.
CO5: Understand the different forms ofbusiness organisations

TEXT BOOKS:

1. Donald F.Kuratko and Richard M. Hodgetts, —Entrepreneurshipl, South-Western.
2. Vasant Desai, —The Dynamics of Entrepreneurial Development and Managementl, HimalayaPublishing House, 2010.

REFERENCES:

1. Gupta S.L., Arun Mittal, —Entrepreneurship Developmentl, International Book House, 2012.
2. Sudha G. S., —Management and Entrepreneurship Developmentl, Indus Valley Publication,2009.
3. Badi V., Badi N. V., —Business Ethicsl, R. Vrinda Publication (P) Ltd., 2012.
4. Prasanna Chandra, —Projects- Planning, Analysis, Financing, Implementation and reviewl,TATA McGraw Hill, 2012.

ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	-	-	-	-	2	2	-	-	2	2	3	-	-	-	2
CO2	-	-	-	-	2	2	-	-	2	2	3	-	-	-	2
CO3	-	-	-	-	2	2	-	-	2	2	3	-	-	-	2
CO4	-	-	-	-	2	2	-	-	2	2	3	-	-	-	2
CO5	-	-	-	-	2	2	-	-	2	2	3	-	-	-	2
AVG	-	-	-	-	2	2	-	-	2	2	3	-	-	-	2

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Programme/Sem	Programme	Course Code	Name of the Course	L	T	P	
B.E./B.Tech./VI	BE	21BM6251	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT – I	3	0	2	3

Course Objective

1. Gather basic knowledge about measurements of parameters related to patient monitoring.
2. Learn techniques of blood gas analyzers and oximeters.
3. Understand blood rheology parameters.
4. Know ultrasound imaging technique and its use in diagnosis .
5. Know the importance of patient safety against electrical hazard .

Unit	Description	Instructional Hours
I	**PATIENT MONITORING SYSTEMS** System concepts- Cardiac monitor- selection of system parameters-Bedside monitors-Central monitors- Heart rate meter- Pulse rate meter- Holter monitor andCardiac stress test- Cardiac cauterization instrumentation- Organization and equipments used in ICCU & ITU. **Experiments:** *Measurement of various biological signals using bedside monitors.* *Analysis of ECG, EEG and EMG signals.*	9
II	**BLOOD GAS ANALYZERS AND OXIMETERS** Blood pH measurement, Blood pCO2 measurement, Blood pO2 measurement, a complete blood gas analyzer-Fiber optic based blood gas sensors, Oximetry- Principles of oximetric measurements-Ear oximeter- Pulse oximeter- Intravascular oximeter. **Experiments:** *Recording of Audiogram. Measurement of pH and conductivity.*	9
III	**EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES** Need for heart lung machine, Functioning of bubble, Disc type and membrane type oxygenators, finger pump, roller pump. Hemodialyser unit, Peritoneal dialyser unit, Thermography – Recording Principle and clinical application. **Experiments:** *To study the working of heart lung machine.To study the working of Hemodialysis unit.*	9

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IV	**CORONARY CARE EQUIPMENTS** Cardiac pacemakers: different modes of operation- external and implantable pacemakers-pacemaker standard codes -Defibrillator: AC and DC defibrillator - Implantable defibrillator and automated external defibrillator(AED) - Pacer- cardioverter defibrillator-defibrillator analysers - Heart lung machine (HLM) and types of oxygenators. **Experiments:** *Study the working of Defibrillator and pacemakers.* *Study of heart lung machine model.*	9
V	**SURGICAL AND THERAPEUTIC EQUIPMENTS** Surgical diathermy unit - Endoscopy basic components and types – Laparoscope-gastro scope- bronchoscope - Cryogenic techniques and application - Operating microscope- arthroscopy - Modern lithotripter system- laser lithotripsy. **Experiments:** *Analyze the working of ESU – cutting and coagulation modes.Study of hemodialysis model*	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Explain about measurements of parameters related to Patient Monitoring Systems.
CO2: Describe the measurement techniques of Blood gas analyzers and Oximeters.
CO3: Analyze different types and uses of Blood cell counters and Blood Flow meters
.CO4: Discuss about the various coronary care equipments used in hospitals.
CO5: Outline the different surgical and therapeutic equipments used in hospitals .

TEXT BOOKS:

T1 Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.

T2 Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, NewDelhi, 2007

REFERENCE BOOKS:

R1 Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education,2004.

R2 L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.

R3 John G. Webster, "Bioinstrumentation", John Willey and sons, New York, 2004.

ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
CO2	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
CO3	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
CO4	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
CO5	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
AVG	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3

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Programme/Sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech./V	21BM6001	BIOSIGNAL PROCESSING LABORATORY	0	0	3	1.5

Description of Experiments

1. MATLAB familiarization
2. Acquisition of bio signals to the system
3. Implementation of filters.
4. Processing of ECG signals for acquiring parameters like heart rate, QRS complex, P wave etc
5. Arrhythmia analysis.
6. Analysis of plethysmographic signal.
7. Automated detection of systolic and diastolic pressure from cuff pressure and peripheral pulse.
8. Signal Classification using neural networks.
9. 50 Hz interference rejection in ECG signals.
10. Event detection in EEG signals
11. Spectral analysis of EEG, EMG signals.

ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
CO2	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
CO3	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
CO4	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
CO5	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
AVG	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	19HE6071	Soft Skills - II	0	0	0	1

Course Objectives:

1. To make the students aware of the importance, the role and the content of softskills through instruction, knowledge acquisition, demonstration and practice.
2. To learn everything from equations to probability with a completely different approach.
3. To make the students learn on an increased ability to explain the problem comprehensively.

Unit	Description	Instructional Hours
I	**Group Discussion & Presentation Skills:** GD skills – Understanding the objective and skills tested in a GD – General types of GDs – Roles in a GD – Do's & Don'ts – Mock GD & Feedback.- Presentation Skills – Stages involved in an effective presentation – selection of topic, content, aids – Engaging the audience – Time management – Mock Presentations & Feedback	7
II	**Interview Skills and Personality Skills:** Interview handling Skills – Self preparation checklist – Grooming tips: do's & don'ts – mock interview & feedback - Interpersonal skills-creative thinking-problem solving-analytical skills	5
III	**Business Etiquette & Ethics:** Etiquette – Telephone & E-mail etiquette – Dining etiquette – do's & Don'ts in a formal setting – how to impress. Ethics – Importance of Ethics and Values – Choices and Dilemmas faced – Discussions from news headlines.	6
IV	**Quantitative Aptitude:** Permutation, Combination - Probability - Logarithm - Quadratic Equations - Algebra - Progression - Geometry - Mensuration.	6
V	**Logical Reasoning:** Logical Connectives - Syllogisms - Venn Diagrams – Cubes - Codedinequalities - Conditions and Grouping	6

Course Outcome:

CO1: Students will have learnt to keep going according to plan, coping with theunfamiliar, managing disappointment and dealing with conflict.

CO2: Students will Actively participate meetings, Group Discussions / interviews and prepare & deliver presentations

CO3: Students will define professional behavior and suggest standards for appearance, actions and attitude in a Business environment

CO4: Students will be able to apply quantitative reasoning and mathematical analysis methodologies to understand and solve problems.

CO5: Students will excel in complex reasoning.

REFERENCE BOOKS:

R1: Bridging the Soft Skills Gap: How to Teach the Missing Basics to Todays Young Talent- Bruce Tulgan

R2: Quantitative Aptitude for Competitive Examinations (5th Edition) - Abhjit Guha

R3: How to crack test of Reasoning - Jaikishan and Premkishan

R4: The hand on guide to Analytical Reasoning and Logical Reasoning - Peeyush Bhardwaj

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SEMESTER VII

Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM7201	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT – II	3	0	0	3

Course Objective

1. Gather basic knowledge about measurements of parameters related to respiratory system.
2. Learn measurement techniques of sensory responses and Hearing Aid Equipments.
3. Understand different types and uses of diathermy units.
4. Know ultrasound imaging technique and its use in diagnosis .
5. Know the importance of patient safety against electrical hazard .

Unit	Description	Instructional Hours
	INSTRUMENTS DEALING WITH BONES AND RESPIRATORY CARE	
I	Respiratory care equipments: humidifier, nebulizer, aspirators - Ventilators and types- Capnography -Anesthesia machine - Baby incubator-BMD measurements- Single X-ray Absorptiometry (SXA) -Dual X-ray Absorptiometry (DXA) - Quantitative ultrasound- bone densitometer.	9
	SENSORY DIAGNOSIS AND HEARING AID EQUIPMENTS	
II	Mechanism of hearing, sound conduction system - basic audiometer, pure tone audiometer - Speech audiometer, Bekesy audiometer system - Evoked response audiometry system - Hearing aids-cochlear implants - Tonometry - Measurement of basal skin response and galvanic skin response.	9
	DIATHERMY	
III	Short wave diathermy -Microwave diathermy -Ultrasonic therapy unit -Electro diagnostic and therapeutic apparatus -Interferential current therapy- Transcutaneous electrical nerve stimulation(TENS)-Spinal cord stimulator-bladder stimulator-deep brain stimulation - Photo therapy unit	9

	ULTRASONIC TECHNIQUE	
IV	Characteristics of sound- interactions of ultrasound with matter -Ultrasound transducers- ultrasound beam properties-image data acquisition -Modes of image display and storage - Doppler ultrasound-Ultrasound doppler blood flow meter -Ultrasonography in emergency cardiovascular care - Echocardiogram- Echoencephalogram	9
	PATIENT SAFETY	
V	Physiological effects of electricity – important susceptibility parameters – Macro shock – Micro shock hazards – Patient's electrical environment – Isolated Power system – Conductive surfaces- Electrical safety codes and standards – IEC 60601-1 2005 standard, Basic Approaches to Protection against shock, Protection equipment design, Electrical safety analyzer – Testing the Electric system.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Explain about measurements of parameters related to respiratory system.
CO2: Describe the measurement techniques of sensory responses.
CO3: Analyze different types and uses of diathermy units.
CO4: Discuss ultrasound imaging techniques and its usefulness in diagnosis.
CO5: Outline the importance of patient safety .

TEXT BOOKS:

T1 Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.

T2 Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007

REFERENCE BOOKS:

R1 Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.

R2 L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.

R3 John G. Webster, "Bioinstrumentation", John Willey and sons, New York, 2004.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	19BM7202	MEDICAL IMAGE PROCESSING	3	0	0	3

Course Objective

6. To become familiar with digital image fundamentals
7. To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
8. To learn concepts of degradation function and restoration techniques.
9. To study the image segmentation and representation techniques.
10. To become familiar with image compression and recognition methods

Unit	Description	Instructional Hours
I	**DIGITAL IMAGE FUNDAMENTALS** Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.	9
II	**IMAGE ENHANCEMENT** Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.	9
III	**IMAGE RESTORATION** Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering	9
IV	**IMAGE SEGMENTATION** Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.	9
V	**IMAGE COMPRESSION AND RECOGNITION** : Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.	9
	Total Instructional Hours	**45**

Course Outcome	CO1: Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms. CO2: Operate on images using the techniques of smoothing, sharpening and enhancement. CO3: Understand the restoration concepts and filtering techniques. CO4: Learn the basics of segmentation, features extraction, compression and recognition methods for color models. CO5: Able to analyze image compression and recognition methods

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, _Digital Image Processing‘, Pearson, Third Edition, 2010.
2. Anil K. Jain, _Fundamentals of Digital Image Processing‘, Pearson, 2002.

REFERENCES:

1. Kenneth R. Castleman, _Digital Image Processing‘, Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, _Digital Image Processing using MATLAB‘, Pearson Education, Inc., 2011.
3. D,E. Dudgeon and RM. Mersereau, _Multidimensional Digital Signal Processing‘, Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, _Digital Image Processing‘, John Wiley, New York, 2002
5. Milan Sonka et al _Image processing, analysis and machine vision‘, Brookes/Cole, Vikas Publishing House, 2nd edition, 1999

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Course code	HOSPITAL MANAGEMENT	L	T	P	C
19BM7203		3	0	0	3

Course Objective:

The student should be made to:

To understand the fundamentals of hospital administration and management
To learn the types of codes followed and applications
To explore various information management systems and relative supportive services
Learn the procedures of Clinical Engineering
To learn the quality and safety aspects in hospital

Course Outcomes:

At the end of this course, students will be able to

Explain the principles of Hospital administration.
Classify the types of codes followed and applications
Identify Information management systems and its uses.
Understand procedures of Clinical Engineering
Understand safety procedures followed in hospitals.

UNIT I Overview of Hospital Administration 9 Hours

Distinction between Hospital and Industry, Challenges in Hospital Administration– Hospital Planning- Equipment Planning – Functional Planning - Current Issues in Hospital Management –Telemedicine - Bio-Medical Waste Management.

UNIT II Regulatory And Voluntary Guidelines And Health Care Codes 9 Hours

FDA Regulation, Joint Commission of Accreditation for Hospitals, National Fire Protection Association Standard, ISO, NABL, ISO:13485, ISO:14791, risk management, Environmental regulation.

Case study on risk management.

UNIT III Hospital Information Systems & Supportive Services 9 Hours

Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems — Medical Transcription, Medical Records Department – Central Sterilization and Supply Department

Pharmacy– Food Services - Laundry Services

UNIT IV Clinical Engineering 9 Hours

Role to be performed in Hospital, Manpower & Market, Professional Registration, Maintenance ofHospital support system, surveillance network, electric power management, Medical gas production,

waste disposal, inventory control. Case study: RF ID tag for inventory.

UNIT V Safety Equipment's 9Hours

Operation of safety devices, personnel safety equipment's, Gas mask, Radiation measurements,

equipment safety systems, elements of basic first aid, firefighting, Case study: Safety Awareness.

Total Lectures45 Hours

Text Books

1. R.C.Goyal, ―Hospital Administration and Human Resource Management‖, PHI –

Fourth Edition,2006.
2. G.D.Kunders, ―Hospitals – Facilities Planning and Management – TMH, New Delhi – FifthReprint 2007
3. Webster.J.G. and Albert M.Cook, "Clinical Engineering Principles and Practices Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979.

Reference Books

1. Robin Guenther, Gail Vittori, "Sustainable Healthcare Architecture", Wiley, 2013
2. Sharma D K, R.C.Goyal, "Hospital administration and human Resource Management in Hospital", Prentice Hall of India, New Delhi, 2017
3. Syed Amin Tabish "Hospital and Health services Administration Principles and Practices" Oxford Press, New Delhi, 2001

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BE 19BM7001 IMAGE PROCESSING LABORATORY 0 0 3 1.5

Description of the Experiments

1. To perform basic operations on images.
2. To perform histogram equalization.
3. To perform image filtering in spatial domain.
4. To perform image filtering in frequency domain.
5. To perform image restoration.
6. To perform image compression using DCT / Wavelet transform.
7. To perform edge detection using various masks.
8. To perform global and adaptive thresholding.
9. To apply morphological operators on an image.
10. To obtain boundary / regional descriptors of an image.
11. To perform image classification / recognition

Note: It is suggested to carry out the above experiments by Matlab / C programming on diagnostic images such as x-ray / CT / MRI / Ultrasound.

Total Practical Hours: 45

Course Outcome

CO1: Develop and implement algorithms for image enhancement and restoration

CO2: Observe filtering in spatial and frequency domain

CO3: Apply image compression

CO4: Develop programs for image segmentation and classification

CO5: Analyze the different filtering techniques on images.

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E	19BM7002	DIAGNOSTIC AND THERAPEUTIC MEDICAL EQUIPMENT LABORATORY	0	0	2	1.5

Course Objective
1: To demonstrate recording and analysis of different Bio potentials.
2: To examine different therapeutic modalities.

Ex.No	DESCRIPTION
1	To study and demonstrate the working of TENS & Ultrasound Therapy Unit.
2	Acquisition of blood flow graph using PC based Vascular Doppler.
3	To study and demonstrate the working of Baby Incubator.
4	To study and demonstrate the working of Radiant heat warmer & Phototherapy.
5	Recording of lung flow, volume and capacities graph using PC based Spirometer.
6	To study and demonstrate the working of Respiratory Ventilator.
7	To study the working of Ultrasound Scanner.
8	To demonstrate the working of Video Endoscopy system.
9	To perform the operation of Drug Delivery Device.
10	To acquire vital parameters from Real time Patient Monitoring System.
11	To perform the sterilization using Autoclave.
12	To demonstrate the Pacemaker System with Patient Simulator

TOTAL INSTRCTIONAL HOURS 45

Course Outcome

CO1: Describedesignrequirements ofbasicbiomedicalsystem used for therapy

CO2: Expressthemeasurementmethods availableformeasuringrespiration rateand heartsound.
CO3: Designof ultrasound scanning system and baby incubator system
CO4: Analyzedrug delivery systems and visualization of internal organs
CO5: Designreal time patient monitoring system and sterilization techniques
CO6: Developand stimulate the pacemaker system.

TEXTBOOKS

1.RobertB.Northrop, "Analysisand ApplicationofAnalogElectronicCircuitstoBiomedical Instrumentation",CRCPRESS,2012.
2.R.S.Khandpur,"HandbookofBio-Medicalinstrumentation",TataMcGrawHillPublishingCoLtd,New Delhi,2015.

REFERENCES

1.JosephE.Parrillo,"CriticalCareMedicine:PrinciplesofDiagnosisandManagementintheAdult",Elsevier 4th edition, 2014.

