HINDUSTHAN

COLLEGE OF ENGINEERING AND TECHNOLOGY

(An Autonomous Institution)

Coimbatore – 641032

DEPARTMENT OF BIOMEDICAL ENGINEERING

Curriculum and ODD Semesters Syllabus for the Batch2024 – 2028 (R2022)

2023 – 2027 (R2022)

2022 – 2026 (R2022)

2021 – 2025 (R2019 with Amendments)

(Board of Studies held on 14.06.2024)

(Academic Council Meeting held on 21.06.2024)

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 andcreativity.

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

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 considerationfor the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. **Conduct investigations of complex problems**: Use research-based knowledge and researchmethods 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 assesssocietal, 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 forsustainable development.

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

PO 9. **Individual and team work**: Function effectively as an individual, and as a member or leaderin 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 clearinstructions.

11.**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 leaderin a team, to manage projects and in multidisciplinary environments.

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

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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 theFundamentals of Biomedical Engineering.

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

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

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

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

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

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

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CURRICULUM

B.E. BIOMEDICAL ENGINEERING (UG)
REGULATION-2022
For the students admitted during the academic year 2024-2025 and onwards
SEMESTER I

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
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
6	22BM1151	Introduction to Biomedical Engineering	ESC	2	0	2	3	4	50	50	100
			EEC Courses(SE/AE)								
7.	22HE1072	Entrepreneurship &Innovation	AEC	1	0	0	1	1	100	0	100
8.	22HE1073	Introduction To Soft Skills (Common to all branches)	SEC	2	0	0	0	1	100	0	100
			Mandatory Courses								
9.	22MC1093/ 22MC1094	தd y˙மyy / HERITAGE OF TAMIL	MC	2	0	0	1	2	40	60	100
10.	22MC1095	UNIVERSAL HUMAN VALUES (Common to all branches)	MC	2	0	0	0	2	100	0	100
		TOTAL		**16**	**1**	**8**	**19**	**26**	**380**	**320**	**700**

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	CP	CIA	ESE	TOTAL
SEMESTER III											
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 andPhysiology	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
			TOTAL	**17**	**1**	**12**	**25**	**30**	**480**	**420**	**900**

B.E. BIOMEDICAL ENGINEERING (UG)
REGULATION-2022
For the students admitted during the academic year 2022-2023 and onwards

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER V											
Theory											
1	22BM5201	Embedded Systems and IoMT	PCC	3	0	0	3	3	40	60	100
2	22BM53XX	Professional Elective-1	PEC	3	0	0	3	3	40	60	100
3	22BM53XX	Professional Elective-2	PEC	3	0	0	3	3	40	60	100
4	22BM53XX	Professional Elective-3	PEC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5	22BM5251	Virtual Instrumentation for Biomedical Signals using Lab VIEW.	PCC	2	0	2	3	4	50	50	100
6	22BM5252	Biomechanics	PCC	2	0	2	3	4	50	50	100
Practical											
7.	22BM5001	Embedded Systems Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses(SE/AE)											
8.	22HE5071	Soft Skills -4/Foreign languages	EEC	1	0	0	1	1	100	0	100
TOTAL				**18**	**1**	**6**	**22**	**25**	**410**	**390**	**800**

B.E. BIOMEDICAL ENGINEERING (UG)

REGULATION-2019

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

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER VII REGULATION-2019											
Theory											
1.	21BM7201	Diagnostic and Therapeutic Equipment-II	PC	3	0	0	3	3	25	75	100
2.	21BM7202	Medical Image Processing	PC	3	0	0	3	3	25	75	100
3.	21BM7203	Hospital Management	PE	3	0	0	3	3	25	75	100
4.	21BM73XX	Professional Elective -III	OE	3	0	0	3	3	25	75	100
5.	21BM74XX	Open Elective II	OE	3	0	0	3	3	25	75	100
Practicals											
6.	21BM7001	Image Processing Laboratory	PCC	0	0	3	1.5	3	50	50	100
7.	21BM7002	Diagnostic and Therapeutic Equipment Laboratory	PC	0	0	3	1.5	3	50	50	100
EEC Courses(SE/AE)											
8.	21BM7901	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 summervacation/placement training and same will be evaluated in Semester VII.

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.

Minor Specialization in Biomedical Instrumentation.(Regulation 2022)

SL. NO.	COURSE CODE	COURSE TITLE	CATEG ORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	22BM5031	Basics of Anatomy and Physiology	MDC	3	0	0	3	3
2.	22BM6031	Biosensors and Medical Instrumentation	MDC	3	0	0	3	3
3.	22BM6032	Radiological Equipment's	MDC	3	0	0	3	3
4.	22BM7031	Biomaterials and Artificial Organs	MDC	3	0	0	3	3
5.	22BM7032	Medical Equipment Calibration and Trouble Shooting	MDC	3	0	0	3	3
6.	22BM8031	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 thestudent's common to all the branches.

B.E- BIOMEDICAL ENGINEERING With Specialization In Advanced Healthcare And Devices

(HONOURS) .(Regulation 2022)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	TCP	CIA	ESE	TOTAL
1	22BM5205	Modeling of Physiological System	PC	3	0	0	3	3	40	60	100
2	22BM6204	Artificial Intelligence And Machine Learning	PC	3	0	0	3	3	40	60	100
3	22BM6205	Robotics In Medicine	PC	3	0	0	3	3	40	60	100
4	22BM7203	Quality Control &Regulatory Aspects Of Medical Devices	PC	3	0	0	3	3	40	60	100
5	22BM7204	3D Printing	PC	3	0	0	3	3	40	60	100
6	22BM8201	Medical products development and trouble shooting	PC	3	0	0	3	3	40	60	100

Minor Specialization in Biomedical Instrumentation .(Regulation 2019 with amendments)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	21BM5031	Basics of Anatomy and Physiology	MDC	3	0	0	3	3
2.	21BM6031	Biosensors and Medical Instrumentation	MDC	3	0	0	3	3
3.	21BM6032	Radiological Equipment's	MDC	3	0	0	3	3
4.	21BM7031	Biomaterials and Artificial Organs	MDC	3	0	0	3	3
5.	21BM7032	Medical Equipment Calibration and Trouble Shooting	MDC	3	0	0	3	3
6.	21BM8031	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 thestudent's common to all the branches.

B.E- BIOMEDICAL ENGINEERING With Specialization In Advanced Healthcare And Devices

(HONOURS) .(Regulation 2022 with amendments)

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 R2022

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

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SYLLABUS

Department of Biomedical Engineering
R-2022
NEW COURSES INTRODUCED

(I) New Course Introduced:

S. No	Regulation	Course Code	Course Name	Credits
1.	2022	22BM1151	Introduction to Biomedical Engineering	3
1.		22BM5201	Embedded Systems and IoMT	3
2.		22BM5301	Bio materials and Artificial Organs	3
3.		22BM5311	Bio MEMS and Nanotechnology	3
4.		22BM5313	Bio control systems	3
5.		22BM5251	Virtual Instrumentation for Biomedical Signals using Lab VIEW.	4
6.		22BM5252	Biomechanics	4
7.		22BM5001	Embedded Systems Lab	4
8.		22HE5071	Soft Skills -4/Foreign languages	1

SEMESTER I

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

Course Objective		**The student 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 single variate calculus.
	3.	Familiarize the student with functions of several variables.
	4	Acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
	5	Make a 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 - Jacobians – Maxima and minima of functions of two variables and Lagrange's method of undetermined 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 vectors - Green's theorem - Stoke's and Gauss divergence theorem (statement only) for cubes only.	12
	Total Instructional Hours	60

Course Outcome	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	Use differential calculus ideas on several variable functions.
	CO4	Apply multiple integral ideas in solving areas, volumes and other practical problems.
	CO5	Apply the concept of vector calculus in two and three-dimensional spaces

TEXT BOOK:

T1	Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th edition, 2019
T2	K. P. Uma and S. Padma, "Engineering Mathematics I (Matrices and Calculus) ", Pearson Ltd,2022.

REFERENCES:

R1	Jerrold E. Marsden, Anthony Tromba, "Vector Calculus", W.H.Freeman, 2003-Strauss M. J, G. L Bradleyand K. J .Smith, "Multivariable calculus", 6th edition, Prentice Hall, 2011.
R2	T, "Engineering Mathematics", 5th edition, Mc Graw Hill Education(India) Pvt Ltd, New Delhi, 2016
R3	G. B. Thomas and R. L. Finney, "Calculus and Analytical Geometry", 9th Edition, Addison Wesley Publishing Company, 2016.