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PROFESSIONAL ELECTIVE I

PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E/B.Tech	21BM5301	**MEDICAL PHYSICS**	**3**	**0**	**0**	**3**

Course Objective

1. To apply the basic concept of radiation physics
2. To Know about the genetic effect and Optical radiation principle
3. Students should know about the fundamentals of Radiation saftety.

UNIT	DESCRIPTION	TOTAL INSTRUCTIONAL HOURS
I	**BASICS OF RADIATION PHYSICS** Atomic Structure - Nuclear Transformation - Radioactivity and Interaction;electromagneticradiation,chargedparticlesandneutrons-Radiationattenuation coefficients – Principle of Radiation dosimetric device - cavitytheories Bremsstrahlung effect, Annihilation Interaction of X and Gammaradiation with matter- Compton Scattering , Pair production -Non IonizationmedicalRadiationphysics-Penetrationandpropagationofsignaleffectsin variousvitalorgans.	9
II	**MOLECULAR PHYSICS AND GENETIC EFFECTS** Introduction- Molecular biophysics - Phases of matter – GIBBS law – TheHagen-poiseuillelaw– StrokesLaw–Raoultlaw–Osmoticpressure–Diffusion–Phaseborderphenomena.GeneticEffects-EffectsonDNA damage,embryo,Chromosomaldamage-factorsaffectingfrequencyofradiationinducedmutation-Genecontrolledhereditarydiseases.	9
III	**ACOUSTICS AND OPTICAL RADIATION** Introduction of Acoustics and properties – Doppler effect- Piezo electriceffect-weber-Fechnerslaw–Effectsofultrasoundintissues-Shockwaves – Propagation of light – Light scattering - Photo Medicine –Various types ofopticalradiations-Opticalpropertiesoftissues,applicationsofopticalradiations.	9
IV	**INTERACTION OF NUCLEAR PHYSICS** Principles of Nuclear Physics – Natural radioactivity, Decay series, type of radiation and their properties. Production of artificial isotopes – acceleratorprinciples:Betatron,Cyclotron.fissionandelectronCapturereaction, radionuclideGenerator-Technetiumgenerator–Applicationsofartificial Isotopes and Radio nuclides in Nuclear Medicine and biology.	9

V	**RADIATIONONCOLOGY&SAFETY** Introduction-exposure-Inversesquarelaw-KERMA-BremsstrahlungradiBragg'scurve-PrinciplesofMPD,ADELandALARA-concept of LD Gammaknife–LINAC–Chemotherapy–Brachytherapy–Dosimeter–RaddetectorandTypes–RadiationsafetyandItsPrinciple	9
	TOTAL INSTRCTIONAL HOURS	**45**

CO1: Analyze the physics of Radiation.
CO2: Understand the use of molecular and Genetic Engineering.
CO3: Understand principles of Acoustics and Optical radiation
CO4: analyze the interaction methods of Nuclear Physics.
CO5: understand the basics of radiation Oncology and safety principles.

TEXTBOOKS

. 1. Daniel Jirak, Frantisek Vitek Basics of Medical Physics.
2. MoumitaMukherjee ,J.K. Mandal, Advance in medical Physics and healthcare Engineering, Springers Singapore,2021.

REFERENCES

1. P.Uma Devi, A.Nagarathnam ,B S Satish Rao,"Introduction to Radiation Biology" B.IChurChillLivingstonepvtLtd,2000.
2. S.Webb" The Physics of Medical Imaging", Taylor and Francis,
2018.3.J.P.Woodcock,Ultrasonic,MedicalPhysicsHandbookseries1, AdamHilger,Bristol.

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Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM5302	Robotics in Medicine	3	0	0	3

Course Objectives:

1.To study the characteristics of robotics.
2.To understand the response of actuators and gripper.
3.To learn about the pneumaticmanipulators
4.To know the compatibility and functioning power source and sensors

UNIT I INTRODUCTION OF ROBOTICS 9

Introduction to Robotics and his history, Overview of robot subsystems, Degrees of freedom,Configurations-Automation,Mechanisms and movements,Dynamic stabilization-Applicationof robotics in medici

UNIT II ACTUATORS AND GRIPPERS 9

Pneumatic and hydraulic actuators, stepper motor control circuits, End effectors, Various types of Gripper and methods, Design consideration in vacuum and, PD and PID feedback actuator models.

UNIT III MANIPULATORS AND BASIC KINEMATICS 9

Constructionof Manipulators,Electronicand pneumaticmanipulator,Forward Kinematic,InverseKinematics.

UNIT IV POWER SOURCE AND SENSORS 9

Sensors and controllers,Internal and external sensors,position,velocity and acceleration sensors, Proximity sensors, force sensors, laser range finder, LASER – Acoustic , Magneticfibreoptic and Tactilesensor.

UNIT V ROBOTICS APPLICATION IN MEDICAL FIELD 9

DaVinci Surgical system,Image guided robotic system in USG,Robotic Tele-surgical system .Urologic applications,Cardiac(CABG)surgery,Neurosurgery,Paediatric,and general–Surgery,Gynaecologic Surgery,Laparoscopy,General Surgery and Nanorobotics.

TOTAL: 45 PERIOD

COURSE OUTCOMES:

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

CO1: Analyze different types of materials and its application in Robotics
CO2: Choose materials for design of Robotics.
CO3: Evaluate response of robotic in medical field.
CO4: Assess compatibility and functioning of robots
CO5: Design and develop robots for biomedical application.

TEXTBOOKS

1. Nagrath and Mittal, "Robotics and Control", Tata Mc Graw-Hill, First edition,2003.
2. Spong and Vidhyasagar, "RobotDynamicsandControl",JohnWiley and Sons,First edition,2008.
3. Fu.K.S. Gonzalaz.R.C., Lee C.S.G," Robotics Control", sensing , Vision and Intelligence, Tata McGrawHillInternational, Firstedition, 2008.

REFERENCES

1. How ie Choset, kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and SebastianThurn,"Priniples of robot motion:Theory,Algorithms,and Implementations",Prentice hall of India,First edition,2005
2. Jacob Rosen, Blake Hannaford & Richard M Satava, " Surgical Robotics: System

   Applications&Visions",Springer2011

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	21BM5303	TOTAL QUALITY MANAGEMENT	3	0	0	3

Course Objectives

Up on completion of this course, the students will be familiar with

1. To facilitate the understanding of Quality Management framework.
2. Understand TQM principles.
3. Learn TQM Tools and Techniques.
4. Know Quality Function Deployment(QFD),Taguchiquality loss function.
5. Understand Quality Management System.

Unit	Description	Instructional Hours
	INTRODUCTION	
I	Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQMFramework-ContributionsofDeming,JuranandCrosby-BarrierstoTQM-Customer focus-Customer orientation,Customer satisfaction,Customer complaints,Customer retention.	9
	TQM PRINCIPLES	
II	Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employeeinvolvement-Motivation,Empowerment,TeamandTeamwork,RecognitionandReward,Performanceappraisal-Continuousprocess improvement-PDCA cycle,5S,Kaizen-Supplierpartnership-Partnering,Supplierselection,SupplierRating.	9
	TQM TOOLS AND TECHNIQUES I	
III	The seven traditional tools of quality - Newmanagement tools - Six sigma:Concepts, Methodology, applications to manufacturing, service sector includingIT-Benchmarking-Reasontobenchmark,Benchmarkingprocess-FMEA-Stages,Types.	9
	TQM TOOLS AND TECHNIQUES II	
IV	QualityCircles-CostofQuality-QualityFunctionDeployment(QFD)-Taguchiqualitylossfunction-TPM-Concepts,improvementneeds-Performancemeasures.	9
	QUALITY MANAGEMENT SYSTEM	
V	Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-SpecificStandards—AS9100,TS16949andTL9000--ISO9001Requirements—Implementation—Documentation—InternalAudits—Registration-ENVIRONMENTALMANAGEMENTSYSTEM:Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO14001—Benefits ofEMS.	9
	Total Instructional Hours	**45**

Course Outcomes	CO1: The student would be able to apply the tools and techniques of quality management to manufacturing and services processes. CO2: Discuss TQM principles. CO3: Able to use TQM Tools and Techniques. CO4: Apply Quality Function Deployment (QFD), Taguchiquality lossfunction. CO5: The student would be able to apply the Quality Management System.

TEXTBOOKS:

T1.DaleH.Besterfiled,CarolB.Michna,GlenH.Besterfield,MaryB.Sacre,HemantUrdhwareshe and RashmiUrdhwareshe, ―Total Quality Management‖, Pearson EducationAsia,RevisedThirdEdition,Indian Reprint,Sixth Impression,2013.

REFERENCES:

R1.JamesR.EvansandWilliamM.Lindsay,"TheManagementandControlofQuality",8th Edition,First IndianEdition,CengageLearning,2012.

R2. Janakiraman.BandGopal.R.K.,"TotalQualityManagement-TextandCases",PrenticeHall(India)Pvt.Ltd.,2006.

R3. Suganthi.LandAnandSamuel,"TotalQualityManagement",PrenticeHall(India)Pvt. Ltd.,2006.

R4. ISO9001-2015standards.

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E/B.Tech	21BM5304	MEDICAL ETHICS AND STANDARDS	3	0	0	3

Course Objective

1. Achieve familiarity with some basic ethical framework& understand how theseethical frameworks can help us to think through contemporary questions inmedicalethics.
2.Studentswill be able to know about the legal and ethical principles
3. To apply these principles in health care settings & gain knowledge about the medical standards that to be followed in hospitals.

UNIT	DESCRIPTION	TOTAL INSTRUCTIONAL HOURS
I	**INTRODUCTION TO MEDICAL ETHICS** Definition of Medical ethics, Scope of ethics in medicine, Americanmedical Association code of ethics, CMA code of ethics-FundamentalResponsibilities, The Doctor and The Patient, The Doctor and TheProfession,ProfessionalIndependence,TheDoctorandSociety	9
II	**ETHICAL THEORIES& MORAL PRINCIPLES** Theories-Deontology & Utilitarianism, Casuist theory, Virtue theory,TheRightTheory.PrinciplesNon-Maleficence,Beneficence,Autonomy, Veracity, Justice. Autonomy & Confidentiality issues inmedicalpractice,EthicalIssuesinbiomedicalresearch,BioethicalissuesinHumanGenetics&ReproductiveMedicine	9
III	**HOSPITAL ACCREDITATION AND SAFETY STANDARDS** Accrediation -JCI Accreditation &its Policies. Patient centered tandards, Healthcare Organization management standards.	9
IV	**HOSPITAL SAFETY STANDARDS** Life Safety Standards- Protecting Occupants, Protecting the Hospital from Fire, Smoke, and Heat, Protecting Individuals from Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards-Minimizing ECRisks, Smoking Prohibitions, Managing Hazardous Material and Waste,Maintaining Fire Safety Equipment, Features,Testing,Maintaining,and Inspecting Medical Equipment.	9
V	**MEDICALEQUIPMENTSAFETYSTANDARDS** Fi General requirements for basic safety & essential performance of medical equipment.IEC60601standards,Indian and International standards,ISO standards-Base Standard-general requirement of Electrical medical devices,Collateral Standards-EMC radiation protection	9

&programmable medical device system,Particular Standards-type of medical device.

TOTAL INSTRCTIONAL HOURS 45

Course Outcome

Upon completion of the course, students will be able to

CO1:Describe the Social responsibility in healthcare systems

CO2:Discuss the Bio ethics and engineers role

CO3: Apply Legaland professional guidelines for the hospital accreditation CO4: Understand hospital safety aspects.

CO5:Comprehend the medical equipment safety standards and medical device maintenance.

TEXT BOOKS:

T1:DomielA Vallero,Biomedical Ethics for Engineers, ElsevierPub.1stedition,2017

T2:Johnna Fisher,Biomedical Ethics:ACanadianFocus.,Oxford University Press Canada,2019.

REFERENCEBOOKS:

R1: RobertMVeatch,The Basics of BioEthics,3rdEdition.Routledge,2019.

R2:PhysicalEnvironmentOnline:AGuidetoTheJointCommission'sSafetyStandardsis published byHCPro,Inc.2020

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Programme	CourseCode	Name of the Course	L	T	P	C
B.TECH	21BM5305	INTELLECTUAL PROPERTY RIGHTS	3	0	0	3

Course Objectives

Uponcompletionofthiscourse,thestudentswillbefamiliarwith

1. To give an idea about IPR,Patents and Copyrights.
2. Understand registration of IPRs.
3. Understand Agreements and Legislations.
4. To know Digital products and Law.
5. Discuss IPRand its enforcement.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents,Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, IndustrialProperty,technologicalResearch,InventionsandInnovations–Important examples ofIPR.	9
II	**REGISTRATIONOFIPRs** MeaningandpracticalaspectsofregistrationofCopyRights,Trademarks,Patents, Geographical Indications, Trade Secrets and Industrial Design registration inIndiaandAbroad.	10
III	**AGREEMENTSANDLEGISLATIONS** InternationalTreatiesandConventionsonIPRs,TRIPSAgreement,PCTAgreement,PatentActofIndia,PatentAmendmentAct,DesignAct,Trademark Act,GeographicalIndicationAct.	10
IV	**DIGITALPRODUCTS ANDLAW** Digital Innovations and Developments as Knowledge Assets – IP Laws, CyberLawandDigitalContentProtection–UnfairCompetition–MeaningandRelationshipbetweenUnfairCompetitionandIPLaws–CaseStudies.	9
V	**ENFORCEMENTOFIPRs** InfringementofIPRs,EnforcementMeasures,Emergingissues–CaseStudies.	7
	Total Instructional Hours	**45**

Course Outcomes	Up on completion of this course,the students will be able to CO1: Ability to manage Intellectual Property port folio to enhance the value of the firm. CO2: Discuss registration of IPRs. CO3: Able to use Agreements and Legislations of IPR. CO4: Use Digital products and Law. CO5: Acquire knowledge of IPR and its enforcement.
TEXT BOOKS:	T1.V.ScopleVinod,Managing Intellectual Property, PrenticeHall of IndiapvtLtd,2012 T2.S.V.Satakar,—Intellectual Property Rights and Copy Rights,EssEssPublications,NewDelhi,2002.
REFERENCES:	R1.DeborahE.Bouchoux,—IntellectualProperty:TheLawofTrademarks,Copy rights,Patents andTradeSecrets‖,CengageLearning,ThirdEdition,2012. R2.Prabuddha Ganguli,‖Intel lectual Property Rights:Unleashing the Knowledge Economy‖, McGrawHillEducation,2011. R3.Edited by DerekBosworth and ElizabethWebster,The Management of Intellectual Property,Edward Elgar PublishingLtd.,2013.

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BE	21BM5205	Modeling of Physiological System	3	0	0	3

Course Objective

To provide basic ideas related to modelling techniques of Physiological System.
To provide basic ideas related to modelling techniques of Circulatory System and Bone Modeling.
To provide basic ideas related to modelling techniques of Thermal Regulation System.
To provide basic ideas related to modelling techniques of Ultra-Filtration System.
To provide basic ideas related to modelling techniques of Respiratory System.

Unit	Description	Instructional Hours
I	**BASICS OF PHYSIOLOGICAL SYSTEMS** Systems Analysis, examples of physiological control systems, differences between engineering and physiological control systems. Generalized system properties, mathematical approach, electrical analogs, linear models, lung mechanics, muscle mechanics, distributed parameter versus lumped parameter models, static analysis, regulation of cardiac output, blood glucose regulation, chemical regulation of ventilation, electrical model of neural control mechanism	9
II	**CIRCULATORY SYSTEMS AND BONE MODELLING** Physical, chemical and rheological properties of blood, problems associated with extracorporeal blood flow, dynamics of circulatory system. Properties of bones, modeling of bones, hills model.	9
III	**THERMAL REGULATORY SYSTEM** Parameters involved, Control system model etc. Biochemistry of digestion, types of heat loss from body, models of heat transfer between subsystem of human body like skin core, etc. and systems like within body, body- environment, etc.	9
IV	**ULTRA FILTRATION SYSTEM** Transport through cells and tubules, diffusion, facilitated diffusion and active transport, methods of waste removal, counter current model of urine formation in nephron, Modelling Henle's loop	9
V	**RESPIRATORY SYSTEM** Modelling oxygen uptake by RBC and pulmonary capillaries, Mass balancing by lungs, Gas transport mechanisms of lungs, oxygen and carbon di oxide transport in blood and tissues.	9
	Total Instructional Hours	**45**

Course Outcome

CO1 Explain the application of basic Physiological system
CO2 Understand the concept of Circulatory system and bone modeling
CO3 Familiarize the parameters involved in Thermal regulatory system
CO4 Understand the process of Ultra filtration system
CO5 Enumerate the mechanism of Respiration

TEXT BOOKS:

T1 Khandpur, R.S., "Hand book of Bio-Medical Instrumentation", II ed., Tata McGraw Hill Pub. Co., Ltd., 2003

T2 Patrick Rcully, Electrical Simulation &Electro pathology, Cambridge University press 4. Joseph Bronzino, Biomedical Instrumentation.

REFERENCE BOOKS:

R1 John.G.Webster., "Medical Instrumentation – Application And Design", Ii Ed., John Wiley & Sons, Inc., New York, 2007.

R2 Joseph Dubovy, "Introduction To Biomedical", Mcgraw Hill Co., 1978.

R3 Terry Bahil.A., "Bio-Medical And Clinical Engineering", Prentice Hall Inc.1981.

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Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM5601	Basics of Anatomy and Physiology	3	0	0	3

Course Objective

1.To learn the basic components of formation of systems
2.To identify all the organelles of an animal cell and their function.
3.To understand structure and functions of the various types of systems of human body.
4.To demonstrate their knowledge of importance of anatomical features and physiology of human systems

Unit	Description	Instructional Hours
I	**INTRODUCTION** Level of Organization – Metabolism and Homeostasis – Plan of Body – Body Parts and Areas, Planes and Sections. Elements in the Human Body – Inorganic Compounds and Organic Compounds	9
II	**BASIC STRUCTURE AND FUNCTION OF ANIMAL CELL** Structure of Cell – Structure and Function of Cell Membrane and Sub organelles. Cellular Transport Mechanism – Cell Division – Mitosis and Meiosis	9
III	**TISSUES, MEMBRANE AND SKELETAL SYSTEM** Epithelial tissue – Connective tissue – Muscle tissue – Nerve tissue – Membrane. Types of Bone tissue - Classification of Bones – Functions of the Skeleton system – Skull, Vertebral Column. Joint - Articulation	9
IV	**NERVOUS AND CARDIOVASCULAR SYSTEMS** Nervous system: Types and Structure of Neuron – Mechanism of Nerve Impulse - Structure and Parts of Brain. Sensory organ: Eye and Ear.Cardiovascular: Composition of Blood and functions – Structure of Heart – Conduction system of Heart – Types of Blood vessel – Blood Pressure.	9
V	**DIGESTIVE AND URINARY SYSTEMS** 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.	9
	Total Instructional Hours	**45**

Course Outcome

CO1 Familiarize with the requirements for formation of systems
CO2 understand the basic structural and functional elements of human body
CO3 Acquire knowledge on Skeletal and muscular systems
CO4 comprehend circulatory and nervous systems and their components
CO5 Understand the importance of digestive and urinary systems in Human body

TEXT BOOKS:

T1 InduKhurana, ArushiKhurana., “Textbook of Anatomy and Physiology”,2nd Edition, CBS Publishers & Distributors,2022.
T2 Edith Applegate MS .,The Anatomy and Physiology Learning System., 4th Edition ., sanders elsevier.,2010.

REFERENCE BOOKS:

R1 Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. Tenth Edition, Pearson Publishers, 2014
R2 Guyton & Hall, “Medical Physiology”, 13th Edition, Elsevier Saunders, 2015.
R3 Elaine.N. Marieb , “Essential of Human Anatomy and Physiology”, Eight Edition, Pearson Education, New Delhi 2007

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Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM5204	Critical Care Equipments	3	0	0	3

Course Objective	To understand the equipment used in Surgeries.
	To elaboratethe equipment used in Critical Care Equipment.
	To understand the conceptsof equipment used in Operation Theatre Equipment.
	To understand the concepts of equipment used in Centralized Systems.
	To analyzethe concepts of equipment used in Patient Safety.

Unit	Description	Instructional Hours
I	**ICU EQUIPMENT** Suction apparatus – Different types; Sterilizers – Chemical, Radiation, Steam for small and larger units.Automated drug delivery systems- Infusion pumps, Closed loop control infusion system, Implantableinfusion system.	9
II	**CRITICAL CARE EQUIPMENT** Hemo Dialysis Machine- Different types of Dialyzers, Membranes, Machine controls and measurements.Heart Lung Machine – different types of oxygenators, peristaltic pumps, Incubators.	9
III	**OPERATION THEATRE EQUIPMENT** Surgical diathermy, Instruments for operation. Anesthesia Equipment – Humidification, Sterilization aspects – Boyles apparatus.	9
IV	**CENTRALIZED SYSTEMS** Centralized Oxygen, Nitrogen, Air supply & Suction.Centralized Air – Conditioning, Operation Theatre table & Lighting.	9
V	**PATIENT SAFETY** Patient electrical safety – Types of hazards – Natural protective mechanisms against electricity – Leakagecurrent – Inspection of grounding and patient isolation, Hazards in operation rooms – ICCU and IMCUs –Opto couplers and Pulse transformers.	9
	Total Instructional Hours	**45**

Course Outcome	CO1	Interpret technical aspects of surgical equipment
	CO2	Maintain the performance of life support equipment
	CO3	Identify intensive care equipment for the upkeep and maintenance of ICCU.
	CO4	Understand concepts of centralized systems.
	CO5	Understand concepts of electrical safety in medical equipment

TEXT BOOKS:

T1	Khandpur, R.S., "Hand book of Bio-Medical Instrumentation", II ed., Tata McGraw Hill Pub. Co., Ltd., 2003
T2	Patrick Rcully, Electrical Simulation &Electro pathology, Cambridge University press 4. Joseph Bronzino, Biomedical Instrumentation.

REFERENCE BOOKS:

R1	John.G.Webster., "Medical Instrumentation – Application And Design", Ii Ed., John Wiley & Sons, Inc., New York, 2007.
R2	Joseph Dubovy, "Introduction To Biomedical", McgrawHill Co., 1978.
R3	Terry Bahil.A., "Bio-Medical And Clinical Engineering", Prentice Hall Inc.1981.

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PROFESSIONAL ELECTIVE II

Programme/Sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech./VI	21BM6301	Biomaterials and Artificial Organs	3	0	0	3

Course Objectives:

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

UNIT I STRUCTURE OF BIO-MATERIALS AND BIO- COMPATIBILITY

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

UNIT II IMPLANTMATERIALS 9

Metallic implant materials, stainless steels, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite, glass ceramics, carbons, medical applications case study on bone replacement

UNITIII POLYMERIC IMPLANTMATERIALS 9

Polymerization, polyamides, Acryrilic polymers, Hydrogels, rubbers, high strength, thermoplastics, medical applications. Bio polymers: collagen and elastin. Medical Textiles:silica,chitosan, PLA, composites ,Sutures, wound dressings .Materials for ophthalmology:

contactlens, Intra ocularlens. Membranes for plasma separation and blood oxygenation.

UNITIV TISSUE REPLACEMENTIMPLANTS 9

Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair.

Soft- tissue replacements, types of transplant by stem cell,sutures, surgicaltapes ,Tissue adhesive/ glue. Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts,har dtissue replacement Implants, joint replacements, Pancreas replacement case study ontissue replacement.

UNITV ARTIFICIALORGANS 9

Artificial Blood, Artificial Skin, Artificial Heart,Prosthetic Cardiac valves, Artificial Lung(Oxy genator), Artificial Kidney(Dialyzer Membrane), Dental Implants, Retinal Implants case study on dental and heart valve

TOTAL:45 PERI

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COURSE OUTCOMES:

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

CO1: Analyze different types of materials and its applicationin biomedical field.

CO2: Choose materials for design of implants in tissue replacement.

CO3:Evaluate response of biomaterials inliving system.

CO4: Assess compatibility and functioning of artificial organs inside the living system.

CO5: Design and develop biomaterial based scaffold for biomedical application.

TEXTBOOKS

1. SujataV.Bhatt,"Biomaterials",Narosa PublishingHouse, 7th Edition,2005.
2. JoonB.ParkJosephD.Bronzino,"Biomaterials-PrinciplesandApplications",CRCpress,2003.

REFERENCES:

1. H.H.Willard,D.L.Merrit,"InstrumentalMethodsof Analysis",CBSPublishers,1992.
2. ParkJ.B.,"BiomaterialsScienceandEngineering",PlenumPress,1984.

ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	2	2	-		3	1	2	1	1	2	2	3	3	3
CO2	3	2	2	-	-	3	1	2	1	1	2	2	3	3	3
CO3	3	2	2	-	-	3	1	2	1	1	2	2	3	3	3
CO4	3	2	2	-	-	3	1	2	1	1	2	2	3	3	3
CO5	3	2	2	-	-	3	1	2	1	1	2	2	3	3	3
AVG	3	2	2	-	-	3	1	2	1	1	2	2	3	3	3

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Programme/Sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech./VI	21BM6302	EMBEDDED SYSTEMS IN MEDICALDEVICES	3	0	0	3

Course Objective

1. Understand overview of Processors and hardware units.
2. Understand Intel MCS51 Architecture.
3. Learn PIC Microcontroller.
4. Understand Embedded systemevolution trends.
5. Discuss applications of embedded system.

Unit	Description	Instructional Hours
I	**Introduction to embedded systems** Definition and Classification – Overview of Processors and hardware units in an embedded system – Software Embedded into the System – Complex System Design and the various Processors - Concept of Design Process in Embedded Systems - Design Examples – Classifications in Embedded Systems and Skills required for an Embedded Systems Designer	9
II	**Interfacing with 8051 and Introduction to Arduino UNO R3** Introduction to 16 bit Microcontroller. Interfacing of 8051 with ADC, sensors, stepper motor, key board, & DAC - Introduction to Arduino UNO R3 Hardware setup – I/O functions – Real time Application	9
III	**Introduction to PIC Microcontroller** PIC Microcontroller - Introduction, CPU architecture, registers, instruction sets addressing modes Loop timing, timers, Interrupts, Interrupt timing, I/o Expansion,I 2C Bus Operation Serial EEPROM, Analog to digital converter, UART-Baud Rate- Data Handling, Special Features	9
IV	**Real time Operating system Concepts** Recursion, Debugging strategies, Simulators. Task and Task States, tasks and data, semaphores and shared Data Operating system Services-Message queues- Timer Function- Events-Memory Management, Interrupt Routines in an RTOSenvironment, basic design Using RTOS	9
V	**Embedded systems application in Medical devices** Embedded medical applications: Ophthalmology - Glaucoma screening device, Medical Imaging Acquisition User Interface, Drug delivery systems, Patient monitoring Systems.	9
	Total Instructional Hours	45

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CO1: Explain overview of Processors and hardware units.
CO2: Apply Intel MCS51 Architecture.
CO3: Describe PIC Microcontroller.
CO4: Explain Embedded systemevolution trends.

Course Outcome CO5:Applyapplications of embedded system.

TEXT BOOKS:

1. Rajkamal, Embedded Systems Architecture, Programming and Design, TATA McGraw-Hill, First reprint Oct. 2003

2. M AMazidi & Mazidi, The 8051 micro controllers, Pearson Education, 2005

REFERENCES:

1. Tim Wilmshusrst, Designing Embedded Systems with PIC, Newnes publishing, 2007
2. Steve Heath, Embedded Systems Design, Second Edition-2003, Newnes,
   David E. Simon, An Embedded Software Primer, Pearson Education Asia, First IndianReprint 2000.

Course Code & Name:21BM6302 Embedded Systems in Medical Devices

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	1	1	-	-	-	3	-	3	-	-	-	-	1
CO2	2	-	3	-	-	-	-	3	-	1	-	1	-	-	1
CO3	2	-	3	-	-	-	-	3	-	1	-	1	-	-	1
CO4	2	-	3	-	-	-	-	3	-	1	-	-	-	-	1
CO5	-	-	3	-	-	-	-	1	-	1	-	-	-	-	1
Avg	2	-	3	0	-	-	-	3	-	1	-	1	-	-	1

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Programme/Sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech./VI	21BM6303	BIOMEDICAL WASTE MANAGEMENT	3	0	0	3

Course Objective

1. Understand hazard control
2. Understand the hazardous materials used in hospital and its impact on health
3. Understand various waste disposal procedures and management.
4. Learn safety of hospital
5. Understand infection control, prevention and patient safety

Unit	Description	Instructional Hours
I	**HEALTHCARE HAZARD CONTROL AND UNDERSTANDINGACCIDENTS** Healthcare Hazard Control : Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers' Compensation, Orientation, Education, and Training.	9
II	HOSPITAL **WASTE MANAGEMENT** Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization,waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal	9
III	**HAZARDOUS MATERIALS** Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.	9
IV	**FACILITY SAFETY** Facility Safety : Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating,and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety.	9
V	**INFECTION CONTROL, PREVENTION AND PATIENT SAFETY** Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety.	9
	Total Instructional Hours	45

Course Outcome

CO1: Analyse various hazards, accidents and its control
CO2: Design waste disposal procedures for different biowastes
CO3: Categorise different biowastes based on its propertiesCO4: Design different safety facility in hospitals
CO5: Propose various regulations and safetynorms

TEXT BOOKS:

1. James T., Healthcare hazard control and safety management-CRCPress_Taylor and Francis (2014).
2.Sukhjit Kaur, Biomedical Waste Disposal, Jaypee BrothersMedical Publishers (P) Ltd (2012).

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REFERENCES:

1. C.Goyal —Hospital Administration and Human Resource Managementl, PHI –Fourth Edition, 2006

2. J. Landrum, —Medical Waste Management and disposall, Elsevier, 1991

Course Code & Name:21BM6303 Biomedical Waste Management

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	-	-	-	-	-	-	3	-	-	-	-	1
CO2	1	2	3	-	-	-	-	-	-	1	-	1	-	-	1
CO3	1	2	3	-	-	-	-	-	-	1	-	1	-	-	1
CO4	2	1	3	-	-	-	-	-	-	1	-	-	-	-	1
CO5	1	1	3	-	-	-	-	-	-	1	-	-	-	-	1
Avg	1	2	2	-	-	-	-	-	-	1	-	1	-	-	1

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Programme/Sem B.E./B.Tech./VI	Course Code	Name of the Course	L	T	P	C
	21BM6304	PHYSIOLOGICAL MODELLING	3	0	0	3

Course Objective

1. To understand the concepts of physiological modelling
2. To learn the different approaches used in modeling of physiologicalsystems.
3. To learn the concepts of modeling human thermal regulatorysystem.
4. To learn the concepts of modeling human respiratorysystem.
5. To studyabout the electrical properties of neuron and to model them.

Unit	Description	Instructional Hours
I	**Introduction to physiological modelling** Physiological complexity and the need for models: Complexity , Feedback and Control in Physiological Systems Models and the modeling process: Model Formulation , Identification Validation and Simulation.	9
II	**Different approaches of modeling physiological systems** Linear Modeling Distributed Modeling Nonlinear Modeling Time-varying Modeling Mathematical approach, electrical analogues, etc. Introduction to various process controls like cardiac rate, blood pressure, respiratory rate. Blood - Glucose regulation. Pharmacokinetic modeling-compartmental models, blood-tissue models.	9
III	**Modeling of human thermal regulatory system** Parameters involved, control system model etc. Biochemistry of digestion, Lossof heat to the environment, Heat transfer within the body, Models describing heat transfer between core and skin, heat distribution in extremities.	9
IV	**Modeling of Respiratory system** Human Lungs: Anatomy and physiology of the respiratory system, mass balance in lungs, oxygen and carbon dioxide transport in blood Modelingoxygen uptake by RBC and pulmonary capillaries .	
V	**Neuron Models** Electrical properties of Neurons, Single compartment models, voltage dependent conductances, Hodgkin Huxley model, Integrate fire neuron model, conductance based models, Cable equation, multi compartment models. Fitzhugh Nagumo models.	9
	Total Instructional Hours	45

Course Outcome

CO1	Gain adequate knowledge about the modeling ofphysiological systems
CO2	Have an in depth idea about different approaches in modeling physiological systems
CO3	Design and develop the physiological model of human thermal regulatorysystem.
CO4	Design and develop the physiological model of human respiratory system
CO5	Gain in-depth knowledge about different types of neuron models and its electrical properties

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TEXT BOOKS:

1. Arthur C Guyton, Text Book of Medical physiology, PRISM Books India, 2000
2. David Cooney, Biomedical Engineering Principles, Marcel Decker Publications, 2001.

REFERENCE BOOKS:

1. Peter Dayan, Theoretical Neuroscience: Computational and Mathematical modeling of Neuralsystems MIT Press
2. Vasilis Z Marmarelis, Nonlinear Dynamic Modeling of Physiological systems IEEE Press series inBiomedical Engineering.

Course Code & Name: 21BM6304 Physiological Modelling

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	2	-	-	-	-	-	-	2	-	-	2
CO3	2	1	-	-	0	-	-	1	-	-	-	1	-	-	-
CO4	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-
CO5	-	-	-	-	-	-	-	1	-	-	-	1	-	-	2
Avg	2	1	-	-	0	-	-	1	-	-	-	1	-	-	1

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Programme/Sem	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech./V	21BM6305	ARTIFICIAL NEURAL NETWORKS	3	0	0	3

Course Objective

To understand the need for machine learning for various problem solving
To study the various supervised, semi-supervised and unsupervised learningalgorithms in machine learning
To learn the new approaches in machine learning
To design appropriate machine learning algorithms for problem solving
To understand about the basic concepts of associative memories.

Unit	Description	InstructionalHours
I	**INTRODUCTION TO NEURAL NETWORKS** Introduction-Humans and Computers- Organization of the Brain- Biological Neuron-Biological and Artificial Neuron Models-Characteristics of ANN- McCulloch Pitts Model- Historical Developments- Potential Applications of ANN.	9
II	**ESSENTIALS OF ARTIFICIAL NEURAL NETWORKS** Artificial Neuron Model- Operations of Artificial Neuron- Types of Neuron Activation Function- ANN Architectures- Classification Taxonomy of ANN – Connectivity- Learning Strategy- Supervised, Unsupervised, Reinforcement-Learning Rules.	9
III	**SINGLE LAYER FEED FORWARD NETWORKS** Introduction-Perceptron Models: Discrete, Continuous and Multi-Category- Training Algorithms: Discrete and Continuous Perceptron Networks- Limitations of the Perceptron Model.	9
IV	**MULTI- LAYER FEED FORWARD NETWORKS** Credit Assignment Problem- Generalized Delta Rule- Derivation of Backpropagation (BP) Training,-Summary of Backpropagation Algorithm- Kolmogorov Theorem- Learning Difficulties and Improvements.	9
V	**ASSOCIATIVE MEMORIES** Paradigms of Associative Memory-Pattern Mathematics-Hebbian Learning- General Concepts of Associative Memory- Bidirectional Associative Memory (BAM) Architecture- BAM Training Algorithms-Storage and Recall Algorithm- BAM Energy Function-Architecture of Hopfield Network: Discrete and Continuous versions-Storage and Recall Algorithm,-Stability Analysis- Neural network applications: Process identification, control, fault diagnosis.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Explain theory underlying machine learning.
CO2: Construct algorithms to Learn ANN.
CO3: Implement single layer feed forward networks.
CO4: Construct Algorithms To learn multi- layer feed forward networks.
CO5: Applyassociative memories learning techniques for real life problems

TEXT BOOKS:

T1 LaureneFausett, "Fundamentals ofNeural Networks" , Pearson Education,2014.