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Programme	Course code	Name of the course	L	T	P	C
B.E	22BM1151	**Introduction to Biomedical Engineering**	3	0	1	4

Course Objective	**The student should be able**	
	1	To understand the fundamentals of Biomedical Engineering and Biomedical Engineer
	2	To understand about the basics of electrical and electronic Engineering
	3	To impart knowledge on principles of various biomedical equipment.
	4	To understand the various techniques used in diagnosis though imaging.
	5	To have a knowledge on ethics and safety standards

Unit	Description	Instructional Hours
I	**Fundamentals of Biomedical Engineering** Evolution of modern healthcare system- Sectors of Biomedical Engineering -Role of Biomedical engineers in various domains -Recent advances in Biomedical Engineering-Importance of Anatomy and Physiology-Nervous system-cardiovascular system-Respiratory system.	9
II	**Electrical and Electronics** Circuit Components: Conductor, Resistor, Inductor, Capacitor, Diode, Transistor, Amplifiers and Filters, Functional elements of an instrument, Standards and calibration. ***Experiments: Half wave and full wave rectifier, Voltage regulator, Logic gates, Inverting and non-inverting amplifier***	9+6
III	**Introduction to Biomedical Equipment** Sources of biomedical signals- basic medical instrumentation system-ECG-EMG-EEG-Pulse oximeter - Blood Glucose Monitor-Patient Monitoring System - Blood Pressure Monitor-Nebulizers. ***Experiments: Case study on measurement of vital parameters for family members, vital parameter monitoring, Blood glucose monitor, Blood pressure measurement***	9+3
IV	**Diagnostic Imaging Equipment** X-ray- CT- Nuclear Medical Imaging-Positron Emission Tomography-Magnetic Resonance Imaging Scanners-Diagnostic Ultrasound ***Experiments: Hospital visit for observing working of radiological equipments, Analysis of real time medical images X-ray, MRI, Ultrasound***	9+3
V	**Medical Safety Standard and Ethics** Medical standards and regulations- Good Laboratory Practices -Good Manufacturing Practices - Human factors- Morality and Ethics-A Definition of terms-Ethical issues in feasibility studies, Ethical issues in emergency use. ***Experiments: Industrial visit for gaining knowledge on medical standards and regulation***	9+3
	Total Instructional Hours	60

Course Outcome	CO1	Interpret the role of biomedical engineering in society
	CO2	Compute electric circuit parameters for simple problems
	CO3	Explore the principle of various biomedical Equipment
	CO4	Describe the techniques used in diagnostic imaging equipment
	CO5	Outline device specific safety goals and standards.

TEXT BOOK:

T1	Enderle, John D, Bronzino, Joseph D, Blanchard, Susan M- Introduction to Biomedical Engineering-Elsevier Inc 3rd edition,2012.
T2	R. S. Khandpur, Handbook of Biomedical Instrumentation, McGraw-Hill Publishing Company Limited, 3rd edition, 2014.
T3	Kothari DP and I.J Nagrath, Basic Electrical and Electronics Engineering, Second Edition, McGraw Hill Education, 2020

REFERENCES:

R1	Joseph. J Carr, John M Brown, Introduction to Biomedical Equipment Technology, John Wiley& Sons, New York,4th edition, 2001.
R2	M.Arumugam, 'Bio-Medical Instrumentation', Anuradha Agencies, 2003.
R3	Daniel A Vallero, Biomedical ethics for Engineers, Elsevier publication, 1st edition,2011

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	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					3				2	2	2	
AVG	2	2	2					2.2				2	2	2	

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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 andits 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'smethod. 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 plasticsCO2: Differentiate hard and soft water and solve the related problems on water purification indomestic as well as in industries.

CO3: Develop knowledge on the basic principles of electrochemistry and understand the causes ofcorrosion, its consequences to minimize corrosion to improve industrial design
CO4: Develop knowledge about the renewable energy resources and batteries along with the need ofnew 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).

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	1	1	1	1	-	1	-	1	2		
CO2	2	3	2	1	1	1	1	-	1	-	1	2		
CO3	2	2	2	2	1	1	1	-	1	-	1	2		
CO4	2	2	3	1	2	1	1	-	1	-	2	2		
CO5	2	3	3	2	2	1	1	-	1	-	1	2		
Avg	2	2.6	2.6	1.4	1.4	1	1	-	1	-	1.2	2		

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Programme	Course Code	Name of the Course	L	T	P	C
B.TECH.	22HE1151	ENGLISH FOR ENGINEERS (Common to all Branches)	2	0	2	3

	The student should be able
Course Objective	1. To help the students of engineering and technology develop a strong base in the use of English.
	2. To help learners use language effectively in professional writing.
	3. To impart basic English grammar and essentials of important language skills
	4 To impart knowledge about the importance of vocabulary and grammar
	5 To develop the communication skills of the students in both formal and informal situations

Unit	Description	Instructional Hours
I	**Language Proficiency**: Parts of Speech, Degrees of Comparison, Abbreviation& Acronyms Writing: Process Description, Instructions. Vocabulary – Words on Environment. Practical Component: Listening- Watching Short Videos and answer the questions, Speaking- Self introduction , Narrating personal experiences / events; Interviewing a celebrity; Reporting / and summarizing of documentaries / podcasts / interviews Reading- Purpose of Reading - Churning & Assimilation, Interpreting Ideas - Interpreting Graphs in Technical Writing.	7+2
II	**Language Proficiency:** Types of Sentences, Framing Question, One Word Substitution Writing: Writing Checklist, Reading Comprehension. Vocabulary– Words on Entertainment. Practical Component: Listening-Comprehensions based on TED talks Speaking- Story Telling Reading - Skimming – Scanning – Reading: Scientific Texts	7+2
III	Language Proficiency: Tenses, Conditional Clause ('If' clause), Active and Passive voices, Writing: Formal letter (invitation, acceptance, decline, Congratulation) Cloze test. Vocabulary – Words on Tools. Practical Component: Listening-Listening pre-recorded English language learning programme Speaking - Just a minute 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, Articles, The Use of Prefixes and Suffixes Writing: Preparing Agenda &Minutes, Writing Recommendations. Vocabulary– Words on Engineering process. Practical Component: Listening-An interview with someone who works for recruitment personnel. Speaking-Presentation on a general topic. Reading-Reading Comprehension - Literary Texts.	5+4
V	Language Proficiency: Prepositions, Phrasal Verbs, Modal Auxiliaries, Writing: Letter to the Editor, 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		
	CO1	Understand English and converse effectively.
	CO2	Enable the students to write coherently and cohesively.
	CO3	Enable the development of basic grammar to enhance language for a better communication
	CO4	Use suitable vocabulary and grammar with confidence and express their ideas in speech and writing.
	CO5	follow the etiquettes in formal and informal communication

TEXT BOOK:

T1	Raymond Murphy, "English Grammar in Use"-5th editionCambridgeUniversityPress, 2019.
T2	Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press, 2016.

REFERENCES:

R1	Kapoor A.N., Business Letters for Different Occasions, New Delhi: S. Chand & Co. Pvt. Ltd., 2012. .
R2	RaymondMurphy, " English Grammar For ESL Learners - Premium Fourth Edition.
R3	McCarthy, Michael et.al (2011) English Vocabulary in Use – advanced, Cambridge University Press.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	2	-	3	2	1	-	-
CO2	-	-	-	-	2	3	2	3	1	3	1	-	-	-
CO3	-	-	-	3		2	-	2	2	3	2	2	-	-
CO4	-	-	-	-	-	2	-	2	1	3	1	1	-	-
CO5	-	-	-	2	-	-	-	2	3	3	3	1	-	-

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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 angleprojections 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 oflateral 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

At the end of the course, the learner will be able to **Total Instructional Hours** **60**

Course Outcome

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

PO& PSO	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO1	PSO 2	PSO3
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

TEXT BOOK:

T1. K.Venugopal, V.Prabu Raja, "Engineering Drawing, AutoCAD, Building Drawings", 5thedition New Age InternationalPublishers, 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 Limi 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

The learner should be able

Course Objective

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. FILES, MODULES, PACKAGES**	9
V	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**	
	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 intofunctions

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.

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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.

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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
AVG	2	2	-	-	3	-	-	-	2	2	-	-	2	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/	22HE1072	UNIVERSAL HUMAN VALUES (COMMON TO ALL BRANCHES)	2	0	0	0

Course Objectives	**The students should be made** 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. TohighlightplausibleimplicationsofsuchaHolisticunderstandingIntermsofethicalhumanconduct, 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 Hur n Relationship 'Trust' – the Foundational Value in Relationship Values in Human to Human Relationship 'Respect' – as the Right Evaluation Understanding Harmony in the Society	6
IV	**Harmony in the Nature / Existence** Understanding Harmony in the Nature.Inter connectedness, 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 Case Studies Strategies 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, Jeevan Vidya Prakashan, Amarkantak,1999.
R4.Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.

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

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	22HE1072	ENTREPRENEURESHIP AND INNOVATION (Common to 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

TEXT BOOKS

T1:AryaKumar"Entrepreneurship–CreatingandleadinganEntrepreneurialOrganization",Pearson,SecondEdition(2012).
T2:EmrahYayici"DesignThinkingMethodology", Artbiztech, FirstEdition(2016).

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	22MC1094	**HERITAGE OF TAMIL (Common to all Branches)**	2	0	0	1

Course Objective	**The learner should be able to** 1. Introduce students to the great History of Tamil literature. 2. Establish the heritage of various forms of Rock art and Sculpture art. 3. To study and understand the various folk and Martial arts of Tamil culture 4. Introduce students to Ancient Tamil concepts to understand the richness of Tamil literature. 5. To learn about the various influences or impacts of Tamil language in Indian culture.