T2 Simon Haykin, "Neural Networks- A comprehensive foundation", Pearson Education, 2013.

REFERENCE BOOKS:

R1 S.N.Sivanandam, S.Sumathi,S. N. Deepa "Introduction to Neural Networks using MATLAB 6.0", TATAMcGraw Hill, 2016.

R2 S. Rajasekharan and G. A. Vijayalakshmipai, "Neural Networks, Fuzzy logic, Genetic algorithms:synthesis and applications", PHI Publication, 2014.

R3 Timothy J. Ross, " Fuzzy Logic With Engineering Applications", Tata McGraw-Hill Inc. 2010.

Course Code & Name:21BM6305 Artificial Neural Networks

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	-	-	2	2	1	1
CO2	1	1	-	-	-	-	-	-	-	-	-	2	2	1	1
CO3	1	1	1	1	-	1	-	-	-	-	-	2	2	2	1
CO4	0	0	1	1	-	1	-	-	-	-	-	1	2	2	1
CO5	0	0	-	-	-	-	-	-	-	-	-	2	2	1	1
Avg	1	1	0	0	-	0	-	-	-	-	-	2	2	1	1

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PROFESSIONAL ELECTIVE III

Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM7301	Drug Delivery	3	0	0	3

Course Objectives:

- To study the characteristics and classification of drug delivey
- To understand the response of materials .
- To learn about the polymeric materials and composites intargeted drug delivery systems.

  To know the compatibility and functioning of implantable delivery systems

UNIT 1CONTROLLED DRUG DELIVERY SYSTEMS 9

Introduction, terminology/definitions and rationale ,advantage ,disadvantages, Selection of drug candidates, approach to design controlled release formulation based on diffusion, dissolution and ion exchange principles, physiochemical and biological Properties of drug revelent to controlled release formulations

UNIT 2 POLYMERS 9

Introduction, classification, properties, advantages and application of polymer in formulation of controlled release drug delivery systems.

UNIT 3 MICROENCAPSULATION AND MUCOSAL DRUG DELIVERY SYSTEMS 9

Definition, advantages and disadvantages, microspheres, micro particles, microcapsules, method of encapsulation: Transmucosal permeability and formulation considerations of buccal delivery systems

UNIT 4 IMPLANT DRUG DELIVERY SYSTEMS 9

concepts of implant and osmotic pump, inflatable and gastro adhesive systems, nasal and pulmonary routes of drug delivery ,formulation of inhaler,nasal spray, nebulizers, syringe pump, infusion pump, volumetric pump.

UNIT 5 Targeted drug delivery systems **9**

Introduction of liposomes, noisome, nanoparticles, monoclonal antibodies, development of intra uterine device and application

COURSEOUTCOMES:

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

CO1: Analyze different types of materials and its application in drug delivery systems
CO2: Choose materials for design microencapsulation
CO3:Evaluateresponseof polymer material
CO4: Assess compatibility and functioning of implantable drug delivery systems
CO5: Design and develop of targeted drug delivery devices

Textbooks:

1. Textbook Of Drug Delivery Systems (M.Pharm) Sem-I Paperback – 1 January 2020 By Sarode Patil, Gayakwad, Usman (Author)

2. Textbook of Novel Drug Delivery System Prof. (Dr.) RanabirChanda/Prof. (Dr.) Jyotirmoy/Prof. (Dr.) AlugubelliGopi Reddy 1st Edition 2019

Reference books:

1. Drug Delivery: Principles and Applications, Second EditionEditor(s):Binghe Wang, Longqin Hu, Teruna J. SiahaanFirst published:25 March 2016

2. Drug Delivery Systems 1st Edition RakeshTekadeublished Date: 22nd October 2019

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Programme	Course Code	Name of the Course	L	T	P	C
BE	**16BM7302**	**Internet of Things and Its Medical Applications**	**3**	**0**	**0**	**3**

Course Objective

- To understand the basic theory of IoT
- To design embedded systems using IoT
- To study the various IoT Protocols
- To study the various Physical Devices
- To study the various IoT Security

Unit	Description	Instructional Hours
I	**Basics of IoT** Definition and characteristics of IoT, Internet of Things:Vision, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Things of IoT, IoT Protocols, Logical design of IoT, IoT functional blocks, IoT communication models.	9
II	**Embedded IoT** M2M: The internet of devices, RFID: The internet of objects, WSN: The internet of transducer, SCADA: The internet of controllers, DCM: Device, Connect and Manage, Device: Things that talk, Connect: Pervasive Network.	9
III	**IoT Protocols** Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards, Protocols –IEEE 802.15.4,BACNet Protocol, Modbus, KNX, Zigbee Architecture, Network layer, APS layer.	9
IV	**IoT Physical Devices** IoT Physical Devices and Endpoints: Basic building blocks of and IoT device, Raspberry Pi,Raspberry Pi interfaces, Programming Raspberry Pi with Python, Beagle board and Other IoT Devices	9

V	**IOT in Medical Field**	9

IoMT-Working,Internet of Things in Hospitals:Collection and Integration of Clinical Data:Benefits of IoT in Healthcare-Future of IoT in Healthcare-IoT-Based Patient Health Monitoring System-Examples of Healthcare IoT-IoT in Healthcare/Medical Projects.

Total Instructional Hours **45**

Course Outcome

Course Outcomes: Upon completion of this course, the students will be able to:

CO1 : Outline the basic concepts of IoT

CO2 : Discuss about Embedded IoT

CO3 : Summarize the IoT protocols

CO4 : Choose a suitable devices and implement program for stated IoT challenge

CO5 : Explain the fundamentals of security in IoT

TEXT BOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2. Arshdeep Bahga, Vijay Madisetti, ―Internet of Things – A hands-on approach, Universities Press, 2015.

REFERENCES:

1. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014.
2. Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols, Wiley, 2012. 5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things, Springer, 2011.

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Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM7303	ADVANCED BIO ANALYTICAL AND THERAPEUTIC TECHNIQUES	3	0	0	3

Course Objective

1. Understand the basics of Analytical Techniques .
2. Understand the basics of enzymes as a diagnostic tool.
3. Explore various Radioisotopic Techniques **.**
4. Explore various applications of Gene Therapy.
5. Understanding on basic principles of Nanotherapeutics.

Unit	Description	Instructional Hours
	ANALYTICAL TECHNIQUES	
I	Principle- instrumentation and application of electrophoresis- SDS, native gel- UV and IR spectroscopy and its application –Spectrophotometry- fluorimetry- NMR – principle- instrumentation and application in medical sciences.	9
	ENZYMES AS A DIAGNOSTIC TOOL	
II	Isoenzymes and their significance in diagnosis-enzyme pattern in health and diseased condition- lipase- amylase- ALP, ACP, SGOT, SGPT, LDH & CPK. - Techniques in screening isoenzymes -Biosensors- enzyme based- antibody based, DNA based -optical biosensor- Blotting techniques-Automation in clinical laboratory.	9
	RADIOISOTOPIC TECHNIQUES	
III	Types of radioisotopes- Units of measurements-methods in measuring radioactivity -G.M liquid scintillation counter application in diagnosis (RIA & ELISA) –autoradiography- biological hazards- safety measures in handling isotopes- disposal of labeled compounds and radio dosimetry.	9
	GENE THERAPY	
IV	Central concept of gene therapy-basic molecular mechanism of gene transfer-human genome project- prerequisite of human gene therapy- biological basis of gene therapy strategies- vehicles for gene transfer- gene transfer methods- clinical gene therapy studies-gene therapy for hereditary disease- gene therapy for cancer-gene therapy for HIV-Ethical issues in human gene therapy.	9

NANOTHERAPEUTICS

V	Nanoparticles as carriers in drug delivery- design- manufacture and Physiochemical properties- transport across biological barriers- nanotechnology in Cancer therapy-bone treatment- nano particles for oral vaccination and skin disease-Types of nanoparticles-half life-Fate of nano particles.	9
	Total Instructional Hours	**45**

Course Outcome

CO1 : Comprehend and appreciate the significance of analytical techniques
CO2 : Demonstrate the knowledge of enzymes as a diagnostic tool
CO3 : Understand the concept and methods of Radio-isotopic techniques
CO4 : Describe the details and ethical issues in human gene therapy
CO5 : Gain knowledge about the concepts of nano-therapeutics in drug delivery

TEXT BOOKS:

T1 Douglas A, ―Principles of Instrumental Analysis, SkoogBrooks Cole publisher 6th edition 2006.

T2 Keith Wilson & John Walker,― Practical Biochemistry , Principles and Techniques. Oxford University Press 7th edition 2010.

REFERENCE BOOKS:

R1 G. Louis Hornyak, John J. Moore, Harry F. Tibbals and Joydeep Dutta, ―Fundamentals of Nanotechnology, CRC press, 1st edition 2008.

R2 Harvey Lodish W. H, ―Molecular Cell Biology, Freeman publisher 7th Edition 2012

R3 Gabor L. Hornyak, Joydeep Dutta, H.F. Tibbals, Anil Rao, ―Introduction to NanoScience, CRC press 2008.

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Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM7304	ADVANCED BIO SIGNAL PROCESSING	3	0	0	3

Course Objective

1. To familiarize the student with biosignal processing algorithm for automated diagnosis of diseases.
2. To make students familiarize about how to classify biomedical signals
3. To understand about signal processing particularly for cardiovascular applications
4. To understand about various data compression techniques
5. To understand about signal processing particularly for neurological applications

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BIOMEDICAL SIGNALS** Examples of Biomedical signals - ECG, EEG, EMG etc - Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of Biomedical signals- Processing of Random & Stochastic signals – spectral estimation – Properties and effects of noise in biomedical instruments - Filtering in biomedical instruments.	9
II	**CONCURRENT, COUPLED AND CORRELATED PROCESSES** llustration with case studies – Adaptive and optimal filtering – Modeling of Biomedical signals - Detection of biomedical signals in noise – removal of artifacts of one signal embedded in another-Maternal-Fetal ECG-Muscle- contraction interference. Event detection - case studies with ECG & EEG – Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals.	9
III	**CARDIO VASCULAR APPLICATIONS** Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multiscale analysis for ECG parameters estimation - Noise & Artifacts-ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis.	9
IV	**DATA COMPRESSION** Lossless & Lossy- Heart Rate Variability – Time Domain measures – Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals.	9

V	**NEUROLOGICAL APPLICATIONS** The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models – Non linear modeling of EEG - artifacts in EEG & their characteristics and processing – Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the basics of signals, systems and spectrum

CO2: Analyze signals in concurrent, coupled and correlated processes.

CO3: Construct signaling algorithm for cardiovascular applications.

CO4: Understanding the importance of data compression in signal processing .

CO5: Analyze bio-signals and demonstrate the neurological applications.

TEXT BOOKS:

T1 D.C.Reddy, "Biomedical Signal Processing – Principles and Techniques", TMH,2005.

T2 Wills J. Tompkins, " Biomedical digital signal processing", Prentice Hall of India Pvt. Ltd,2008.

REFERENCE BOOKS:

R1 R. Rangayan, "Biomedical Signal Analysis", Wiley 2002.

R2 Bruce, "Biomedical Signal Processing & Signal Modeling," Wiley, 2001.

R3 Sörnmo,"Bioelectrical Signal Processing in Cardiac & Neurological Applications", Elsevier,2005.

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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E/ B.Tech	19BM7305	ULTRASOUND IN MEDICINE	3	0	0	3

Course Objective

7. To apply the basics ultrasound and Echo techniques
8. To find the Imaging modalities and its diagnostic techniques
9. Students should know about the fundamentals of troubleshooting techniques.

UNIT	DESCRIPTION	TOTAL INSTRUCTIONAL HOURS
	USG & ECHO	
I	History - Properties of ultrasound – Principle Doppler Effects - Ultrasound Transducers: Piezoelectric Effect- Transducer Beam Characteristics – Scanning Techniques and modes –Biological effects of ultrasound – ECHO principle and Instrumentation – Pulse Echo concept - Pulse generator – Sound waves – Modes of Transducer - Acoustic Properties of Transducer Materials – PLAX and PSAX View – Stress Echocardiogram	9
	IMAGING TECHNIQUES	
II	Grey scale and colour Imaging – Panoramic Imaging - Contrast agent and Tissue contrast – 3D & 4D Imaging Techniques – Strain Imaging – Image processing techniques - modalities of Echo – Elasticity Imaging – CT & MRI guided USG	9
	DIAGNOSTIC ULTRASOUND	
III	Introduction – Principle and concepts of Intravascular Imaging – Transesophageal Ultrasound – Transabdominal Ultrasound – Transrectal and Vaginal Ultrasound – Fetal monitoring – Soft tissue evaluation of human body organs – Ultrasound Guided biopsy techniques	9
	THERAPEUTIC ULTRASOUND	
IV	Thermal and Non-Thermal Ultrasound therapy – Ultrasound Drug delivery – HIFU - Cancer therapy – Phacoemulsification using USG - Lithotripsy – Selerotherapy	9
	TROUBLESHOOTING & SAFETY MANAGEMENT	
V	Troubleshooting techniques– Power supply – Calibration of Transducer & Sca – Servicing methodology – USG Licenses – Preventive maintenance precautions of USG during Imaging. USG-ECHO Management system..	9
	TOTAL INSTRCTIONAL HOURS	**45**

CO1: Understand about basic design of USG & Doppler medical devices .
CO2:explain the effect of ultrasound in medical Imaging
CO3: detail about system description of Diagnostic equipments
CO4: detail about system description of therapeutic equipments
CO5: Understand the concept of USG troubleshooting & Safety

TEXT BOOKS

1. K.Shung "Diagnostic Ultrasound: Imaging and Doppler Flow Measurements"Francis & Taylor, CRC Press Boca Raton FL, 2005
2. Szabo. T-Diagnostic Ultrasound Imaging:Inside Out" Elsevier AcademicPress, Amesterdam, 2004.
3. Harald lutz, Elisabetta buscarini , Manual of diagnostic Ultrasound, WHO-2020

REFERENCE

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2018
2. John G.Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2009.

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PROFESSIONAL ELECTIVE IV

Programme	CourseCode	NameoftheCourse	L	T	P	C
BE	19BM8301	BIOFLUIDS AND DYNAMICS	3	0	0	3

Course Objective

1. An understanding on the physiology and anatomy of studied systems,
2. A capability to analyze the flow properties of blood.
3. To analyze cellular,ocular,cardio vascular and respiratory fluid mechanics
4. To understand the basics of soft tissue mechanics,
5. To understand mathematical modeling of fluid biological systems.

Unit	Description	Instructional Hours
I	**BIO-FLUID MECHANICS** Newtons laws, Stress, Strain, Elasticity- Hooks-law-viscosity- Newtonian fluid-Non-Newtonianfluid-Viscoelasticfluids-vasculartree-Relationship between diameter-velocity and pressure of blood flow-Resistance against flow- Bio viscoelastic fluid:Visco elasticity-Viscoelastic models,Maxwell,Voigt and Kelvin Models, Response to Harmonic variation- Use of viscoelastic models- Bio-Viscoelastic fluids: Protoplasm-Mucus-Saliva-Synovialfluids.	9
II	**FLOW PROPERTIESOFBLOOD** Physical- Chemical and Rheological properties of blood-Apparent and relative viscosity- Blood viscosity variation- Effect of shear rate- hematocrit- temperature-protein contents of blood- Casson'sequation-Problems associated with extracorporeal blood flow-Rheology of Blood In Micro vessels-Fahraeus-Lindquist effect and inverse effect- distribution of suspended particles in a narrow rigid tube-Nature of red blood cells in tightly fitting tubes-hematocrit in very narrow tube.	9
III	**CARDIACMECHANICS** Cardio vascular system-Mechanical properties of blood vessels:arteries,arterioles, capillaries and veins- Blood flow: Laminar and Turbulent- Physics of cardiovascular diseases-Prosthetic heart valves and replacements-Respiratory Mechanics- Alveoli mechanics- Interaction of Blood and Lung P-V curve of Lung-Breathing mechanism-Airway resistance-Physics of Lung diseases.	9

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IV	**SOFTT ISSUE MECHANICS** Pseudo elasticity -non-linear stress-strain relationship -Visco elasticity- Structure-functionand mechanical properties of skin-ligaments and tendons.	9
V	**ORTHOPEDICMECHANICS** Mechanical properties of cartilage- diffusion properties of Articular cartilage-mechanical properties of bone- kinetics and kinematics of joints- lubrication of joints.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Understand the principles of bio fluid mechanics
CO2: Outline the flow properties of blood.
CO3: Discussion Cardio vascular and pulmanory system in human body
CO4: Explain blood properties specially the anatomy and physiology of soft tissues.
CO5: Understanding the concepts of or the orthopedic mechanics.

TEXTBOOKS:

T1 Y.C Fung,"Biomechanics-Mechanical properties of living tissues",2ndEdition,Springer-Verlag,2003.

T2 David A.Rubenstein,Weiyin,Mary D.Frame,"Biofluid Mechanics-An Introduction to fluid Mechanics,Macro circulation and Microcirculation",Springer,2013.

REFERENCE BOOKS:

R1 Dhanjoo N.Ghista.(2008).Applied Biomedical Engineering Mechanics.CRC Press.

R2 SilverFrederickH. Biomaterials,Medical Devices&Tissue Engineering:Chapman&Hall,London,1994

R3 Nihanthozkai,D.A McDonald,"Biomechanics,Blood flow in arteries", Edward Arnold ltd,1998.

Course Code & Name: 19BMI8301 Biofluids and Dynamics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	3	2	-	-	-	-	-	-	-	3	-	-	1
CO2	1	-	-	2	-	-	-	-	2	-	-	-	-	-	1
CO3	1	-	3	2	-	-	1	-	2	-	-	3	-	3	1
CO4	1	-	3	2	-	-	1	-	3	-	-	-	-	-	1
CO5	1	-	-	2	-	-	-	-	-	-	-	3	-	1	1
Avg	1	-	2	2	-	-	1	-	2	-	-	2	-	1	1

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Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM8302	AI In Healthcare	3	0	0	3

Course Objective

1. To understand the need for machine learning for various problem solving
2. To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning
3. To learn the new approaches in machine learning
4. To design appropriate machine learning algorithms for problemsolving
5. To understand about the basic concepts of associative memories.

Unit	Description	Instructional Hours
I	**INTRODUCTION & SEARCH STRATEGIES** Intelligence: history, the state of the art - Intelligent agents: structure, environment.Breadth-first search,uniform cost search,depth-first search,depth-limited search,iterative deepening search, bidirectional search, heuristic search techniques, comparing search strategies..	9
II	**KNOWLEDGE AND REASONING** Representation,logic: propositional logic,using predicate logic,using rules,forward and backward chaining,strong and weaks lot fillers.	9
III	**PLANNING & UNCERTAINTY** Overview,components,goal stack planning,non-linear planning,hierarchical planning,reactive systems.Non-monotonic reasoning,logics,implementation, Probability and Bayes theorem,certain factors-Bayesian networks,dempster-Shafer theory.	9
IV	**MACHINE LEARNING IN HEALTHCARE** Introduction–Machine learning models–Categories–Tools–Patient centric machine learning model – Healthcare dataset – Supervised and Unsupervised technique-Introduction to Deep learning.	9
V	**HEALTHCARE APPLICATIONS** Disease detection system –methodology,case diagram –for cancer detection–Brain convolution–Smart Health record-Virtual Nursing assistance-Surgical Assistance.	9
	Total Instructional Hours	**45**

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Course Outcome

CO1: Explain theory underlying machine learning.
CO2: Construct algorithms to Learn ANN.
CO3: Implement single layerfeedforwardnetworks.
CO4: Construct Algorithms To learn multi-layer-feed forward networks.
CO5: Apply associative memories learning techniques for real life problems

TEXT BOOKS:

T1 Stuart Russell,"Artificial Intelligence:A Modern Approach",4thEdition,Pearson,2020
T2 Arvin Agah,"Medical Applications of Artificial Intelligence",CRC Press,2017

REFERENCE BOOKS:

R1 James V Stone,"Artificial Intelligence Engines:A Tutorial Introduction to the Mathematics of Deep Learning,"2019
R2 Robert Scoble & Shel Israel,"The Fourth Transformation:How Augmented Reality &Artificial IntelligenceWill Change Everything",Patrick Brewster Press;1st edition,2016
R3 S. Rajasekharan and G. A. Vijayalakshmi pai, "Neural Networks, Fuzzy logic, Genetic algorithms:synthesis and applications",PHI Publication,2004.

Course Code & Name:19BMS302 Artificial Intelligence in Healthcare

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	-	-	-	-	-	-	-	-	1	-	-	-	1
CO2	3	2	3	-	-	-	1	-	-	-	1	-	3	-	1
CO3	3	2	3	-	-	-	3	-	-	-	1	-	3	-	1
CO4	3	-	2	-	-	-	2	-	-	-	3	-	2	-	1
CO5	3	-	-	-	-	-	-	-	-	-	3	-	-	-	1
Avg	3	1	2	-	-	-	1	-	-	-	2	-	2	-	1

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Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM8303	MEDICAL INFORMATICS	3	0	0	3

Course Objective

1. To study about the evolution of medical informatics and its application inhealthcare field.
2. To understand the various standards and terminologies used in medical informatics
3. To gain knowledge about the theories such as E health,human factors involvedin Medical informatics.
4. To learn about statistical computation in bioinformatics.
5. To understand the implementation and visualization of medical data.

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Definition-evolution of medical informatics–screening, diagnosisandprognosis - applications:clinical informatics,nursing informatics,public health informatics - principles of bioethics-Indian and International health agencies-featuresofmodern personalcomputers and peripherals.	9
II	**STANDARDS AND TERMINOLOGY:** MeSH,UMLS,ICD,SNOMED,LOINC- CCHIT,HL7,HIE,HIMSS,DICOM, and HIPAA -networking medical data:PACS,clouds and web-Hospital Information System(HIS):characteristics,functional online and offline modules –introduction to RIS and LIS.	9
III	**THEORIES OF MEDICAL INFORMATICS:** Definition and six levels of interfacing–E-health-Evidence based medicine–Qualityof Care-work flow analysis-usability and human factors–User Interface design– challenges and limitations of technological solutions..	9
IV	**MEDICAL INFORMATICS TOOLS:** Introduction to statistical computing:statistical analysis and characterization of healthcare data,descriptive statistics–logistic and linear regression -introduction To data mining:variable types and terminology,supervised learning and functionapproximation..	9
V	**IMPLEMENTATIONAND VISUALIZATION:** Electronic medical records: components and functionality, development tools,computerized prescription -telemedicine:technologies and applications-multimedia applications in medicine: visualization of medical data, virtual reality,VRML	9
	Total Instructional Hours	45

Course Outcome

CO1	Understand the evolution of medical informatics and its application in healthcare field
CO2	Understand the various standards and terminologies used in medical informatics
CO3	Understand knowledge about the theories such as E health,human factors involved in Medical informatics.
CO4	Understand about statistical computation in bio informatics.
CO5	Understand the implementation and visualization of medical data

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TEXT BOOKS:

1. Ramachandra Lele, —Computers in Medicine: Progress in Medical Informatics‖, TataMcGraw Hill,New Delhi,2005.

2.Hastie Tibshirani and Friedman, —The Elements of Statistical Learning‖, SpringerSeriesinStatistics,2013.

REFERENCE BOOKS:

1.Mohan BansalMS,—Medical Informatics‖,TataMcGraw Hill,NewDelhi,2002.

2.Edwa rd H.Shortliffe and JamesJ.Cimino,—Biomedical Informatics:ComputerApplications in Health Care and Biomedicine‖,Springer,2006.

3.HM Dietel,P JDietel,—Internetand WorldWideWeb:HowtoProgram‖,PearsonEducation,New Delhi,2011.

4. Joseph Tan, —Medical Informatics: Concepts, Methodologies, Tools, and Applications‖, Medical InformationScience Reference,2 008.

Course Code & Name:19BMI5303 Medical Informatics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	-	2	-	-	-	-	1	-	1	-	3	-	1
CO2	-	1	-	3	-	1	-	-	2	-	2	-	3	-	1
CO3	-	-	-	3	-	-	-	-	3	-	1	-	3	-	1
CO4	-	1	-	3	-	1	-	-	2	-	-	-	3	-	1
CO5	-	1	-	3	-	-	-	-	-	-	-	-	1	-	1
Avg	-	1	-	3	-	0	-	-	2	-	1	-	3	-	1

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Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM8304	WEARABLE MEDICAL DEVICES	3	0	0	3

Course Objective

1. To understand wearable health monitoring systems and the electrodes used for the acquisition of biological signals.
2. To determine the multi functional sensor systems for health monitoring and their energy harvesting methodology under the self powered category
3. To apply the various wireless communication modalities for healthcare devices and understand the designing of wireless healthplatforms.
4. To understand the sensors kins used for healthcare monitoringand nanomaterial based skin Electronics.
5. To apply the concept of wearable electronics to medical diagnostics and monitoring.

Unit	Description	Instructional Hour
	INTRODUCTION	
I	Sensors for wearable systems, optical electrodes, Multifunctional Epidermal Sensor Systems with Ultra thin Encapsulation-Packaging for Health Monitoring,sensing of biological signals-Device requirements, data acquisition, system integration.	9
	ENERGY HARVESTING	
II	Energy Harvesting for Self-powered wearable devices, wireless communication technologies,Design of wireless health platforms.	9
	LOW POWER HEALTH MONITORING SYSTEMS	
III	Semiconductors in flexible electronics, Low power analog and digital circuit design for bio potential acquisition – architecture and practical considerations.Intelligent patches.	9
	SENSOR SKINS	
IV	Sensor Skins: An Overview, Nanomaterials- Based Skin-Like Electronics forthe Unconscious and Continuous Monitoring of Body Status - detection	9

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MEDICALTEXTILES

V	Textile engineering for wearable sensing devices, Sensory application of textiles- EMG and ECG monitoring,Respiratory monitoring.Active Textiles for therapeutic applications- Textile electrodes for electrical muscle stimulation,textile interactive medical agent(depots and disposing systems), Heatable textiles.Passive textile for therapeutic applications- Reusable 3- D knitted elastic short traction bandages.	9
	Total Instructional Hours	**45**

Course Outcome

CO1 Describe the concepts of wearable system.
CO2 Explain the energy harvestings in wearable device.
CO3 Use the concepts of BAN in health care.
CO4 Illustrate the concept of smart textile
CO5 Compare the various wearable devices in healthcare system

TEXT BOOKS:

1.BonfiglioA ,DeRossi.D,"Wearable monitoring Systems",Springer,2011.

2.RogersJ.A, Ghaffari.R,Kim.D,"Stretchable Bio electronics for Medical Devices and Systems",Springer,2016.

REFERENCE BOOKS:

1. Roger Narayan, "Medical Biosensors for Point of Care, (POC) Applications", 1st Edition,Wood head publishing,2016.
2.WenZhong,"An IntroductiontoHealthcare and Medical Textiles",DE Stechpublication,Inc, 2013.
3.BartelsV.T,"Hand book of MedicalTextiles",WoodHeadpublishing,2011.
4. Subhas Chandra Mukhopadhyay, "Intelligent Sensing, Instruments and Measurement- Wireless Sensors and Sensor Networks",1st edition,Springer Berlin Heidelberg,2013.

ENTRY MAPPING OF COs and POs:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3
CO2	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3
CO3	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3
CO4	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3
CO5	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3
AVG	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3

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Programme/sem	CourseCode	NameoftheCourse	L	T	P	C
B.E	19BM8305	CARDIOVASCULAR ENGINEERING	3	0	0	3

Course Objective

1. Understanding the common anatomy of heart and vascular structure in depth
2. Understanding the electrical activityof heart throughECG,
3. Knowing moreaboutthecommoncardiovascularstates such as coronary artery disease, hypertension, dysrhythmias, and valvular heartdisease.
4. Gain the knowledge mechanisms of blood flow.
5. Knowing more about the cardiovascular diseases.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO CARDIOVASCULAR SYSTEM** Introduction,Blood vessels-Arteries and Arterioles,Veins and Venules,capillaries, control of blood vessel diameter, blood supply- internal respiration,and cell nutrition.Heart-position,structure pericardium,myocardium,endo cardium,interior of the heart.	9
II	**CARDIO CIRCULATORY SYSTEM** Flow of blood through the heart, blood supply to heart, conducting systemof the heart, factors affecting heart rate,the cardiac cycle,cardiac output,excitation contraction coupling,electro physiology,congenital heart defects,blood pressure, control of blood pressure, pulse and factors affecting the pulse rate.Circulation of the blood-pulmonary circulation,systemic circulation-aorta(different parts of aorta & their blood supply,in brief).	9
III	**CARDIAC EQUIPMENT** ECG;continuous monitoring systems for pulse rate,temperature,B.P.Respiration, Arrhythmia monitor; B.P. monitor, Blood flow and cardiac output,Measurement, Plethysmography, Oximetry, Tread mill (Stress ECG), External and implantable pacemakers, Programmable pacemakers, Power sources, Design of encapsulation and leads,Pacing system analyzers.Cardiac Defibrillators,Basic principles and comparison of different Defibrillators,Energy requirements, Synchronous operation,Implantable Defibrillators,Defibrillator analyzers.	9

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MECHANISM OF BLOODFLOW

IV Biofluidics:Biofluid mechanics,Flow properties of blood,Rheology of blood in micro vessels,Mechanical properties of blood capillaries veins vessels:arteries,arterioles,Cardio vascular regenerative engineering

CARDIOVASCULAR DISEASES

V Pericardial vasular Disease,Atherosclerotic Disease,Ischemic Disease,Peripheral disease,Heart Failure,Arrhythmias,Valvular Disease,PulmonaryVascular Disease various cardiac circulatory system

Total Instructional Hours 45

TEXTBOOKS:

T1-ArchillesJ.Pappano,WithrowGilWier,"CardiovascularPhysiology:MosbyPhysiology Series",Elsevier;11thedition, September6, 2018.

T2-Michel R.Labrosse,"Cardiovascular Mechanics", 2019,CRCPRESS Taylor and Francis.

REFERENCE BOOKS:

R1-Elaine N.Marie,"Essential of human anatomy and physiology",11 edition,Pearson Education,New Delhi,2019.

R2- Braunwald,Eugene.(2012)Heart Disease:A Text book of Cardio vascular Medicine.9thEd. W.B.Saunders Company.

Course Outcome

CO1: Understanding detailed anatomy of the cardiovascular regions
CO2: Understanding various cardiac circulatory system
CO3:Understanding cardiac electrical activity with various equipment's used for heart analysis.
CO4:Understanding the mechanism behind bloodflow
CO5:Understanding cardiovascular diseases and it Recovery.

Course Code & Name:19BMI8305 Cardiovasular Engineering

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	3	-	2	-	-	3	-	-	2	-	2	-	1
CO2	-	-	3	-	2	-	-	3	-	-		-	-	-	1
CO3	2	-	3	-	2	-	-	3	-	-	1	-	-	-	1
CO4	2	-	1	-	2	-	-	-	-	-		-	-	-	1
CO5	-	-	-	-	2	-	-	1	-	-	2	-	-	-	1
Avg	1	-	2	-	2	-	-	2	-	-	1	-	0	-	1

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PROFESSIONAL ELECTIVE V

Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM8306	REHABILITATION ENGINEERING	3	0	0	3

Course Objective

1. To understand the rehabilitation concepts and Rehabilitation team members for future development and applications
2. To understand the Principles of Rehabilitation Engineering.
3. To understand the different types of Therapeutic Exercise Technique.
4. To understand the the tests to assess the hearing loss, development of electronic devices to compensate for the loss and various assist devices for visually and auditory impaired
5. To understand the concepts of orthotic devices and prosthetic devices to overcome orthopedic problems.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO REHABILITATION** What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team Classification of members, The Role of Psychiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist.	9
II	**PRINCIPLES OF REHABILITATION** Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles - Practice of Rehabilitation and Assistive Technology	9
III	**THERAPEUTIC EXERCISE TECHNIQUE** Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises	9
IV	**MANAGEMENT OF COMMUNICATION & VIRTUAL REALITY** Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids. Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation	9

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V	General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers- FO, AFO, KAFO, HKAFO. Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myoelectric controlled prosthetics and Externally powered limb prosthetics. Functional Electrical Stimulation systems- Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS)..	

Total Instructional Hours:4

TEXT BOOKS:

1 Sunder 'Textbook of Rehabilitation', Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007 2. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third edition-3 volume set, Taylor & Francis, 2006

REFERENCE BOOKS:

1. Horia- Nocholai Teodorecu, L.C.Jain ,Intelligent systems and technologies in rehabilitation Engineering; CRC;
December 2000.
2. Keswick. J., What is Rehabilitation Engineering, Annual Reviews of Rehabilitation- Springer-Verlag, New York, 1982.

ENTRY MAPPING OF COs and POs

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2	PSO-3
CO1	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2
CO2	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2
CO3	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2
CO4	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2
CO5	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2
AVG	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2

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OGRAMME	COURSE CODE	NAMEOF THE COURSE	L	T	P	C
.E/B.Te h	19BM8307	VIRTUAL REALITY IN MEDICINE	3	0	0	3

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ctive

1.To know about virtual reality in medicine.