Unit	Description	Instructional Hours
I	**Language and Literature** Language families in India – Dravidian Languages – Tamil as a classical language – Classical Literature in Tamil- Secular nature of Sangam Literature – Distributive justice in Sangam Literature – Management principles in Thirukural – Tamil epics and impacts of Buddhism & Jainism in Tamil and Bakthi literature of Azhwars and Nayanmars – Forms of minor poetry _ Development of Modern literature in Tamil – Contribution of Bharathiyar and Bharathidasan.	6
II	**Heritage _ Rock Art Paintings to Modern Art – Sculpture** Hero Stone to Modern Sculpture – Bronze icons – Tribes and their handcrafts - Art of temple car making – Massive Terracotta sculptures, Village deities, Thiruvalluvar statue at Kanyakumari, Making of musical instruments – Mridangam, Parai, Yazh and Nadhaswaram - Role of Temples in social and economic life of Tamils.	6
III	**Folk and Martial Arts** Therukoothu, Karagattem, Villupattu, Kaniyankoothu, Oyilattam, Leather puppertry, Silambattam.,Valari Tiger dance – Sports and Games of Tamils.	6
IV	**Thinai Concept of Tamils** Flora and Fauna of Tamils – Aham and Puram Concept from Tholkappiyam and Sangam Literature – Aram concept of Tamils – Education and Literacy during Sangam Age - Ancient cities and ports of Sangam age – Exporot and Import during Sangam age – Overseas conquest of Cholas.	6
V	**Contribution of Tamils to Indian National Movement and Indian Culture** Contribution of Tamils to Indian freedom struggle – The cultural influence of Tamils over the other parts of India – Self respect movement – Role of Siddha Medicine in indigenous systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil books.	6
	Total Instructional Hours	**30**

Course Outcome	**At the end of the course, the learner will be able to** CO1: Learn about the works pertaining to Sangam age CO2: Aware of our Heritage in art from Stone sculpture to Modern Sculpture. CO3Appreciate the role of Folk arts in preserving, sustaining and evolution of Tamil culture. CO4: Appreciate the intricacies of Tamil literature that had existed in the past. CO5: Understand the contribution of Tamil Literature to Indian Culture

TEXT BOOKS:

T1: Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

T2: Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by:International Institute of Tamil Studies.

T3: Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu)(Published by: International Institute of Tamil Studies).

REFERENCE BOOKS:

R1-The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies)

R2- Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu TextBookand Educational Services Corporation, Tamil Nadu)

R3-Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – ReferenceBook.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech	22MC1093	TAMIZHAR MARABHU	2	0	0	1

GE3152 **தமிழர் மரபு** **L T P C**
1 0 0 1

அலகு I **மொழி மற்றும் இலக்கியம்:** 3

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II **மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை:** 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – கூமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III **நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்:** 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV **தமிழர்களின் திணைக் கோட்பாடுகள்:** 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V **இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு:** 3

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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Programme	Course Code	Course Title	L	T	P	C
B.E	22HE1073	INTRODUCTION TO SOFT SKILLS	2	0	0	0

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	11
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 ofquantitative 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 whilemaking optimum use of

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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	CP	CIA	ESE	TOTAL
		SEMESTER III									
Theory											
1.	22BM3201	Signals and Systems	PCC	3	1	0	4	4	40	60	100
2.	22BM3202	Electron Devices andCircuits	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 andPhysiology	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5.	22MA3151	Statistics and Numerical Methods With 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
			TOTAL	**17**	**1**	**12**	**25**	**30**	**480**	**420**	**900**

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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 III	**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
IV	**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
V	**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
	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, 2013edition.

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 EducationIndia, 2015.

R3 Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to BiomedicalInstrumentation", 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

PO & PSO	PO1	PO2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO1 2	PSO 1	PSO2	PSO 3
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	33	22	3
CO4	2	2	3	2	2	-	-	-	-	-	-	2	3	2	3
CO5	2	2	3	2	2	-	-	--	--	-	-	2	3	2	3
AVG	2.2	2	3	2	2	-	--	-	-	--	-	2	3	2	3

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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, OrientBlackswan 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

PO & PSO	PO 1	PO2	PO 3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
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	-	-
AVG	3	2	-	-	-	2	-	-	-	-	-	2	3	-	-

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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 humanbody.
2. Learn about the structure and functions of the skeletal ,muscular and respiratorysystems.
3. Students would have knowledge on Skeletal and muscular systems.
4. Students would be able to comprehend circulatory and nervous systems and theircomponents.
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 theSkin, 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 Lymphaticsystems – 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

PO & PSO	PO 1	PO 2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
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
AVG	3	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	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.

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	1	-	-	1	2	2	3	2
CO2	3	3	3	3	3	-	1	-	-	1	2	2	3	2
CO3	3	3	3	3	2	-	1	-	-	1	2	2	3	2
CO4	3	3	3	2	2	-	1	-	-	1	2	2	2	2
CO5	3	3	3	2	2	-	1	-	-	1	3	2	2	2
Avg	3	3	3	2.6	2.4		1			1	2.2	2	2.6	2

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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 functionsTo 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 toBinary 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.	9
IV	**Experimental Design and implementation of Shift registers, Synchronousand Asynchronous Counters** **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, PearsonEducation,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, 2013R2
Kharate G.K "Digital Electronics" Oxford, First edition-2018

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

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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
BE	22BM3002	Electron Devices and Circuits Lab	0	0	3	2

Course Objective

1. To learn the characteristics of PN junction diode.
2. To understand the characteristics of Zener diode.
3. To learn the characteristics of Transistors and frequency response of amplifiers.
4. To learn the working of oscillators.
5. 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.

PO & PSO	PO 1	PO 2	PO 3	PO4	PO 5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
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	-
AVG	3	3	-	--	3	-	-	-	3	-	--	-	3	3	-

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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

1. General guidelines for working and functional component of biochemistry lab
2. Preparation of solutions: 1) percentage solutions, 2) molar solutions, 3) normal solutions
3. Demonstration of proper use of volume and weight measurement devices.
4. Preparation of buffer-titration of a weak acid and a weak base.
5. Qualitative tests for carbohydrates-distinguishing reducing from non-reducing sugrase and keto from aldo sugars
6. Spectroscopy: Determination of absorption maxima (λ-max) of a given solution
7. Estimation of blood glucose.
8. Estimation of Hemoglobin
9. Estimation of creatinine.
10. Estimation of urea.
11. Estimation of cholesterol.
12. Preparation of serum and plasma from blood.
13. Separation of proteins by SDS electrophoresis(Demo)
14. Separation of amino acids by thin layer chromatography(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 parameterand their interpretation in Blood sample.

CO5: Understand the separation technology of proteins and amino acids.

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
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 Code	Course	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
I	**Logical Reasoning** Clocks - Calendars - Direction Sense - Cubes - Data Interpretation: Tables, Pie Chart, Bar Graph - Data Sufficiency	9
II	**Quantitative Aptitude** 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
III	**Verbal Ability** 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
IV	**Writing skills for placements** 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 thanconventional methods.

CO3 : Students will heighten their awareness of correct usage of English grammar inwriting 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. SijwaliR2: How to prepare for data interpretation for CAT by Arun Sharma.

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

R4: Quantitative Aptitude for Competitive Examinations -Dr. R.S. Aggarwal, S. ChandR5: 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 tomake them understand the Importance of roots of knowledge system.
2. To make the students understand the traditional knowledge and analyze it and applyit to their day to day life.
3. To impart basic principles of thought process, Itihas and Dharma Shastra andconnecting society and nature.
4. To understand the concept of Intellectual and intellectual property rights with specialReference.
5. The course focuses on introduction to Indian Knowledge System, Indian perspective ofmodern 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 **Protection of traditional knowledge:**	6
II	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.

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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 VidyaBhavan, Mumbai, 5th Edition, 2014.
5 . V N Jha (Eng. Trans,), Tarkasangraha of Annam Bhatta, Inernational ChinmayFoundation, Velliarnad, Amaku,am

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FIFTH SEMEMSTER

Programme	Course code	Name of the course	L	T	P	C
BE	22BM5201	EMBEDDED SYSTEMS and IoMT	3	0	0	3

Course Objective	The student should be able
	1 Acquire knowledge and understand fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.
	2. Understand the hardware architecture and features of embedded microcontrollers and peripherals.
	3 Understand programming aspects of embedded system design.
	4 Understand IoT architecture and Build simple IoT Systems using e
	5 Understand IoMT infrastructure for healthcare applications.

Unit	Description	Instructional Hours
I	**Introduction To Embedded System Design** Introduction to embedded processors- Application Areas- Categories of embedded processors Challenges in Embedded System Design, Design Process- Requirements- Specifications Hardware architecture- Software architecture-Introduction to Harvard & Von Neuman architectures CISC & RISC Architectures. CPU Bus- Bus Protocols- Bus Organization, Memory Devices, and their Characteristics- RAM, EEPROM-Flash Memory- DRAM. BIOS, POST, Device Drivers.	9
II	**Peripheral Interfacing:** I/O Devices-Timers and Counters- Watchdog Timers, Interrupt Controllers- A/D and D/A, Interfacing- Memory interfacing with a case study- I/O Device Interfacing with case Study Programmed IO-Memory Mapped IO, Interfacing Protocols-SPI, I 2C, USB, CAN, Ethernet/WiFi, Bluetooth.	9
III	**Embedded System Software Design:** Application Software, System Software, Design techniques – State diagrams, sequence diagrams, flowcharts, etc., Model-based system engineering (MBSE), Use of High-Level Languages- embedded C / C++ Programming, Integrated Development Environment tools- Editor- Compiler Linker- Automatic Code Generators- Debugger- Board Support Library- Chip Support Library, Analysis and Optimization-Execution Time- Energy & Power.	9
IV	**Design And Development of IOT:** Definition and characteristics of IoT, Technical Building blocks of IoT, Communication Technologies, Physical design of IoT – system building blocks – sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino), Benefits and impact of IoMT. Cyber security – vulnerability, penetration & encryption technologies.	9
V	**Internet of Medical Things**: Case studies – Novel Symmetrical Uncertainty Measure (NSUM) Technique for Diabetes Patients, Healthcare Monitoring system through Cyber-physical system, An IoT Model for Neuro sensors, AdaBoost with feature selection using IoT for somatic mutations evaluation in Cancer, A Fuzzy Based expert System to diagnose Alzheimer's Disease, Secured architecture for IoT enabled Personalized Healthcare Systems, Healthcare Application Development in Mobile and Cloud Environments.	9
	Total Instructional Hours	45

Course Outcome		
	CO1	Explain fundamental embedded systems design paradigms, architectures, possibilities, and challenges, both with respect to software and hardware.
	CO2	Describe the hardware architecture and features of embedded microcontrollers and peripherals.
	CO3	Explain software design tools and embedded system design programming phases.
	CO4	Describe IoT Architectures and Build simple IoT Systems using embedded target boards.
	CO5	Exhibit understanding of IoMT infrastructure for healthcare applications.