2. To understand about basics of modelling and representation

3. To understand about the applications of virtual reality in medicine

UNIT	DESCRIPTION	TOTAL INSTRUCTIONAL HOURS
I	**INTRODUCTION** Defining Virtual Reality,History of VR-Human Physiology and Perception - Key Elements of Virtual Reality Experience - Virtual Reality System – Interface to the Virtual World-Input & output-Visual,Aural&Haptic Displays,Applications & representation of Virtual Reality-Study about unity3D–UE4.–3DxMax&Maya–Skecthup	9
II	**BASICS OF MODELLING & REPRESENTATION** Geometric modeling - kinematics modeling - physical modeling - behavior modeling – model management. Representation of the Virtual World - Visual Representation in VR -Aural Representation in VR - Haptic Representation in VR.	9
III	**HUMAN FACTORS** Introduction-Changing Position and Orientation,Axis-Angle Representations of Rotation,ViewingTransformations-ChainingtheTransformations - Human Eye - eye movements & implications for VR –Interaction: Motor Programs and Remapping, Locomotion, Manipulation,Social Interaction. Audio -The Physics of Sound, The Physiology of Human Hearing,Auditory Perception,Auditory Rendering.	9
IV	**MOTION TRACKING** Motion in Real and Virtual Worlds-Velocities and Accelerations,The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection.Tracking-Tracking2D&3DOrientation,Tracking Position and Orientation,Tracking Attached Bodies.	9

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V	**CLINICALAPPLICATIONS** Medical and Surgical training–Pain Management–Physical Therapy management– Health Educations–Image guided surgery–Pre&Postope planning–3D modelling-Diagnostic Applications	9
	TOTAL INSTRCTIONAL HOURS	45

CO1: understand about basics of Virtual reality
CO2:Understand the design and implementation of the modeling & Implementation.
CO3:Understand the system of human vision
CO4:Explain the concepts of motion and tracking in VR systems.
CO5:detail about system description of Medical Applications

TEXT BOOKS

1. M. La Valle,"Virtual Reality, Steven",Cambridge University Press,2016
2. William R Sherman and Alan B Craig, " Understanding Virtual Reality", Interface,Application and Design, , (The Morgan Kaufmann Series in Computer Graphics)".Morgan Kaufmann Publishers,San Francisco,CA,2002
3. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications:Foundations of Effective Design",Morgan Kaufmann,2009.

REFERENCE

1. Surgical Scene Generation For Virtual Reality-Based Training In Medicine Edition2008 by Harders M,SPRINGER
2. Riener,Robert,Harders,Matthias,Virtual reality in medicine,2015

Course Code & Name:19BM8307 Virtual Reality in Medicine

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	2	-	-	-	-	-	-	-	-	-	1
CO2	3	-	1	-	2	-	2	-	2	-	-	2	-	3	1
CO3	3	-	3	-	2	-	-	-	-	-	-	-	-	3	1
CO4	-	-	2	-	2	-	3	-	-	-	-	2	-	1	1
CO5	1	-	-	-	3	-	-	-	-	-	-	-	-	-	1
Avg	2	-	1	-	2	-	1	-	0	-	-	1	-	1	1

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Programme	Course Code	Name of the Course	L	T	P	C
B.E/B.Tech	19BM8308	BIOPHOTONICS	3	0	0	3

CourseObjective

1. Understand Optics principle.
2. Understand Light-matter interactions.
3. Learn Optical Imaging
4. Learn Optical Imaging in biomedical.
5. Understand various applicatons of optical biosensors.

Unit	Description	Instructional Hours
I	**IntroductoryOptics.** Geometric,Wave,EM and Quantum Picture of Light.Concept of phase, Polarization and coherence.Diffraction and Interference	9
II	**Light-matter interactions.** Energy level picture of materials.Photons, Photoelectric effect, Interaction of photons with materials.Phosphorescence and fluorescence.Stimulated emission of photons.Principle of laser action.Laser types and applications (CW, Pulsed,Ultra-fast,Solid state,Gas,Dye …). Spectroscopy:Types and applications (UV-Vis, Infrared, Raman, FTIR…).	9
III	**Optical Imaging I.** Basic imaging theory,concept of diffraction limit.Optical microscope.Methods for contrast- generation(Dark- field,Phase contrast,DIC,Polarization).Fluorescence microscopy.Fluorescence techniques (FRET, FLIM,FRAP, FCS …). Nanoparticle fluorescence.3D sectioning: Confocal and multi-photon imaging. Advanced Topics.Nanoparticle fluorescence. Super-resolution techniques (STED, STEM, STORM, PALM …).Super-resolution image reconstruction methods.	9
IV	**Optical Imaging II.** Biomedical(Physiological Imaging).Light Scattering phenomena.Tomographic techniques:OCT.Image reconstruction techniques	9
V	**Other applications.** Optical biosensors.Optical manipulation of biological materials.Optical tweezers.Laser dissection and surgery.Neural excitation.	9
	Total Instructional Hours	**45**

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Course Outcome

CO1:Discuss Optics principle.
CO2:Describe Light-matter interactions.
CO3:Analyze Optical Imaging
CO4:Apply Optical Imaging in biomedical.
CO5:Apply new applications of optical biosensors

EXTBOOKS:

1.Bahaa Saleh and MalvinTeich,*Fundamentals of Photonics*,Wiley&Sons(2002).
2.Paras N .Prasad ,*Introduction to Biophotonics,*Wiley&Sons(2003).

EFERENCES:

1.P.N.Prasad,Introduction to Biophotonics,Wiley,2003
2.J.R.Lakowicz,Principles of fluorescence spectroscopy,3rd edition,Springer,2006
3.J.Mertz,Introduction to optical microscopy,Roberts&Co.Publishers,2009.

Course Code & Name:19BMI8306 Biophotonics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	1	1	-	2	2	3	-	-	-	-	1
CO2	-	-	-	-	2	2	-	2	2	3	-	-	-	2	1
CO3	-	-	-	-	1	1	-	2	2	3	-	-	-	-	1
CO4	-	-	-	-	1	1	-	2	2	3	-	-	-	2	1
CO5	-	-	-	-	-	-	-	2	2	3	-	-	-	-	1
Avg	-	-	-	-	1	1	-	2	2	3	-	-	-	1	1

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Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM8309	TELEMEDICINE	3	0	0	3

Course Objective

1. To study about telemedicine and telehealth and telecare techniques.
2. To understand the different type of information and standards used in telemedicine.
3. To understand the applications in the field of telemedicine.
4. To understand the use of internet in telemedicine.
5. To understand the ethical and legal aspects in telemedicine.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Definitions of telemedicine telehealth and telecare. History of telemedicine: Main phases of telemedicine Pre electronic telemedicine Electronic telemedicine Technical Requirements.	9
II	**TYPE OF INFORMATION AND STANDARDS** Type of information and standards, audio, data, Fax, Video Types of communications and networking- networking architecture, POTS, ISDN, ATM Other Fixed networks, Air/aireless communications.- RF,Microwaves, Satellite, GSM, CDPD (Cellular Digital Packet Data) Acquisition/ displays: Acquisition systems Cameras, Scanners, Other medical specialized acquisition system	9
III	**APPLICATIONS** Telemedicine applications- Basic parts of a teleradiography system- Telepathology- Telecytology- Telecardiology- Teleoncology- Teledermatology- Telesurgery, telepsychiatry	9
IV	**INTERNET IN TELEMEDICINE** Internet in telemedicine 1) The internet 2) Basic concepts 3) Security – secure socket layer – Firewalls – proxies. Personal Communication , Medical data sharing needs for telemedicine- -Internet problems Distant training, teleworking and telecasting.	9
V	**ETHICAL AND LEGAL ASPECTS** Ethical and legal aspects of telemedicine-confidentiality, patient rights and consent-ehtical and legal aspects of internet-telemedical malpractice. Constraints for the wide spread use of telemedicine-constraints linked to economy, social	9

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acceptance Strategic planning for telemedicine implementation

Total Instructional Hours 45

Course Outcome

CO1 Understand the concepts of telemedicine, telehealth and telecare.
CO2 Acquire knowledge in different types of information and standards used in telemedicine.
CO3 Understand the applications of telemedicine.
CO4 Explain the use of internet in telemedicine
CO5 Learn the ethical and legal aspects in telemedicine.

TEXT BOOKS:

1. Olga (EDT), Ferrer – Roca, M. Sosa (EDT), Marcelo C, *Handbook of telemedicine*, IOS Press 2003.
2. A. C. Norris *Essentials of Telemedicine and Telecare*, John Wiley & Sons 2002.

REFERENCE BOOKS:

1. Ling Guan, *Multimedia image and video processing*, CRC Press 2000

2. Thorsten M Buzug, Heinz Handels, Dietrich Holz, *Telemedicine: Medicine and Communication*", Springer Verlag 2001
3. Douglas V.Goldstein, " *E Healthcare: Harness the power of Internet, e-commerce and e-care*", Jones and Barlett Publishers

Course Code & Name:19BMI8309 Telemedicine

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1
CO2	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO3	1	-	1	1	1	-	-	-	-	-	-	2	2	1	1
CO4	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO5	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-
Avg	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1

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Programme	Course Code	Name of the Course	L	T	P	C
BE	19BM8310	BIOMETRIC SYSTEMS	3	0	0	3

Course Objective

1. To understand the technologies of fingerprint, iris, face and speech recognition
2. To understand the general principles of design of biometric systems and the underlying trade-offs.
3. To recognize personal privacy and security implications of biometrics based identification technology.
4. To identify issues in the realistic evaluation of biometrics based systems.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BIOMETRICS** Introduction and back ground – biometric technologies – passive biometrics – active biometrics - Biometrics Vs traditional techniques – Benefits of biometrics - Operation of a biometric system– Key biometric processes: verification, identification and biometric matching – Performance measures in biometric systems: FAR, FRR, FTE rate, FTA rate and rate- Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications	9
II	**FINGERPRINT IDENTIFICATION TECHNOLOGY** Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges - Fingerprint Image Processing - Minutiae Determination - Fingerprint Matching: Fingerprint Classification, Matching policies.	9
III	**FACE RECOGNITION** Introduction, components, Facial Scan Technologies, Face Detection, Face Recognition, Representation and Classification, Kernel- based Methods and 3D Models, Learning the Face Spare, Facial Scan Strengths and Weaknesses, Methods for assessing progress in Face Recognition.	9
IV	**VOICE SCAN** Introduction, Components, Features and Models, Addition Method for managing Variability, Measuring Performance, Alternative Approaches, Voice Scan Strengths and Weaknesses, NIST Speaker Recognition Evaluation Program, Biometric System Integration.	9
V	**FUSION IN BIOMETRICS** Introduction to Multibiometric - Information Fusion in Biometrics - Issues in Designing a Multibiometric System - Sources of Multiple Evidence - Levels of Fusion in Biometrics - Sensor level, Feature level, Rank level, Decision level fusion - Score level Fusion. Examples – biopotential and gait based biometric systems.	9
	Total Instructional Hours	**45**

Course Outcome

CO1 Understand the basic technologies used in biometric systems

CO2 Acquire knowledge the most common abstractions for data collections

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(e.g., stacks, queues, lists).

CO3 Use non linear data structures such as trees to solve problems. .

CO4 Apply Graph algorithms to find the shortest path cost

CO5 Apply Algorithms for solving problems like sorting and searching.

TEXT BOOKS:

1. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, —Biometric Systems, Technology Design and Performance Evaluation‖, Springer, 2005.

2. David D. Zhang, —Automated Biometrics: Technologies and Systems‖, Kluwer Academic Publishers, New Delhi, 2000.

REFERENCE BOOKS:

ıul Reid, —Biometrics for Network Security‖, Pearson Education, 2004.
alini K Ratha, Ruud Bolle, —Automatic fingerprint Recognition System‖, Springer, 2003
C Jain, I Hayashi, S B Lee, U Halici, —Intelligent Biometric Techniques in Fingerprint and Face Recognition‖ CRC Press, 1999.
hn Chirillo, Scott Blaul, —Implementing Biometric Security‖, John Wiley, 2003.

XTBOOKS:

1. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, —Biometric Systems,Technology Design and Performance Evaluation‖,Springer,2005.

2. David D.Zhang,—Automated Biometrics:Technologies and Systems‖,Kluwer Academic Publishers,NewDelhi,2000.

FERENCEBOOKS:

1. PaulReid, —Biometrics for Network Security‖, Pearson Education, 2004.
2. Nalini K Ratha,Ruud Bolle, —Automatic fingerprint Recognition System‖, Springer, 2003
3. LCJain, IHayashi, S BLee, UHalici, —IntelligentBiometricTechniquesinFingerprintandFaceRecognition‖CRC Press,1999.
4. John Chirillo,ScottBlaul, —Implementing Biometric Security‖,John Wiley,2003.

Course Code & Name:19BMI8310 Biometric Systems

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	-	-	-	-	-	-	-	-	2	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	-	2	2	1	1
CO3	2	1	2	-	-	-	-	-	-	-	-	1	3	1	1
CO4	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1
CO5	2	1	2	-	-	-	-	-	-	-	-	2	2	1	1
Avg	2	1	2	-	-	-	-	-	-	-	-	1	2	1	1

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OPEN ELECTIVE

Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM6401	APPLICATIONS OF BIOMEDICAL ENGINEERING	3	0	0	3

Course Objective

To elucidate the recent advancements in the fields of biomedical computing.
To gain knowledge about fiber optics and lasers application in biomedical application
Knowing how IoT and Biometrics is important in Healthcare.
Knowing about the use of robotics in Healthcare.

Unit	Description		Instructional Hours
I	**INTRODUCTION TO BIOMEDICAL ENGINEERING** Introduction to biomedical engineering, Role of biomedical engineers, players in biomedical engineering equipment's	Major	9
II	**BIOMEDICAL INSTRUMENTS** Diagnostic and therapeutic devices like ECG,EEG,EMG, Patient monitoring, Ventilator		6+(3)P
III	**FIBER OPTICS AND LASER INSTRUMENTATION** Fiber optic sensors, fiber optic communication and instrument system, Biomedical applications of optical sensor, Types of lasers, Lasers and tissue interaction, Laser instruments for micro surgery, removal of tumors of vocal cords, plastic surgery, dermatology.		6+(3)P
IV	**IoT and BIOMETRICS in healthcare** Applications of IoT in healthcare, Various recognition systems and its applications in healthcare.		6+(3)P

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ROBOTICS IN HEALTHCARE

V Robots in surgeries, Augmenting human abilities, Nano bots inside body, Future healthcare and Robots. 9

Total Instructional Hours 45

CO1 Understand the various perspectives of biomedical engineering.
CO2 Understand the concept of medical instruments in healthcare
CO3 Understandingfiber optics and laser used in the field of health care
CO4 Understand the concepts of IoT and Biometrics in healthcare
CO5 Understand the concepts of Robotics in healthcare.

TEXT BOOKS:

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw Hill, 2018.
2. John G. Webster, —Medical Instrumentation Application and Design, 5th edition, Wiley India Pvt Ltd,New Delhi, 2020.
3. Joseph D. Bronzino, Donald R. Peterson, "The Biomedical Engineering Handbook", 4th edition, CRC Press, 2015.
4. Kirill Lazarev, "Internet of things for Personal Healthcare.studies of application, motivation and audience of e-health secor", Smart wearable design, December 2016.
5. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, —Biometric Systems, Technology Design and Performance Evaluation‖, Springer, 2015.

REFERENCES:

1. Khandpur R.S, —Handbook of Biomedical Instrumentation‖, 3rdedition,Tata McGraw-Hill,New Delhi, 2014.
2. Leslie Cromwell, —Biomedical Instrumentation and measurement‖, 2nd edition, Prentice hallof India, New Delhi, 2015.
3. Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation andMeasurement Techniques‖, Prentice Hall of India, 1stedition, 2016.

Course Code & Name: 19BM6401 Applications of Biomedical Engineering

PO& PSO	PO1	PO2
CO1	3	2
CO2	3	-
CO3	-	1
CO4	3	-
CO5	1	3
Avg	2	1

Course Code & Name: 19BM6401 Applications of Biomedical Engineering

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	1
CO2	3	-	2	-	-	2	-	-	-	-	-	-	3	2	1
CO3	-	1	2	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3	-	2	-	-	-	-	-	-	-	-	2	-	3	1
CO5	1	3	3	3	-	-	-	-	-	-	-	2	-	3	1
Avg	2	1	2	1	-	0	-	-	-	-	-	1	1	2	1

SO	PSO 3
2	1
2	1
3	1
3	1
3	1
2	1

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Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM7401	FIRST AID IN EMERGENCY CARE	3	0	0	3

Course Objective

1. To study about introduction of first aid
2. To understand about emergency first aid
3. To gain a knowledge in First Aid Techniques
4. To learn about emergency equipment
5. To study about healthcare technologies

Unit	Description	Instructional Hours
I	INTRODUCTION TO FIRST AID	
	First aider - First aid priorities- Managing incident - Traffic accident – Fires – Clothing onFire - Electrical Incidents-low and high Voltage current – Lighting- Water Incidents- Water recue	9
II	EMERGENCY FIRST AID	
	Action in an Emergency-Chest compression only CPR- CPR for adult - CPR forchild- CPR for infant- Heart attack- Stroke – Asthma – Head Injuries.	9
III	FIRST AID TECHNIQUES	
	Removing head gear- First aid Material – Dressing – Types of Dressing – Principles ofBandaging – Roller bandages – Hand Bandages – Hand and Foot cover –Arm Sling	9
IV	EMERGENCY EQUIPMENT	
	Patient Monitor – Sphygmomanometer – Pulse oximeter- Heart rate monitor-Defibrillators – Ventilator – ECG.	9
V	HEALTHCARE TECHNOLOGIES	
	Introduction to mhealth – heathcare 3.0 – IoT in health care – Medical IoT devices– Remote Patient Monitoring – Depression Monitoring.	9
	Total Instructional Hours	**45**

Course Outcome	**CO1:** Explain the Introduction to First aid. **CO2:** Familiar with emergency First aid. **CO3:**Discuss about First aid technologies. **CO4:** Explain the emergency equipment. **CO5:** Discuss about the various healthcare technologies.