TEXT BOOK:

T1	Embedded Systems – A Contemporary Design Tool, James K Peckol, , John Weily, 2008, ISBN: 0- 444-51616-6
T2	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.
T3	Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat, "Internet of Things and Personalized Healthcare Systems", Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019

REFERENCES:

R1	Introduction to Embedded Systems, Shibu K V, Tata McGraw Hill Education Private Limited, 2009, ISBN: 10: 0070678790 3.
R2	Embedded Software Primer, David E.Simon, ,Addison Wesley, ISBN-13: 978-0201615692
R3	The Intel Microprocessors, Architecture, Programming and Interfacing" Barry B.Brey, 6th Edition, Pearson

	Educatio"
R4	Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015

Course Code &Name : 22BM5201**&**EMBEDDED SYSTEMS and IoMT

PO & PSO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO 3
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
BE	21BM5251	VIRTUAL INSTRUMENTATIONUSING LabVIEW	2	0	2	3

Course Objective

Understand the fundamentals of Virtual Instrumentation.

1. Idea behind the software used in Virtual 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 andstrings, 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/Otechniques,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
I	**TOOLKITS** Biomedical toolkit, Signal Processing Tools-Fourier Transform, Power lV 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 beatrate using LabVIEW*
2. *Acquisition of PCG,EMG Signal*

V	**BIOMEDICALAPPLICATIONUSINGLabVIEW** Case study: Process Control and Automation Application, Biomedical application,robotics application,IoT application using LabVIEW,Real Timeacquisition of ECG,EMG,PCG and EEG signals.	9
	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.

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PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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	-
AVG	2	2	-	-	3	-	-	-	3	2	-	2	3	3	-

TEXTBOOKS:

1. John Essick,"Hands-On Introduction to LabVIEW for Scientists and Engineers",OxfordUniversity 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
B.E.	22BM5252	BIOMECHANICS	2	0	2	3

Course Objective	The student should be able
1	To summarize the fundamental concepts of biomechanics.
2	To infer the structure and properties of biosolids and biofluids.
3	To infer the structure and properties of hard and soft tissues.
4	To illustrate the functions of joint mechanics.
5	To illustrate the functions of sports mechanics.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BIOMECHANICS:** Definition and perspective of biomechanics – kinematics concept for analyzing human motion – kinetic concepts for analyzing human motion – linear kinetics of human movement – angular kinetics of linear movement – equilibrium and human movements.	9
II	**MECHANICS OF BIOSOLIDS AND BIOFLUIDS:** Constitutive equation – stress – strain – viscoelasticity – flow properties of blood – rheology of blood in micro vessels – bio viscoelastic solids.	9
III	**MECHANICS OF HARD AND SOFT TISSUES:** Bones – structure – composition – mechanical properties – anisotropy fracture mechanisms – pseudo elasticity – structure – function – mechanical properties of skin – ligaments – skeletal muscles and tendons.	9
IV	**MECHANICS OF JOINTS:** Skeletal joints – force and stresses in human joints – mechanics of the elbow – mechanics of shoulder – mechanics of spinal column – mechanics of hip – mechanics of knee – mechanics of ankle.	9
V	**SPORTS BIOMECHANICS:** Gait analysis – qualitative biomechanical analysis to improve technique – qualitative analysis of sports movements – understand injury development – geometry of motion – force and pressure measurement.	9
	LIST OF EXPERIMENTS 1. Measure the joint angle movements using goniometer. 2. Analyze mobility using motion capture system. 3. Foot pressure measurement using force plate. 4. Implementation of a skeletal tracking system using skell cam. 5. Design and development of pedometers and activity tracker using accelerometers. 6. Gait analysis using motion capture system.	15
	Total Instructional Hours	45 + 15

Course Outcome		
	CO1	Apply the basic concepts of biomechanics.
	CO2	Illustrate significant mechanical properties of biosolids and biofluids.
	CO3	Classify the significant mechanical properties of hard and soft tissues.
	CO4	Outline the function of mechanics of joints.
	CO5	Examine the applications of biomechanical studies in sports.

TEXT BOOK:

T1	Susan J Hall, "Basic Biomechanics", 7th Edition, McGraw Hill, 2015.
T2	Peter M McGinnis, "Mechanics of Sports and Exercise", 1st Edition, Human Kinetics, 2013.

REFERENCES:

R1	Roger Bartlett, "Introduction to sports mechanics", 2nd Edition, Routledge, 2007.
R2	Michael W Whittle, "Gait Analysis: An Introduction", Butterworth Heinemann, 3rd Edition, Elsevier, 2007.

Course Code & Name: 22BM5252 / BIOMECHANICS

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	1	1
CO2	3	1	-	-	-	-	-	-	-	-	-	1	2	1	1
CO3	3	1	-	-	-	-	-	-	-	-	-	1	2	1	1
CO4	3	2	2	-	1	-	-	-	-	-	-	1	2	1	1
CO5	3	2	2	1	1	-	-	1	-	-	-	1	2	1	1
AVG	3	1.3	0.8	0.2	0.3	-	-	0.2	-	-	-	1	2	1	1

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Programme	Course code	Name of the course	L	T	P	C
BE	22BM5001	EMBEDDED SYSTEMS and IoMT Laboratory	0	0	4	2

Course Objective	The student should be able
	1 Acquire knowledge for hardware architecture
	2. Create programming aspects of embedded system design.
	3 Understand IoT architecture
	4 Reflect specific knowledge in simple IoT Systems using embedded target boards.
	5 Knowledge about loMT infrastructure for healthcare applications.

Exp No.	Description	
1.	Explore AVR/ARM based controllers using Embedded C.	
2.	Basic and arithmetic Programs Using Embedded C.	
3.	Embedded C program to test interrupt and timers.	
4.	Develop Real time applications – clock generation, waveform generation, and counterusing embedded C.	
5.	Explore different communication methods with IoT devices.	
6.	Interface LED/Buzzer with platform/ Aurduino /Raspberry Pi, and write an embedded Cprogram to turn on / off LED/Buzzer with specified delay.	
7.	Interface DC/stepper motor using relay with open platform/ Aurduino /Raspberry Pi. and write an embedded C program to turn on motor if push button is pressed.	
8.	Develop simple application – testing infrared sensor – IoT Applications – using open platform/Raspberry Pi.	
9.	Develop simple application to interface DHT11 sensor with and write a program to displaytemperature humidity readings in LCD.	
10	Develop IoMT Application using open platform/ Aurduino. /Raspberry Pi. and sensorssuch as temperature, ECG, Pulse etc.	
11	Deploy IoMT applications using platforms.	
12	Mini Project.	
	Total Practical Hours	45

Course Outcome		
	CO1	Explain hardware architecture of embedded systems
	CO2	Apply the use of software design tools.
	CO3	Describe IoT Architectures
	CO4	Build simple IoT Systems using embedded target boards.
	CO5	Exhibit understanding of IoMT infrastructure for healthcare with simple applications.

Course Code &Name :22BM5001&EMBEDDED SYSTEMS and IoMT Laboratory

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	3	-	3	-	2	-	-	1	3	2	3	1
CO2	3	2	3	3	-	3	-	2	-	-	1	3	2	3	1
CO3	3	2	3	3	-	3	-	2	-	-	1	3	2	3	1
CO4	3	2	3	3	-	3	-	2	-	-	1	3	2	3	1
CO5	3	2	3	3	-	3	- -	2	-	-	1	3	2	3	1
AVG	3	2	3	3	-	3	-	2	-	-	1	3	2	3	1

Check mapping , read POs and PSOs and correlate

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5301	Biomaterials and Artificial Organs	3	0	0	3

Course Objective

The student should be able

1. To study the characteristics and classification of biomaterials.
2. To understand the response of biomaterials in living system.
3. To learn about the polymeric materials and composites in tissue replacements.
4. To know the compatibility and functioning of artificial organs inside the living system.
5. To understand various kinds of artificial organs and their importance.

Unit	Description	Instructional Hours
I	**STRUCTURE OF BIO-MATERIALS AND BIO- COMPATIBILITY** Definition and classification of bio-materials, mechanical properties, viscoelasticity ,woundHealingprocess, body response to implants, blood compatibility, HLA compatibility.	9
II	**IMPLANTMATERIALS** Metallic implant materials, stainless steels, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite, glass ceramics, carbons, medical applications case study on bone replacement.	9
III	**POLYMERIC IMPLANTMATERIALS** 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.	9
IV	**TISSUE REPLACEMENTIMPLANTS** Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft- tissue replacements, types of transplant by stem cell,sutures, surgical tapes ,Tissue adhesive/ glue. Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts,hard tissue replacementImplants, joint replacements, Pancreas replacement case study ontissuereplacement.	9
V	**ARTIFICIALORGANS** 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 heartvalve.	9
	Total Instructional Hours	45

Course Outcome

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 in living system.
CO4 Assess compatibility and functioning of artificial organs inside the living system.CO5 Design and develop biomaterial based scaffold for biomedical application.

TEXT BOOK:

T1 Sujata V.Bhatt,"Biomaterials",Narosa PublishingHouse, 7th Edition,2005.
T2 Joon B.ParkJosephD. Bronzino,"Biomaterials-PrinciplesandApplications",CRCpress,2003.

REFERENCES:

R1 H.H.Willard, D.L. Merrit,""Instrument alMethodsof Analysis",CBS Publishers,1992. R2
ParkJ.B.,"BiomaterialsScienceandEngineering'',PlenumPress,1984.

Course Code &Name : 22BM5301- Biomaterials and Artificial Organs

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2			3	1	2	1	1	2	1	2	2	2
CO2	3	2	2			3	1	2	1	1	2	1	2	2	2
CO3	3	2	2			3	1	2	1	1	2	1	2	2	2
CO4	3	2	2			3	1	2	1	1	2	1	2	2	2
CO5	3	2	2			3	1	2	1	1	2	1	2	2	2
AVG	3	2	2			3	1	2	1	1	2	1	2	2	2

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5302	CANCER BIOLOGY	3	0	0	3

Course Objective		The student should be able
	1	Understand the various types and features of cancer.
	2	Understand the role of mutagens, viruses, oncogenes and growth factors that lead to cancer.
	3	Understand the the signalling pathways and Tumor Suppressor genes in cancer development andProgression.
	4	Understanding the cell cycle and differentiation process of cancer.
	5	Understanding the Process and methods of cancer treatment.

Unit	Description	Instructional Hours
I	**NATURE OF CANCER** Defining Cancer- Tumor and Normal Cells, 6 hall marks of Cancer, Causes of Cancer – Mutagens, Carcinogens, Radiations. Tumor viruses-HPV, RSV, HIV, Oncogenes, Growthfactors and receptors in Cancer development- EGF receptors, Integrin receptors.	9
II	**MOLECULAR MECHANISMS** Signaling pathways in Cancer- Tyrosine phosphorylation, Downstream of RAS controlling Akt/PKB Kinase, RAS through Ral, Jak-STAT, Wnt-β catenin. Error in DNA Replication andRepair mechanisms-enzymes, nucleotide exicision repair, base-excision repair, mismatch repair.	9
III	**SIGNALING PATHWAYS** Tumor Suppressor Genes and Cell cycle checkpoints in Cancer development- Cyclins, cdks,pRb,E2F, Myc oncoprotein, TGF- β, p53 and other signaling pathways involved in apoptosis	9
IV	**CANCER DEVELOPMENT** \Tumorigenesis- Telomeres, multi step tumor formation, Darwinian model of clonal selection, Tumor promoters- non mutagenic, toxic, mutageninc agents, chronic inflammation, Stromal cells, and macrophages. Angiogenesis- Switch, Promoters, Inhibitors,Metastasis- E-cadherin, proteases, Ras-like GTPases.	9
V	**CANCER TREATMENT** Tumor immunology, immunotherapy, radiation therapy. Anti-cancer drugs- proteins, drug inclinical trials, EGF receptor antagonists, Proteasome inhibitors, Teratogen mTOR.	9
	Total Instructional Hours	45+15=60

Course Outcome		
	CO1	Differentiate between cancer and normal cell and name the six hallmarks of cancer.
	CO2	Explain role of mutagens, viruses, oncogenes and growth factors that lead to cancer.
	CO3	Outline the signaling pathways and Tumor Suppressor genes in cancer development andProgression.
	CO4	List the loss of cell cycle checkpoints, Cell immortalization development, and faulty DNArepair that leads to cancer.
	CO5	Describe the Process of apoptosis, Angiogenesis and Metastasis.

TEXT BOOK:

T1	Robert A. Weinberg, "The Biology of Cancer", 2nd edition, Garland Science, 2014.
T2	Lewis J. Kleinsmith, "Principles of Cancer biology", 1st Edition Pearson Education India, 2016

REFERENCES:

R1	Roger J.B. King and Mike W.Robins, "Cancer Biology", 3rd edition, Benjamin Cummings, 2006.
R2	Robert G. McKinnell, Ralph E. Parchment, Alan O.Perantoni, G.Barry Pierce, "The Biological Basis of Cancer",2nd Edition, Cambridge University Press, 1998

Course Code &Name : 22BM5302- CANCER BIOLOGY

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1								1			
CO2	3	2	3	1								1			
CO3	3	2	3	1				1	1			1			
CO4	3	2	3	1				1	1			1			
CO5	3	2	3	1								1			
AVG	3	2	3	1								1			

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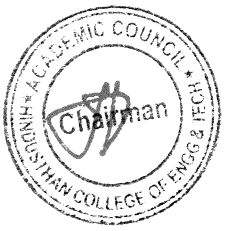

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Programme	Course code	Name of the course	L	T	P	C
B.TECH.	22BM5303	BIOMEDICAL OPTICS AND BIOPHOTONICS	3	0	0	3

Course Objective

The student should be able to

1. Understand the about the physical properties of light and optical properties of tissues.
2. Learn the design and working principle of various optical components.
3. Understand the principles and applications of optical biosensors.
4. Understand the engineering and practical applications of optics related to diagnostic and surgical applications.
5. Understand the phenomenon of laser tissue interaction and practical applications of optics related to therapeutic applications

Unit	Description	Instructional Hours
I	**OPTICAL PROPERTIES** Basic principles of light - Reflection - Refraction - Absorption - Polarization - Interference - Coherence, Basic laws of light - Beer Lambert law - Snell's law, Optical properties of tissues - Absorption - Scattering - Anisotropy.	9
II	**OPTICAL INSTRUMENTATION** Working principle of light sources - Lasers - LEDs, Working principle of optical detectors - Photodiode - Spectrometer - CMOS and CCD cameras - Lens - Optical filters - Optical fibers.	9
III	**OPTICAL BIOSENSORS** Principles of Optical biosensing - Immobilization of bio-recognition elements, Types of optical biosensor - Fiber optic - Planar waveguide - Evanescent - Interferometric - Surface plasmon resonance - Advantages and disadvantages - Applications.	9
IV	**APPLICATIONS OF LASERS** Diagnostic - Optical coherence tomography, Fluorescence, Raman, Photoacoustic tomography, Laser induced breakdown spectroscopy (LIBS), Hyperspectral imaging. Surgical - Lasers in dentistry, Dermatology, Ophthalmology.	9
V	**LASER TISSUE INTERACTION** Laser tissue interactions via photochemical, Photothermal, Photomechanical techniques, Photodynamic therapy (PDT) - Oncological and non-oncological applications, Low level laser therapy (LLLT) - Biostimulation applications.	9
	Total Instructional Hours	45

Course Outcome

CO 1	Explain the various physical properties of light and optical properties of tissues.
CO 2	Understand the working principles of optical components.
CO 3	Discuss the various applications of biosensors in medicine.
CO 4	Summarize the diagnostic and surgical applications of lasers in medicine.
CO 5	Explain the laser tissue interaction and various therapeutic applications of lasers.

TEXT BOOKS:

T1 Tuan Vo Dinh, "Biomedical Photonics –Handbook, CRC Press, Bocaraton, 2014.

T2 Jurgen Popp, Valery V. Tuchin, Arthur Chiou and Stefen Heinemann, Handbook of Biophotonics, Vol 2:Photonics for Healthcare, John Wiley and Sons, 1st Edition, 2011.

REFERENCES:

R1 Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications" Springer, 2007.

R2 Splinter R and Hooper B. A., "An Introduction to Biomedical Optics", Taylor and Francis, 2006.

Course Code &Name : 22BM5303- BIOMEDICAL OPTICS AND BIOPHOTONICS

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1								1	2	2	2
CO2	2	2	3	1								1	2	2	2
CO3	2	2	3	1				1	1			1	2	2	2
CO4	2	2	3	1				1	1			1	2	2	2
CO5	2	2	3	1								1	2	2	2
AVG	2	2	3	1								1	2	2	2

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5304	NEURAL ENGINEERING	3	0	0	3

Course Objective

The student should be able to

1. Understand the basics of nervous system development.
2. Understand the neuronal diseases and disorders.
3. Understand with nerve reconstruction and repairing.
4. Understand the about the principles of neurophysiologic recording and imaging technologies.
5. Understand the about the applications of neural engineering in sensory, motor, neurological andmental disorders.