TEXT BOOKS:

T1 The authorized manual of St. John Ambulance, St. Andrew's Ambulance associationand the British red cross society, First Aid manual, 9th edition, Dorling Kindersley, London

T2 American college of emergency physicians, First Aid manual, 5th edition, Dorling Kindersley, London

REFERENCE BOOKS:

R1 Clement Text book on First Aid & Emergency Nursing, First edition, JP brothers, 2012

R2 Philip Jevon, Emergency care and First Aid for Nurses, A practical guide, Churchill Living Stone, 2007

R3 Mahadevan, Swaminatha V., and Gus M. Garmel. An introduction to clinical emergency medicine: guide for practitioners in the emergency department. Cambridge University Press, 2005

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MINOR SUBJECTS

Programme	Course code	Name of the course	L	T	P	C
B.E	21BM6601	BIOSENSOR AND MEDICAL INSTRUMENTATION	3	0	0	2

Course Objective

The student should be able

1. To understand the electrophysiological measurements
2. To understand the various measurement of blood pressure
3. Know the different types of biosensors.
4. Know the different medical imaging systems.
5. Know the electrical hazards and their prevention.

Unit	Description	Instructional Hours
I	**Electrophysiological Measurements:** Resting and action potential, Nernst and GHK potentials. Basic block diagram of biomedical instruments, instrumentation amplifier, electrodes tissue interface, skin contact impedance, sensor design and characteristics for measurement of bio-signals - ECG, EMG, EEG.	9
II	**Measurement of Blood Pressure:** Cardiac output, heart rate, heart sound, pulmonary function measurements, spirometer, photo plethysmography, body plethysmography, blood gas analyzers, pH of blood, measurement of blood pCO2, pO2 - pulse oximeter.	9
III	**Introduction of Biosensors:** Introduction of biosensors, classification of biosensors, sensor characteristics. Different transduction mechanism in biosensor, electrochemical, optical, enzymatic, immune, DNA biosensors. Applications of biosensors. Analytical modeling of biosensors.	9
IV	**Medical Imaging Systems:** X-Ray, computed tomography and MRI. Biomedical telemetry.	9
V	**Electrical Hazards & their Prevention:** Physiological effects of electrical currents, preventive measures to reduce shock hazards, leakage current, isolation of patient circuit, open ground problems and earthing methods.	9
	Total Instructional Hours	45

Course Outcome

CO1	To make the student acquire an adequate knowledge of the physiological systems of the human body and relate them to the parameters that have clinical importance.
CO2	Identify to describe how bio specific interaction is used for various applications.
CO3	To describe the most common sensor principles used today, such as electric, optical, and mechanic.
CO4	To compare different techniques with emphasis on sensitivity and selectivity.
CO5	To provide awareness of electrical safety of medical equipment's

TEXT BOOK:

T1 A John G Webster, Medical Instrumentation - Application and Design, Wiley, 2009.

T2 John G. Webster, Medical Instrumentation: Application and Design, 4th edition

REFERENCES:

R1 R.S.C. Cobbold, Transducers for Biomedical Measurements: Principles and Applications. Wiley, 1974.

R2 Donald G. Buerk, Lancaster, Biosensors: Theory and Applications, CRC Press, 1995.

Course Code &Name : 21BM3206 BIOSENSOR AND MEDICAL INSTRUMENTATION

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	-	-	2	2	1	1
CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
CO3	3	3	3	2	3	-	-	-	-	-	-	2	2	2	1
CO4	3	3	3	3	3	-	-	-	-	-	-	2	2	3	1
CO5	3	3	3	3	3	-	-	-	-	-	-	2	1	2	1
AVG	3	3	3	2.6	2.8	-	-	-	-	-	-	2	1.8	2	1

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Programme	Course code	Name of the course	L	T	P	C
B.E.	21BM6602	RADIOLOGICAL EQUIPMENTS	3	0	0	3

The student should be able

Course Objective

1. To get the clear understanding of X-ray.
2. To study the different types radio diagnostic unit.
3. To know about the portable X-ray units.
4. To have an idea about nuclear medicine.
5. To understand the need for radiation protection and various monitoring and protection techniques used in radiological equipment.

Unit	Description	Instructional Hours
I	**X-Rays:** Nature of X-Rays, X-rays production and properties, X-Ray Equipment (Block Diagram), X-ray tube, Quality of x-rays, Factors affecting quality, Digital Radiography.	9
II	**Modalities:** Fluoroscopy, Digital Fluoroscopy, Angiography, Cine angiography, Digital Subtraction, Mammography, Dental Radiography.	9
III	**Portable/Mobile X-ray Units:** Equipment for mobile radiography - Principle - uses, Mobile image intensifiers, Skill in using mobile units, Mobile units types - Differences, Cordless mobiles, Selection of equipment.	9
IV	**Nuclear Medicine Equipments:** Basics in nuclear medicine, Nuclear medicine equipments, Gamma cameras, Rectilinear scanners, Radioisotope generators, SPECT-CT & PET-CT - Advantages-Limitations.	9
V	**Radiation Safety:** Biological effects of Radiation, Radiation safety instruments - ICRP / AERB, Hazardous effect of Radiation, Radiation protection techniques, Safety limits.	9
	Total Instructional Hours	45

Course Outcome

CO1	Describe X-ray principles and functioning.
CO2	Recall the different types of modalities used in radiology.
CO3	Recognize the portable units used in radiology.
CO4	Understand the principle, components and applications of Nuclear medicine imaging system.
CO5	Identify the need for radiation protection and various monitoring techniques used in radiological protection.

TEXT BOOK:

T1 Jerrold T.Bushberg, J.Anthony Seibert, Edwin M.Leidholdt,Jr, John M.Boone, "The Essential Physics of Medical Imaging"", Lippincott Williams and Wilkins, 3rd Edition, 2012.

T2 Myer Kutz, —Standard handbook of Biomedical Engineering and design, McGraw Hill, 2003.

REFERENCES:

R1 B.H.Brown, PV Lawford, RH Smallwood, DR Hose, DC Barber, "Medical physics and Biomedical Engineering"", – CRC Press,1999.

R2 Physics and Radiobiology of Nuclear Medicine –Third edition – Gopal B.Saha – Publisher – Springer, 2006.

Course Code & Name : 21BM6602 / RADIOLOGICAL EQUIPMENT

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	2	-	-	1	-	-	-	-	-	2	1	1	2
CO2	3	-	3	-	-	1	-	-	-	-	-	2	1	1	2
CO3	3	-	3	-	2	1	-	-	-	-	-	2	1	1	2
CO4	3	-	3	-	2	1	-	-	-	-	-	2	1	1	2
CO5	2	-	3	-	1	3	2	3	-	-	-	2	1	1	2
AVG	2.8	-	2.8	-	1	1.4	0.4	0.6	-	-	-	2	1	1	2

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HONOUR SUBJECTS

Programme	Course code	Name of the course	L	T	P	C
B.E	21BM6204	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	3	0	0	3

Course Objective

The student should be able

1. To study the concept of machine learning
2. To understand the unsupervised and supervised learning
3. To explore the fundamental concept of artificial intelligence
4. To have an idea about various types of neural network
5. To understand about fuzzy logic and genetic algorithm concept with example

Unit	Description	Instructional Hours
	Introduction to Machine Learning	
I	Learning-Types of Machine Learning- The Brain and the Neuron-Design a Learning System-Perspective and Issues in Machine Learning- Concept Learning Tasks- Finding a Maximally Specific Hypothesis-Version Spaces and the candidate Elimination Algorithm- Linear Discriminates.	9
	Supervised and Unsupervised Learning	
II	Learning with Trees- Decision Tree-Constructing Decision Trees- Classification and Regression Trees- Nearest Neighbour Methods- Naive Bayes Linear models: Linear Regression, Logistic Regression- Data Clustering Algorithms- K means Algorithms- Fuzzy C means clustering - Mountain clustering- Subtractive clustering	9
	Introduction to Artificial Neural Network	
III	Charactertics- learning methods- taxonomy- Evolution of neural network-McCullough-Pitts neuron- linear separability- Hebb network- supervised learning network: perceptron networks-adaptive linear neuron- multiple adaptive linear neuron	9
	Types of Neural Network	
IV	BPN, associative memory network: auto-associative memory network, hetero-associative memory network, BAM, Hop-field network, Kohonen self-organizing, ART network, case studies on biomedical application	9
	Fuzzy Logic and Genetic Algorithm	
V	Classical set vs. Fuzzy set- Operation and Properties- Fuzzy Relations- Fuzzy Logic control-Fuzzification, Membership Function- De fuzzification and its application Genetic algorithm and search space-general genetic algorithm, operators in GA- genetic Programming-Advance in GA	9
	Total Instructional Hours	45

Course Outcome

CO1	Describe features that can be used for a particular machine learning approach
CO2	Classify contrast pros and cons of various machine learning techniques
CO3	Illustrate various artificial In intelligence techniques and paradigms
CO4	Interpret the various neural networks with biomedical application
CO5	Infer fuzzy logic and genetic algorithm concepts with example

TEXT BOOK:

T1 Tom M Mitchell,-Machine Learning, First Edition, McGraw Hill Education India Ltd,2013

T2 Jang J.S.R.,Sun C.T and Mizutani E,"Neuro Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence",Prentice Hall,2008

REFERENCES:

R1 Stephan Marsland, "Machine Learning:An Algorithmic Perspective", CRC Press, 2015

R2 LaurentFausett, "Fundamentals of Neural Networks:Architecture, Algorithms and Applications",Pearson Education India,2006

Course Code & Name : 21BM6204 / ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	-	-	-	-	-	-	-	-	1	-	-	-	1
CO2	3	2	3	-	-	-	1	-	-	-	1	-	3	-	1
CO3	3	2	3	-	-	-	3	-	-	-	1	-	3	-	1
CO4	3	-	2	-	-	-	2	-	-	-	3	-	2	-	1
CO5	3	-	-	-	-	-	-	-	-	-	3	-	-	-	1
Avg	3	1	2	-	-	-	1	-	-	-	2	-	2	-	1

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Programme	Course code	Name of the course	L	T	P	C
B.E	21BM6205	ROBOTICS IN MEDICINE	3	0	0	3

Course Objective

The student should be able

1. Understand the basic concept of robots
2. Classify types of robots, manipulators, actuators and grippers.
3. Understand basic kinematics.
4. Study about various types of sensors and power sources
5. Study various application of robot in medical field.

Unit	Description	Instructional Hours
	Introduction of Robotics:	
I	Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace,Automation,Mechanisms and movements, Dynamic stabilization-Applications of robotics in medicine	9
	Actuators ,Grippers and Manipulators:	
II	Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, various types of Grippers, design consideration in vacuum and other methods of gripping, PD and PID feedback actuator models ,Construction of manipulators, Manipulator Dynamic and force control, Electronic and Pneumatic manipulator.	12
	Basic Kinematics:	
III	Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse kinematic Problems.	6
	Power Source and Sensors:	
IV	Sensors and controllers, Internal and external sensors,position,velocity and acceleration sensors, proximity sensors, force sensors, laser range finder, variable speed arrangements, path determination-Machinery vision, Ranging-Laser-Acoustic, Magnetic ,fibre optic and Tactile sensor.	9
	Medical robotics:	
V	Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery,Neuro-surgery,Pediatric and General Surgery,Gynecological Surgery and Nano robotics.	9
	Total Instructional Hours	45

Course Outcome

CO1	Identify the concepts of robotics,motion,joints
CO2	Summarize the principles of sensors and actuators for robots
CO3	Use the software tools for designing and analysing the robot motion
CO4	Classify the performance to various sensors to its environment
CO5	Recommend suitable principles for specific application.

TEXT BOOK:

T1 Nagrath and Mittal,"Robotics and Control",Tata McGraw-Hill,First edition,2003.

T2 Spong and Vidhyasagar,"Robot Dynamics and Control",John Wiley and Sons,First edition,2008.

REFERENCES:

R1 Jacob Rosen,Blake Hannaford & Richard M Satva,"Surgical Robotics:System Applications & visions", Springer 2011

R2 Howie Choset,Kelvin Lynch,Seth Hutchinson,George Kantor,Wolfarm Burgard,Lydia Kavraki and Sebastian Thurn,:Principles of Robot Motion:Theory,Algorithms and Implementations,"Prentice Hall of India,First edition,2005.

R3 Barbara Webb and Thomas Consi R,"BioRoborics :Methods & Applications"'AAAI Press,MIT Press,First Egition,2001.

Course Code & Name : 21BM6205 / ROBOTICS IN MEDICINE

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	-	-	-	-	-	-	2	2	2	2
CO2	3	2	2	2	3	-	-	-	-	-	-	2	2	2	2
CO3	3	2	2	2	3	-	-	-	-	-	-	2	2	2	2
CO4	3	2	2	2	3	-	-	-	-	-	-	2	2	2	2
CO5	3	2	2	2	3	-	-	-	-	-	-	2	2	2	2
AVG	3	2	2	2	3	-	-	-	-	-	-	2	2	2	2

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DEPARTMENT OF BIOMEDICAL ENGINEERING

COs-POs AND PSOs MAPPING

BATCH-2019-2023

Course Code	COURSE NAME	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C101	21HE1101- Technical English	CO1	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
		CO2	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
		CO3	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
		CO4	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
		CO5	-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
			-	-	-	-	-	-	-	-	3	3	3	3	-	-	-
C102	21MA1103- Calculus and differential Equations	CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
		CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
		CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	2	2
		CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
		CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	2	2
			3	**3**	**3**	**2.4**	**2.4**	-	-	-	-	-	-	**2**	**2**	**2**	**2**
C103	21PH1151- APPLIED PHYSICS	CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
		CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
		CO3	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
		CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
		CO5	3	3	3	2	2	-	-	-	-	-	-	2	2	2	2
			3	3	3	3	2	-	-	-	-	-	-	2	2	2	2

C104	21CY1151- CHEMISTRY For ENGINEERS	CO1	3	2	2	-	2	1	1	-	-	-	-	1	1	1	1
		CO2	3	2	2	-	2	1	-	-	-	-	-	1	1	-	2
		CO3	3	2	2	-	2	1	1	-	-	-	-	1	1	-	3
		CO4	3	2	2	2	2	1	-	-	-	-	-	1	1	1	1
		CO5	3	2	2	-	2	1	-	-	-	-	-	1	1	1	2
			3	3	2	2	2	1	1	-	-	-	-	1	1	1	1.8
C105	21CS1151 - PYTHON PROGRAMMING AND PRACTICES	CO1	2	2	-	-	3	-	-	-	2	2	-	-	2	2	2
		CO2	2	2	-	-	3	-	-	-	2	2	-	-	2	2	2
		CO3	2	2	-	-	3	-	-	-	2	2	-	-	2	2	2
		CO4	2	2	-	-	3	-	-	-	2	2	-	-	2	2	2
		CO5	2	2	-	-	3	-	-	-	2	2	-	-	2	2	2
			2	2	-	-	3	-	-	-	2	2	-	-	2	2	2
C106	21EE1155 - BASICS OF ELECTRICAL ENGINEERIN G	CO1	2	2	2	2	-	-	-	-	-	-	-	-	1	1	1
		CO2	2	2	2	2	-	-	-	-	-	-	-	-	2	1	2
		CO3	2	2	2	2	-	-	-	-	-	-	-	-	3	1	3
		CO4	2	2	2	2	-	-	-	-	-	-	-	-	1	1	1
		CO5	2	2	2	2	-	-	-	-	-	-	-	-	2	1	2
			2	2	2	2	-	-	-	-	-	-	-	-	1.8	1	1.8
C107	21HE2101 BUSSINESS ENGLISH FOR ENGINEERS	CO1	1	2	1	1	1	2	1	2	2	3	-	3	1	-	2
		CO2	2	1	1	1	1	2	2	2	2	3	-	2	-	1	1
		CO3	2	2	1	1	1	2	2	2	2	3	1	3	1	-	1
		CO4	2	2	1	1	2	2	2	2	3	3	1	3	1	1	2
		CO5	1	1	1	1	1	2	2	1	2	3	1	3	1	1	1
			1.6	1.6	1	1	1.2	2	1.8	1.8	2.2	3	1	2.8	1	1	1.4
C108	21MA2102 - COMPLEX VARIABLES AND TRANSFORM CALCULUS	CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2	-
		CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2	-
		CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	2	-
		CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	2	-
		CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	2	-
			3.0	**3.0**	**3.0**	**2.4**	**2.4**	-	-	-	-	-	-	**2.0**	**2.0**	**2.0**	