Unit	Description	Instructional Hours
I	**BASICS OF NEURON STRUCTURE AND FUNCTIONS** Nervous system development. Trophic factors, extra cellular matrix components in nervous system development. Neuron: structure – function – classification. Glial cells – myelination. Neurotransmitter – types and functions. Synapses - Transport of materials and impulse in neurons.	9
II	**BRAIN, BRAIN STEM AND SPINALCORD** Brain: structures – lobes – functional areas. Brain stem: structures – functional areas. Spinal cord: structure – functions. Concepts of nuclei – sensory and motor Tracts - Reticular formation. Blood supply to Brain and spinal cord.	9
III	**NEURONALDISEASES AND DISORDERS** Neuro degeneration: Degenerative, Demyelinated and injury related disorders associatedwith nervous system. Wallerian Degeneration. Neuronal plasticity – CNS acting drugs and their pharmacokinetics. Alzheimer's, Parkinson's and Prion diseases.	9
IV	**NEUROPHYSIOLOGY & NEURORADIO LOGY** Physiology of nerve conduction. Peripheral nerves – structure & Functions. Synaptic transmission and cellular signaling of Neurons. Electrical activity of the Brain and recording of brain waves. Evoked potentials. Visualization of nervous system. Neuromotor-machineinterface: human voluntary motor control system.	9
V	**NERVE RECONSTRUCTION AND REHABILITATION** Neural plasticity; Neurological dysfunctions - Regeneration of the peripheral nervous system. Neural tissue engineering; Nerve graft; Drug delivery system in CNS. Rehabilitation; Mechanisms for Neuromotor rehabilitation; Robotics and virtual reality inphysical therapy; Transcranial magnetic stimulation.	9
	Total Instructional Hours	45

Course Outcome

CO 1	Explain the basic structure and functions of human nervous system.
CO 2	Understand diseases and degeneration related to nervous system.
CO 3	Analyze visualization and radiological assessment of nervous system.
CO 4	Apply neural tissue engineering for rehabilitation.
CO 5	Discuss about Regeneration of nervous system.

TEXT BOOK:

T1 Mathews G.G., "Neurobiology", 2nd edition, Blackwell Science, UK, 2000.

T2 Malcom Carpenter, "Textbooks of Neuroanatomy", Mc. Graw hill Edition, 1996.

REFERENCES:

R1 W. M[illegible]k Saltzman, "Tissue Engineering – Engineering principles for design of replacement organs and tissue",Oxford University Press Inc New York, 2004.

R2 Park J.B., "ACS Biomaterials Science and Engineering", Plenum Press, 2014.
Saunders, 2006.

Course Code & Name : 22BM5304- NEURAL ENGINEERING

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	1								1			

CO2	3	2	3	1								1			
CO3	3	2	3	1								1			
CO4	3	2	3	1								1			
CO5	3	2	3	1								1			
AVG	3	2	3	1								1			

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Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM5305	Principles of Tissue Engineering	3	0	0	3

Course Objective

1. To understand basics of Tissue Engineering.
2. To understand fundamentals of cell mechanisms.
3. To teach the Physical & biological principles that serve as the scientific basis for understanding the interactions of biological molecules and cells
4. To understand the techniques with biomaterials employed for the fabrication of permanent implantable prostheses and as matrices for tissue engineering.
5. To understand application of Tissue Engineering

Unit	Description	Instructional Hours
I	**BASICS OF TISSUE ENGINEERING** Introduction to Tissue Engineering - Objectives of Tissue Engineering - Basic definitions - Structure and organization of Tissues – Development of Tissue – Tissue exchange and diffusion of simple metabolites – Tissue Equivalent - Wound Healing Process - Biocompatibility and toxicity assessment.	9
II	**FUNDAMENTALS OF CELL MECHANISMS** Cell adhesion, Cell migration and Cell aggregation – Cell growth and Cell cycle. Cellular Interactions: Cell – Cell and Cell – Matrix. Control of Cell migration in Tissue Engineering – Cell delivery and Recirculation – Cell Culture in vitro – 3D culture in Tissue Engineering - In vitro Organogenesis - Cell transplantation.	9
III	**BIOMATERIALS IN TISSUE ENGINEERING** Definition – Biological vs Nonbiological materials – Extra Cellular Matrix – Collagen, Chitin & Degradable and Nondegradable materials – Polymer, Ceramics and Metals – Cell interaction with different materials – Scaffolds - Control releaser agents in Tissue Engineering – Cell interaction with suspension and gels – Tissue response to implants	9
IV	**STEM CELLS IN TISSUE ENGINEERING** Introduction of Stem cells – Hem poetic Stem cells - Embryonic Stem cells - Adult stem cells – Cancer Stem cells – Cord Blood cells – Induced Pluripotent Stem cells - Stem cell identification - Surface markers & FACS analysis – Differentiation, Dedifferentiation and Immortalization – Application of stem cells in tissue Engineering.	9
V	**TISSUE ENGINEERING APPLICATIONS** Synthetic components – Artificial organs – Joints and dental prostheses - Connective Tissue Engineering – Cardiovascular Tissue Engineering – Neural Tissue Engineering - Cell and Drug Delivery systems	9
	Total Instructional Hours	**45**

Course Outcome

CO1	Identify the importance of tissue engineering in the field of biomedical engineering
CO2	Explain the mechanisms involved in interaction of different materials with cells and tissues
CO3	Explain different methods involved in characterization and preparation of biomaterials in tissue engineering.
CO4	Analyse different types of stem cells and its application in tissue engineering
CO5	Apply the knowledge in creating new models in drug delivery systems using synthetic and natural scaffolds

TEXT BOOKS:

T1 W. Mark Saltzman Tissue Engineering – Engineering principles for des ign of replacementorgans and tissue, Oxford University Press Inc. New Yo rk, 2004.

T2 Gray E Wnek, Gray L Browlin, Encyclopaedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc. New York, 2004.

REFERENCE BOOKS:

R1 R.Lanza, J.Gearhart et.al,(Eds), Essential of Stem cell Biology, Elsevier Academic Press,2006.

R2 Sujata V.Bhatt, Biomaterials (2nd Edition), Narosa Publishing House, 2005.

R3 Develop new approaches to build new t issues using tissue engineering techniques.

Course Code & Name : 22BM5305/ Principles of Tissue Engineering

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1								1	1	1	1
CO2	3	2	3	1								1	1	1	1
CO3	3	2	3	1				1	1			1	1		1
CO4	3	2	3	1				1	1			1	1	1	1
CO5	3	2	3	1								1	1	1	1
AVG	3	2	3	1								1	1	1	1

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5306	ADVANCED BIO ANALYTICAL AND THERAPEUTICTECHNIQUES	3	0	0	3

Course Objective

The student should be able

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 - opticalbiosensor- 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 andradio 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- clinicalgene therapy studies- gene therapy for hereditary disease- gene therapy for cancer- gene therapy for HIV-Ethicalissues in human gene therapy.	9
	NANOTHERAPEUTICS	
V	Nanoparticles as carriers in drug delivery- design- manufacture and Physiochemical properties- transport across biological barriers- nanotechnology inCancer therapy-bone treatment- nano particles for oral vaccination and skin disease-Types of nanoparticles-halflife-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 Explain 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 BOOK:

T1 Douglas A, —Principles of Instrumental Analysis, Skoog Brooks Cole publisher 6th edition 2006.

T2 Keith Wilson & John Walker,— Practical Biochemistry , Principles and Techniques. OxfordUniversity Press 7thedition 2010.

REFERENCES:

R1 G. Louis Hornyak, John J. Moore, Harry F. Tibbals and Joydeep Dutta, —Fundamentals ofNanotechnology, CRCpress, 1st edition 2008.

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

Course Code &Name : 22BM5306- ADVANCED BIO ANALYTICAL AND THERAPEUTICTECHNIQUES

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1								1		2	
CO2	3	2	3	1								1		2	
CO3	3	2	3	1				1	1			1		2	
CO4	3	2	3	1				1	1			1		2	
CO5	3	2	3	1								1		2	
AVG	3	2	3	1								1		2	

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5307	FOUNDATION SKILLS IN INTEGRATED PRODUCTDEVELOPMENT	3	0	0	3

Course Objective	The student should be able	
	1	Understand the global trends and development methodologies of various types of products and services.
	2	Conceptualize, prototype and develop product management plan for a new product based on thetype of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems.
	3	Understand requirement engineering and know how to collect, analyze and arrive at requirementsfor new product development and convert them into design specification.
	4	Understand system modelling for system, sub-system and their interfaces and arrive the optimumsystem specification and characteristics.
	5	Gain knowledge of the innovation and product development process in the business context.

Unit	Description	Instructional Hours
I	**FUNDAMENTALS OF PRODUCT DEVELOPMENT:** **Global Trends Analysis and Product decision** - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - **Introduction to Product Development Methodologies and Management** - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle - Product Development Planning and Management.	9
II	**REQUIREMENTS AND SYSTEM DESIGN:** **Requirement Engineering** - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - **System Design & Modeling** - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.	9
III	**DESIGN AND TESTING:** **Conceptualization** - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – **Challenges in Integration of Engineering Disciplines** – Concept Screening & Evaluation - **Detailed Design** - Component Design and Verification – **Mechanical, Electronics and Software Subsystems** - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – **Prototyping** - Introduction to Rapid Prototyping and Rapid Manufacturing - **System Integration, Testing, Certification and Documentation.**	9
IV	**SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT:** Introduction to Product verification processes and stages - Introduction to Product Validationprocesses and stages - Product Testing Standards and Certification - Product Documentation-**Sustenance** -Maintenance and Repair – Enhancements - **Product EoL** – ObsolescenceManagement – Configuration Management - EoL Disposal.	9
V	**BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY:** **The Industry** - Engineering Services Industry - Product Development in Industry versus Academia – **The IPD Essentials** - Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.	9
	Total Instructional Hours	45

Course Outcome	CO1	Define, formulate and analyse a problem.
	CO2	Solve specific problems independently or as part of a team.
	CO3	Develop documentation, test specifications and coordinate with various teams and sustain up tothe EoL support activities for engineering customers.
	CO4	Work independently as well as in teams.
	CO5	Manage a project from start to finish.

TEXT BOOK:

T1	Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition,New Delhi, 2011.
T2	John w Newstrom and Keith Davis, 'Organizational Behavior", Tata McGraw Hill, Eleventh Edition, New Delhi, 2005.

REFERENCES:	
R1	Hiriyappa B, "Corporate Strategy – Managing the Business", Authorhouse, USA, 2013.
R2	Peter F Drucker, "People and Performance", Butterworth – Heinemann (Elsevier), Oxford, UK, 2004.

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Course Code & Name: 22BM5307 / FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT

PO & PSO	PO1	PO2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO11	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	1	-	-	-	-	-	-	-	-	1	1	1	1
CO2	3	2	2	2	-	-	-	-	-	-	-	1	2	1	1
CO3	3	2	2	2	1	-	-	-	-	-	-	1	1	1	1
CO4	3	2	1	2	-	-	2	1	3	-	-	1	2	1	1
CO5	3	2	1	2	-	-	2	1	-	-	2	1	1	1	1
AVG	3	2	1.2	1.3	0.2	-	0.6	0.3	0.5	-	0.3	1	1.2	1	1

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Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM5308	ARTIFICIAL NEURAL NETWORKS	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 problem solving
5. To understand about the basic concepts of associative memories.

Unit	Description	Instructional Hours
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: Apply associative memories learning techniques for real life problems

TEXT BOOKS:

T1 Laurene Fausett, "Fundamentals of Neural Networks" , Pearson Education,2004.

T2 Simon Haykin, "Neural Networks- A comprehensive foundation", Pearson Education, 2003.

REFERENCE BOOKS:

R1 S.N.Sivanandam, S.Sumathi,S. N. Deepa "Introduction to Neural Networks using MATLAB 6.0", TATAMc Graw Hill, 2006.

R2 S. Rajasekharan and G. A. Vijayalakshmi pai, "Neural Networks, Fuzzy logic, Genetic algorithms:synthesis and applications", PHI Publication, 2004.

R3 Timothy J. Ross, " Fuzzy Logic With Engineering Applications", Tata McGraw-Hill Inc. 2000.

Course Code&Name: 22BM5308\ ARTIFICIAL NEURAL NETWORKS

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	2	-	-	-	-	-	-	1	2	1	1
CO2	3	2	1	2	2	-	-	-	-	-	-	1	2	1	1
CO3	3	2	1	2	2	-	-	-	-	-	-	1	2	1	1
CO4	3	2	1	2	2	-	-	-	-	-	-	1	2	1	1
CO5	3	2	1	2	2	-	-	-	-	-	-	1	2	1	1
AVG	3	2	1	2	2	-	-	-	-	-	-	1	2	1	1

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Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM5309	**PATIENT SAFETY, STANDARD AND ETHICS**	3	0	0	3

Course Objective	**The student should be able**	
	1	Applying the fundamental concepts and principles of electricity
	2	Applying the concept and principles of patient safety and the regulations to be followed
	3	Apply the concept and principles of ISO standards for medical instruments
	4	Applying the concept and principles in several departments.
	5	Applying the medical ethics drafted by several associations

Unit	Description	Instructional Hours
I	**EFFECTS OF ELECTRICITY:** Physiological effects of electricity – important susceptibility parameters – microshock – macroshock hazards -patients electrical environment – isolated power system – conductive surfaces	9
II	**PATIENT SAFETY LAWS AND REGULATIONS:** Mandatory Reporting systems. Anatomy of a patient safety Law: Compliance Tips, Federal patient safety Legislation Initiatives, Medical Device Reporting, Clinical trials and Adverse-Event Reporting, Patient safety Goals and standards, The Quality Assessment and performance Improvement rule.	9
III	**ISO STANDARDS:** ISO 13485:2016: Requirements for regulatory purposes: Quality Management Systems, certification process. ISO 14971: Application of Risk management to medical Devices.	9
IV	**PATIENT SAFETY IN MAIN CLINICAL SPECIALITIES:** Intensive care and Anesthesiology, safety surgery save lives, Emergency department clinical risk, Obstetric safetypatient, Patient safety in internal medicine, Patient safety in Radiology.	9
V	**MEDICAL ETHICS:** Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor And Society, Case Studies.	9
	Total Instructional Hours	45

Course Outcome	CO1	Outline the importance of patient safety against electrical hazards.
	CO2	Brief out the patient safety laws and regulations
	CO3	Explain the standards and testing of patient
	CO4	Understand the concept of the patient safety specialities in clinical
	CO5	Know about various health care organization

TEXT BOOK:

T1	John G.Webster, "Medical Instrumentation Application and design", 4th edition, Wiley India PvtLtd, New Delhi, 2015.
T2	Liam Donaldson,Walter Ricciardi, "Textbook of patient safety and clinical Risk manageme ", Springer.

REFERENCES:

R1	Fay A. Rozovsky, James R. Woods, Jr, " The Handbook of Patient Safety Compliance", 2016

Course Code&Name: 22BM5309\ PATIENT SAFETY, STANDARD AND ETHICS

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	1	2	3	-	1	2	1	1	3	-	3	1	2	1	2
CO2	2	2	3	-	1	3	1	2	3	-	3	1	2	1	2
CO3	2	2	3	-	3	2	1	2	3	-	3	1	2	1	2
CO4	1	2	3	-	3	2	2	2	3	-	3	1	2	1	2
CO5	2	2	3	-	2	2	2	2	3	-	3	1	2	1	2
AVG	2	2	3	-	1	2	1	2	3	-	3	1	2	1	2

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5310	WEARABLE MEDICAL DEVICES	3	0	0	3

Course Objective

The student should be able

1. To understand wearable health monitoring systems and the electrodes usedfor the acquisition ofbiological signals.
2. To determine the multi functional sensor systems for health monitoring and their energyharvesting methodology under the self powered category.
3. To apply the various wireless communication modalities for healthcare devices and understand thedesigning of wireless health Platforms.
4. To understand the sensors used for healthcare monitoring and nanomaterial based skin Electronics.
5. To apply the concept of wearable electronics to medical diagnostics and monitoring.

Unit	Description	Instructional Hours
I	INTRODUCTION 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
II	ENERGY HARVESTING Energy Harvesting for Self-powered wearable devices, wireless Communication technologies, Design of wireless health	9
III	platforms. LOW POWER HEALTH MONITORING SYSTEMS Semiconductors in flexible electronics, Low power analog and digital circuit design for bio potential acquisition – architecture and practical considerations .Intelligent patches.	9
IV	SENSOR SKINS Sensor Skins: An Overview, Nanomaterials-Based Skin-Like Electronics for the Unconscious and Continuous Monitoring of Body Status – detection mechanisms, fabrication.	9
V	MEDICALTEXTILES 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,textileinteractivemedicalagent(depotsanddisposingsystems),Heat ablete tiles. 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 systems.
- CO2 Explain the energy harvesting in wearable devices.
- CO3 Use the concepts of BAN in healthcare.
- CO4 Illustrate the concepts of BAN textiles.
- CO5 Compare the various wearable devices in healthcare systems.

TEXT BOOK:

T1 BonfiglioA ,DeRossi.D,"WearablemonitoringSystems",Springer,2011.

T2 RogersJ.A, Ghaffari.R,Kim.D," Stretchable Bioelectronics for Medical Devices and Systems",Springer,2016.

REFERENCES:

R1 Roger Narayan, "Medical Biosensors for Point of Care, (POC) Applications", 1st Edition, Wood headpublishing,2016.

R2 Subhas Chandra Mukhopadhyay, "Intelligent Sensing, Instruments and Measurement- Wireless Sensors andSensor Networks",1st edition,Springer Berlin Heidelberg,2013.

Course Code & Name : 22BM5310- WEARABLE MEDICAL DEVICES

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO 9	PO10	PO 11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	1								1		1	1
CO2	3	2	3	1								1		1	1
CO3	3	2	3	1				1	1			1		1	1
CO4	3	2	3	1				1	1			1		1	1
CO5	3	2	3	1								1		1	1
AVG	3	2	3	1								1		1	1

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5311	BioMEMS AND NANOTECHNOLOGY	3	0	0	3

Course Objective

The student should be able

1. Learn about MEMS and Nanotechnology.
2. Learn various MEMS and Nanotechnology fabrication techniques.
3. Understand different types of sensors and actuators and their principles of operation.
4. Learn about Microfluidic systems.
5. Know the application of MEMS and Nanotechnology in different field ofmedicine.

Unit	Description	Instructional Hours
	INTRODUCTION TO MEMS & NANOTECHNOLOGY	
I	Introduction to Bio MEMS and Nanotechnology, Development of MEMS technology- Comparison of microsystems and microelectronics - Materials for MEMS-Smart Materials and Structures- Applications of MEMS.	9
	MICRO AND NANOFABRICATION TECHNIQUES	
II	Nanotechnology, Bottom up and top down methods of synthesis- Self-assembly-lithography techniques, etching - Ion implantation, surface micromachining- LIGA process-CVD technique.	9
	MEMS SENSORS AND ACTUATORS	
III	Sensing and Actuation- Piezoresistive and Capacitive sensing -Electrostatic actuation - Pressuresensors - Accelerometers, Gyroscopes- Interfacing with Sensors and Actuators-Nanopore sensors-magnetic sensors, Thermal sensors and actuators.	9
	MICRO-OPTO ELECTROMECHANICAL SYSTEMS & MICROFLUIDICS	
IV	Fundamental principle of MOEMS Technology - Light Modulators, Beam splitter ,Micro- lens, Micro-mirrors - Digital Micro-mirror Device, Light detectors - ImportantConsiderationon Micro-scale fluid, Properties of fluid - Fluid Actuation Methods , Micro-pumps - TypicalMicro-fluidic Channel, Micro-fluid Dispenser.	9
	APPLICATIONS OF MEMS AND NANOTECHNOLOGY IN MEDICINE	
V	Biochip-Micro Total Analysis Systems detection and measurement methods-DNA sensor- Drug delivery system, Ampero-metric Biosensor - Multi-analyte measurement, Micro- dialysis - Monitoring of Glucose & Lactate with a micro-dialysis probe , Ammonia Monitoring - Electronic Nose, Biomolecular sensing for cancer diagnostics using carbon nanotubes, Carbon nanotube biosensors, Magnetic nanoparticles for MR Imaging, Nano- devices in biomedical applications.	9
	Total Instructional Hours	45

Course Outcome

CO 1	Explain thr fundamentals of micro and nanotechnology
CO 2	Explain fabrication techniques of micro and nanotechnology
CO 3	Choose different types of MEMS sensor and actuators
CO 4	Discuss about the Micro-Opto Electromechanical Systems & Micro fluidics
CO 5	Describe the recent applications of MEMS and Nanotechnology in Medicine

TEXT BOOK:

T1 Tai Ran Hsu, —MEMS and Microsystems Design and Manufacture‖, Tata McGraw HillPublishing Company,New Delhi, 2002. (Unit I, II, III & IV).