C109	21CS2152-Essentials of C and C++ Programming	CO1	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
		CO2	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
		CO3	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
		CO4	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
		CO5	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
			3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
C110	21ME2154-ENGINEERING GRAPHICS	CO1	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
		CO2	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
		CO3	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
		CO4	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
		CO5	3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
			3	3	3	-	3	-	-	-	3	-	-	-	3	3	3
C111	21PH2151 - MATERIAL SCIENCE	CO1	3	3	3	2	2	-	3	-	-	-	-	2	1	1	1
		CO2	3	3	3	2	2	-	3	-	-	-	-	3	1	1	1
		CO3	3	3	3	2	2	-	3	-	-	-	-	3	1	1	1
		CO4	3	3	3	2	2	-	3	-	-	-	-	3	1	1	1
		CO5	3	3	3	2	2	-	3	-	-	-	-	3	1	1	1
			3	3	3	2	2	-	3	-	-	-	-	2.8	1	1	1
C112	21CY2151 ENVIRONMENTAL STUDIES	CO1	2	-	-	-	-	2	3	3	2	-	-	2	-	-	1
		CO2	2	-	-	-	-	2	3	3	2	-	-	2	-	-	2
		CO3	2	1	1	-	-	2	3	3	2	-	-	2	-	-	1
		CO4	2	1	2	-	-	2	3	3	2	-	-	2	-	-	1
		CO5	2	1	2	-	-	2	3	3	2	-	-	2	-	-	2
			2	1	1.67	-	-	2	3	3	2	-	-	2	-	-	1.4
C113	21ME2001-ENGINEERING PRACTICES LABORATORY	CO1	2	2	2	2	2	-	-	-	2	-	-	-	2	-	-
		CO2	2	2	2	2	2	-	-	-	2	-	-	-	2	-	-
		CO3	2	2	2	2	2	-	-	-	2	-	-	-	2	-	-
		CO4	2	2	2	2	2	-	-	-	2	-	-	-	2	-	-
		CO5	2	2	2	2	2	-	-	-	2	-	-	-	2	-	-
			2	2	2	2	2	-	-	-	2	-	-	-	2	-	-

C201	21MA3102-FOURIER ANALYSIS AND TRANSFORMS	CO1	3	3	3	3	-	-	-	-	-	-	-	2	2	3	-
		CO2	3	2	3	3	-	-	-	-	-	-	-	2	2	3	-
		CO3	3	3	2	3	-	-	-	-	-	-	-	2	2	3	-
		CO4	3	3	2	3	-	-	-	-	-	-	-	2	2	3	-
		CO5	3	3	3	3	-	-	-	-	-	-	-	2	2	3	-
			3	2.8	2.6	3	-	-	-	-	-	-	-	2	2	3	-
C202	21BM3201-ELECTRON DEVICES AND CIRCUITS	CO1	2	2	3	2	2	-	-	-	-	-	-	2	3	2	3
		CO2	2	2	3	2	2	-	-	-	-	-	-	2	3	2	3
		CO3	3	2	3	2	2	-	-	-	-	-	-	2	3	2	3
		CO4	2	2	3	2	2	-	-	-	-	-	-	2	3	2	3
		CO5	2	2	3	2	2	-	-	-	-	-	-	2	3	2	3
			2.2	2	3	2	2	-	-	-	-	-	-	2	3	2	3
C203	21BM3202-MEDICAL BIOCHEMISTRY	CO1	3	2	-	-	-	2	-	-	-	-	-	2	3	-	-
		CO2	3	2	-	-	-	2	-	-	-	-	-	2	3	-	-
		CO3	3	2	-	-	-	2	-	-	-	-	-	2	3	-	-
		CO4	3	2	-	-	-	2	-	-	-	-	-	2	3	-	-
		CO5	3	2	-	-	-	2	-	-	-	-	-	2	3	-	-
			3	2	-	-	-	2	-	-	-	-	-	2	3	-	-
C204	21BM3203-HUMAN ANATOMY AND PHYSIOLOGY	CO1	3	3	3	3	-	3	-	-	-	-	-	3	3	3	3
		CO2	3	3	3	3	-	3	-	-	-	-	-	3	3	3	3
		CO3	3	3	3	3	-	3	-	-	-	-	-	3	3	3	3
		CO4	3	3	3	3	-	3	-	-	-	-	-	3	3	3	3
		CO5	3	3	3	3	-	3	-	-	-	-	-	3	3	3	3
			3	3	3	3	-	3	-	-	-	-	-	3	3	3	3
C205	21BM3251-DIGITAL ELECTRONICS	CO1	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
		CO2	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
		CO3	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
		CO4	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
		CO5	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
			3	3	3	3	-	-	-	-	2	2	-	2	3	-	3

C206	21BM3001 - ELECTRON DEVICES AND CIRCUITS LAB	CO1	3	3	-	-	3	-	-	-	3	-	-	-	3	3	
		CO2	3	3	-	-	3	-	-	-	3	-	-	-	3	3	
		CO3	3	3	-	-	3	-	-	-	3	-	-	-	3	3	
		CO4	3	3	-	-	3	-	-	-	3	-	-	-	3	3	
		CO5	3	3	-	-	3	-	-	-	3	-	-	-	3	3	
			3	3	-	-	3	-	-	-	3	-	-	-	3	3	
C207	21BM3002 BIOCHEMISTRY LAB	CO1	3	3	3	-	3	-	-	-	3	-	-	2	3	-	-
		CO2	3	3	3	-	3	-	-	-	3	-	-	2	3		
		CO3	3	3	3	-	3	-	-	-	3	-	-	2	3		
		CO4	3	3.	3	-	3	-	-	-	3	-	-	2	3		
		CO5	3	3	3	-	3	-	-	-	3	-	-	2	3		
			3	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**3**		
C208	21BM4201 LINEAR INTEGRATED CIRCUITS	CO1	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
		CO2	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
		CO3	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
		CO4	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
		CO5	3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
			3	3	3	-	3	-	-	-	-	-	-	2	3	-	-
C209	21BM4202 BIOMEMS AND NANO TECHNOLOGY	CO1	3	3	3	3	-	-	-	-	-	-	-	2	3	-	3
		CO2	3	3	3	3	-	-	-	-	-	-	-	2	3	-	3
		CO3	3	3	3	3	-	-	-	-	-	-	-	2	3	-	3
		CO4	3	3	3	3	-	-	-	-	-	-	-	2	3	-	3
		CO5	3	3	3	3	-	-	-	-	-	-	-	2	3	-	3
			3	3	3	3	-	-	-	-	-	-	-	2	3	-	3
C210	21BM4203 PATHOLOGY AND MICROBIOLOGY	CO1	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
		CO2	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
		CO3	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
		CO4	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
		CO5	3	3	3	3	-	3	3	-	-	-	-	2	3	3	3
			3	3	3	3	-	3	3	-	-	-	-	2	3	3	3

C211	21MA4152 STATSTICS AND NUMERICAL METHODS	CO1	3	-	3										2	1	-
		CO2	3	2	3										2	1	-
		CO3	3	3	2										-	1	2
		CO4	3	3	2										-	1	2
		CO5	3	3	-										-	1	2
			3	2.75	2.5	-	-	-	-	-	-	-	-	-	2	1	2
C212	21BM4251 SENSOR AND MEASUREMENT	CO1	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
		CO2	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
		CO3	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
		CO4	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
		CO5	3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
			3	3	3	3	-	-	-	-	2	2	-	2	3	-	3
C213	21BM4001 INTEGRATED CIRCUITS LAB	CO1	3	3	3		3	-	-	-	3	3	-	2	3		3
		CO2	3	3	3		3	-	-	-	3	3	-	2	3		3
		CO3	3	3	3		3	-	-	-	3	3	-	2	3		3
		CO4	3	3	3		3	-	-	-	3	3	-	2	3		3
		CO5	3	3	3		3	-	-	-	3	3	-	2	3		3
			3	**3**	**3**		**3**	**-**	**-**	**-**	**3**	**3**	**-**	**2**	**3**		**3**
C214	21BM4002 HUMAN PHYSIOLOGY LABORATORY	CO1	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
		CO2	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
		CO3	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
		CO4	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
		CO5	3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
			3	3	3	-	3	-	-	-	3	3	-	2	3	3	3
C301	21BM5201 BIOCONTROL SYSTEMS	CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
		CO2	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
		CO3	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
		CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
		CO5	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
			3	3	3	3	-	-	-	-	-	-	-	-	3	3	3

C302	21BM5202 BIOMECHANICS	CO1	3	3	3	3	-	3	-	-	-	-	-	2	3	3	3
		CO2	3	3	3	3	-	3	-	-	-	-	-	2	3	3	3
		CO3	3	3	3	3	-	3	-	-	-	-	-	2	3	3	3
		CO4	3	3	3	3	-	3	-	-	-	-	-	2	3	3	3
		CO5	3	3	3	3	-	3	-	-	-	-	-	2	3	3	3
			3	3	3	3	-	3	-	-	-	-	-	2	3	3	3
C303	21BM5203 MICROPROCESSORS AND MICROCONTROLLERS	CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3
		CO2	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3
		CO3	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3
		CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3
		CO5	3	3	3	3	-	-	-	-	-	-	-	-	3	-	3
			3	3	3	3	-	-	-	-	-	-	-	-	3	-	3
C304	21BM5204 BIOMEDICAL INSTRUMENTATION	CO1	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
		CO2	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
		CO3	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
		CO4	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
		CO5	3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
			3	3	3	3	-	3	2	-	-	1	-	1	3	3	3
C305	21BM5301 MEDICAL PHYSICS	CO1	3	3	-	-	-	-	3	-	-	-	-	2	3	3	3
		CO2	3	3	-	-	-	-	3	-	-	-	-	2	3	3	3
		CO3	3	3	-	-	-	-	3	-	-	-	-	2	3	3	3
		CO4	3	3	-	-	-	-	3	-	-	-	-	2	3	3	3
		CO5	3	3	-	-	-	-	3	-	-	-	-	2	3	3	3
			3	3	-	-	-	-	3	-	-	-	-	2	3	3	3
C306	21BM5001 MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	CO1	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
		CO2	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
		CO3	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
		CO4	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
		CO5	3	3	3	3	-	-	-	-	3	3	-	-	3	-	3
			3	3	3	3	-	-	-	-	3	3	-	-	3	-	3

C307	21BM5251 VIRTUA L INSTRUMENTATI ON	CO1	2	2	-	-	3	-	-	-	3	2	-	2	3	3	-
		CO2	2	2	-	-	3	-	-	-	3	2	-	2	3	3	-
		CO3	2	2	-	-	3	-	-	-	3	2	-	2	3	3	-
		CO4	2	2	-	-	3	-	-	-	3	2	-	2	3	3	-
		CO5	2	2	-	-	3	-	-	-	3	2	-	2	3	3	-
			2	2	-	-	3	-	-	-	3	2	-	2	3	3	-
C308	21BM5002 BIOMEDICAL INSTUMENTATIO N LAB	CO1	3	2	-	-	-	-	-	-	3	-	-	2	-	3	1
		CO2	2	-	2	-	-	-		-	3	-	-	2	-	3	1
		CO3	3	-	3	2	-	-	-	-	3	-	-	-	-	3	1
		CO4	3	-	-	-	2	-	-	-	3	-	-	-	-	2	1
		CO5	3			2	-	-	-	-	3	-	-	2	3	3	1
			2.8	**2**	**2.5**	**2**	**2**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**3**	**2.8**	**1**
C309	21BM6201 BIO SIGNAL PROCESSING	CO1	3	2	1	2	3	-	-	-	1	-	-	-	3	3	2
		CO2	3	2	1	2	3	-	-	-	1	-	-	-	3	3	2
		CO3	3	2	3	3	3	-	-	-	1	-	-	-	3	3	2
		CO4	3	2	1	2	3	-	-	-	1	-	-	-	3	3	2
		CO5	3	2	3	3	3	-	-	-	1	-	-	-	3	3	2
			3	2	1.8	2.4	3	-	-	-	1	-	-	-	3	3	2
C310	21BM6202 RADIOLOGICAL EQUIPMENTS AND NUCLEAR MEDICINE	CO1	3	2	2	-	-	3	3	-	-	-	-	2	3	3	3
		CO2	3	2	2	-	-	3	3	-	-	-	-	2	3	3	3
		CO3	3	2	2	-	-	3	3	-	-	-	-	2	3	3	3
		CO4	3	2	2	-	-	3	3	-	-	-	-	2	3	3	3
		CO5	3	2	2	-	-	3	3	-	-	-		2	3	3	3
			3	**2**	**2**	**-**	**-**	**3**	**3**	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**
C311	21BM6301 BIOMATERIALS AND ARTIFICIAL ORGANS	CO1	3	2	2	-		3	1	2	1	1	2	2	3	3	3
		CO2	3	2	2	-	-	3	1	2	1	1	2	2	3	3	3
		CO3	3	2	2	-	-	3	1	2	1	1	2	2	3	3	3
		CO4	3	2	2	-	-	3	1	2	1	1	2	2	3	3	3
		CO5	3	2	2	-	-	3	1	2	1	1	2	2	3	3	3
			3	2	2	-	-	3	1	2	1	1	2	2	3	3	3

C312	21BM6203 ENTREPRENEURSHIP DEVELOPMENT	CO1		-	-	-	2	2	-	-	2	2	3	-	-	-	2
		CO2		-	-	-	2	2	-	-	2	2	3	-	-	-	2
		CO3	-	-	-	-	2	2	-	-	2	2	3	-	-	-	2
		CO4	-	-	-	-	2	2	-	-	2	2	3	-	-	-	2
		CO5	-	-	-	-	2	2	-	-	2	2	3	-	-	-	2
			-	-	-	-	**2**	**2**	-	-	**2**	**2**	**3**	-	-	-	**2**
C313	21BM6251 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT - 1	CO1	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
		CO2	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
		CO3	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
		CO4	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
		CO5	2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
			2	1	2	1	2	2	-	-	1	-	-	1	3	3	3
C314	21BM6001 BIOSIGNAL PROCESSING LABORATORY	CO1	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
		CO2	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
		CO3	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
		CO4	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
		CO5	3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
			3	3	-	-	3	-	-	-	3	2	-	2	-	3	-
C401	21BM7201- DIAGNOSTIC AND THERAPEUTIC EQUIPMENT-2	CO1	3	3	2	2		3	-	-	-	-	-	3	3	3	3
		CO2	3	3	2	2	-	3	-	-	-	-	-	3	3	3	3
		CO3	3	3	2	2	-	3	-	-	-	-	-	3	3	3	3
		CO4	3	3	2	2	-	3	-	-	-	-	-	3	3	3	3
		CO5	3	3	2	2	-	3	-	-	-	-	-	3	3	3	3
			3	3	2	2	-	3	-	-	-	-	-	3	3	3	3
C402	21BM7202- MEDICAL IMAGE PROCESSING	CO1	2	2	2	-	2	-	-	-	-	2	-	2	2	1	1
		CO2	2	2	2	-	2	-	-	-	-	2	-	2	2	1	1
		CO3	2	2	2	-	2	-	-	-	-	2	-	2	2	1	1
		CO4	2	2	2	-	2	-	-	-	-	2	-	2	2	1	1
		CO5	2	2	2	-	2	-	-	-	-	2	-	2	2	1	1
			2	2	2	-	2	-	-	-	-	2	-	2	2	1	1

C403	21BM7303- ADVANCED BIO ANALYTICAL AND THERAPEUTIC TECHNIQUES	CO1	3	3	3	3	-	2	1	-	-	-	-	2	3	3	3
		CO2	3	3	3	3	-	2	1	-	-	-	-	2	3	3	3
		CO3	3	3	3	3	-	2	1	-	-	-	-	2	3	3	3
		CO4	3	3	3	3	-	2	1	-	-	-	-	2	3	3	3
		CO5	3	3	3	3	-	2	1	-	-	-	-	2	3	3	3
			3	3	3	3	-	2	1	-	-	-	-	2	3	3	3
C404	21BM7251- HOSPITAL MANAGEMENT	CO1	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1
		CO2	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
		CO3	1	1	2	1	1	-	-	-	-	-	-	2	2	1	1
		CO4	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
		CO5	1	1	2	1	-	-	-	-	-	-	-	2	2	1	1
			1	1	1.4	1	1	-	-	-	-	-	-	1.6	2	1	1
C405	21BM7001- IMAGE PROCESSING LABORATORY	CO1	2	2	2	2	3	-	-	-	3	-	-	-	1	3	1
		CO2	2	2	2	2	3	-	-	-	3	-	-	-	1	3	1
		CO3	2	2	2	2	3	-	-	-	3	-	-	-	1	3	1
		CO4	2	2	2	2	3	-	-	-	3	-	-	-	1	3	1
		CO5	2	2	2	2	3	-	-	-	3	-	-	-	1	3	1
			2	2	2	2	3	-	-	-	3	-	-	-	1	3	1
C406	21BM7002- DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY	CO1	2	2	-	2	-	-	-	-	3	-	-	2	3	3	3
		CO2	2	2	-	2	-	-	-	-	3	-	-	2	3	3	3
		CO3	2	2	-	2	-	-	-	-	3	-	-	2	3	3	3
		CO4	2	2	-	2	-	-	-	-	3	-	-	2	3	3	3
		CO5	2	2	-	2	-	-	-	-	3	-	-	2	3	3	3
			2	**2**	**-**	2	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**2**	**3**	**3**	**3**
C407	21BM7901 - PROJECT PHASE-1	CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

C408	21BM6701-Industrial Training	CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
		CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
C409	21BM8304-WEARABLE MEDICAL DEVICES	CO1	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3	
		CO2	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3	
		CO3	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3	
		CO4	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3	
		CO5	3	2	2	-	1	3	3	-	-	-	-	3	-	-	3	
			3	2	2	-	1	3	3	-	-	-	-	3	-	-	3	
C410	21BM8306-REHABILITATION ENGINEERIN	CO1	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2	
		CO2	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2	
		CO3	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2	
		CO4	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2	
		CO5	2	2	2	2	-	2	2	2	-	-	1	2	2	2	2	
			2	2	2	2	-	2	2	2	-	-	1	2	2	2	2	
C411	21BM8901-PROJECT PHASE-II	CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
		CO2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
		CO3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
		CO4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
		CO5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
			3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

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