T2 Wanjun Wang, Stephen A.Soper, ‖BioMEMS: Technologies and Applications‖, CRC Press,New York,2007.(Unit V).

REFERENCES:

R1 Marc J. Madou —Fundamentals of Microfabrication: the Science of Miniaturization‖,CRC Press,2002.

R2 Nadim Maluf, Kirt Williams. —An introduction to Microelectro Mechancial Systems Engineering‖,Second Edition, Artech House Inc, MA, 2004.

Course Code &Name : 22BM5311- BioMEMS AND NANOTECHNOLOGY

PO & PSO	PO1	PO 2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	2								1		
CO2	3	2	1	1	2								1		
CO3	3	2	1	1	2								1		
CO4	3	2	1	1	2								1		
CO5	3	2	1	1	2								1		
AVG	3	2	1	1	2								1		

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Programme	Course code	Name of the course	L	T	P	C
B.E	22BM5312	Medical Informatics	3	0	0	3

Course Objective	The student should be able
	1 To understand health informatics and the function of Hospital Information Systems.
	2 To analyse medical standards.
	3 To describe how medical data is stored.
	4 To comprehend the basic concepts of bioinformatics.
	5 To understand about the application of medical informatics.

Unit	Description	Instructional Hours
I	**MEDICAL INFORMATICS :** Introduction, Medical Informatics, Bioinformatics, Health Informatics, Structure of Medical Informatics Functional capabilities of Hospital Information System, On-line services and off-line services, History taking by computer, Dialogue with the computer.	9
II	**MEDICAL STANDARDS:** Evolution of Medical Standards, IEEE 11073, HL7, DICOM, IRMA, LOINC, HIPPA, Electronics Patient Records, Healthcare Standard Organizations, JCAHO (Join Commission on Accreditation of Healthcare Organization), JCIA (Joint Commission International Accreditation), Evidence Based Medicine, Bioethics.	9
III	**MEDICAL DATA STORAGE AND AUTOMATION :** Plug in Data Acquisition and Control Boards, Data Acquisition using Serial Interface, Medical Data formats, Signal, Image and Video Formats, Medical Databases, Automation in clinical laboratories, Intelligent Laboratory Information System, PACS, Data mining.	9
IV	**HEALTH INFORMATICS:** Bioinformatics Databases, Bio, information technologies, Semantic web and Bioinformatics, Genome projects, Clinical informatics, Nursing informatics, Public health informatics, Education and Training.	9
V	**RECENT TRENDS IN MEDICAL INFORMATICS :** Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment, Surgical simulation, Radiation therapy and planning , Telemedicine , virtual Hospitals , Smart Medical Homes , Personalized e-health services , Biometrics , GRID and Cloud Computing in Medicine	9
	Total Instructional Hours	45

Course Outcome		
	CO1	Discuss about health informatics and the function of Hospital Information Systems
	CO2	Analyze medical standards
	CO3	Explain about storage of medical data
	CO4	Understand the basic concepts of bioinformatics
	CO5	Discuss about the application of medical informatics

TEXT BOOK:

T1	R.D.Lele, —Computers in medicine progress in medical informatics, Tata McGraw Hill Publishing computers Ltd, 2005, New Delhi.
T2	Mohan Bansal, —Medical informatics, Tata McGraw Hill Publishing Computers Ltd, 2003 New Delhi

REFERENCES:

R1	N.Mathivanan, —PC-Based Instrumentationl, Prentice Hall of India Pvt Ltd , New Delhi , 2007.
R2	OrpitaBosu and Simminder Kaur Thukral, —Bioinformatics Databases, Tools and Algorithms, Oxford University press, 2007, New Delhi.
R3	Yi, Ping Phoebe Chen, —Bioinformatics Technologies, Springer International Edition, 2007, New Delhi.

Course Code &Name : 22BM5312/ MEDICAL INFORMATICS

PO & PSO	PO1	PO 2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1	-	-	2	-	1	-	1	1	2	2
CO2	3	2	1	1	1	-	-	2	-	1	-	1	1	2	2
CO3	3	2	1	1	1	-	-	2	-	1	-	1	1	2	2
CO4	3	2	1	1	1	-	-	2	-	1	-	1	1	2	2
CO5	3	2	1	1	1	-	-	2	-	1	-	1	1	2	2
AVG	3	2	1	1	1	-	-	2	-	1	-	1	1	2	2

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5313	BIOCONTROL SYSTEMS	3	0	0	3

Course Objective

The student should be able to

1. Understand the concept behind feedback and continuum in various systems and subsystems.
2. Analyze the systems in time and frequency domain and to understand the concept of stability.
3. Apply mathematical modeling principles in understanding the various fundamental biologicalsystems.
4. Understand biological system models.
5. Analyze 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 flow graph.	9
II	**TIME RESPONSE ANALYSIS** Standard test signals, time response of first order and second order systems, time domain specifications teady State errors	9
II	**FREQUENCY RESPONSE ANALYSIS** Determination of closed loop response from open loop response,Bode plot, Nichol'schart,Polarplot.	9
I	**STABILITYANALYSIS** Characteristic equation, Location of roots in s-plane for stability, Routh Hurwitz criterion, Root locus techniques-Construction, Gain margin and phase margin ,Nyquist stability criterion.	9
IV	**PHYSIOLOGICAL CONTROL SYSTEM ANALYSIS** Difference between engineering and physiological control system-Model development of Cardio vascular system-Heart model-circulatory model –Simple models of muscle stretch reflex action-Stability analysis of Pupillary light reflex-Regulation of cardiac output, Regulation of ventilation.	9
V		
	Total Instructional Hours	45

Course Outcome

CO1 Enumerate the need for mathematical modeling of various systems, representation of systemsin block diagrams and signal flow graphs and are introduced to biological control systems.

CO2 Analyze the time response of various systems and discuss the concept of system stability. 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 physiologicalcontrol systems.

TEXT BOOK:

T1 I.J. Nagarath and M. Gopal —Control Systems Engineering", Fifth Edition, AnshanPublishers,2008.T2 MichaelCKKhoo,—PhysiologicalControlSystemsl,IEEEPress,PrenticeHall of India,2005.

REFERENCES:

R1 John Enderle Susan Blanchard, Joseph Bronzino —Introduction to BiomedicalEngineeringl,secondedition,AcademicPress,2005

R2 BenjaminC. Kuo,—AutomaticControlSystemsl,PrenticeHallofIndia,1995.

Course Code &Name : 22BM5313& BIOCONTROL SYSTEMS

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2				1			2		2	2	2
CO2	3	3	3	2				1			2		2	2	2
CO3	3	3	3	2				1			2		2	2	2
CO4	3	3	3	2				1			2		2	2	2
CO5	3	3	3	2				1			2		2	2	2
AVG	3	3	3	2				1			2		2	2	2

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5314	BIOFLUIDS AND DYNAMICS	3	0	0	3

Course Objective

The student should be able to

1. Understand on the physiology and anatomy of studied systems.
2. Understand the flow properties of blood.
3. Analyze cellular, ocular, cardiovascular and respiratory fluid mechanics.
4. Understand the basics of soft tissue mechanics.
5. Learn 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- Newtonian fluid-Viscoelastic fluids -Bio viscoelastic fluid: Viscoelasticity - Viscoelastic models, Maxwell, Voigt and Kelvin Models, Response to Harmonic variation- Use of viscoelastic models- Bio- Viscoelastic fluids: Protoplasm- Mucus- Saliva- Synovial fluids.	9
II	**FLOW PROPERTIES OF BLOOD** Physical- Chemical and Rheological properties of blood-Apparent and relative viscosity-Blood viscosity variation- Effect of shear rate- hematocrit- temperature- protein contents of blood- Nature of red blood cells in tightly fitting tubes-hematocrit in very narrow tube.	9
III	**CARDIAC MECHANICS** Cardiovascular system- Mechanical properties of blood vessels: arteries, arterioles, capillaries and veins- Blood flow: Laminar and Turbulent- Respiratory Mechanics-Alveolimechanics- Interaction of Blood and Lung P-V curve of Lung-Breathing mechanism-Airway resistance- Physics of Lung diseases.	9
IV	**SOFT TISSUE MECHANICS** Pseudo elasticity- non-linear stress-strain relationship- Visco elasticity- Structure-functionand mechanical properties of skin- ligaments and tendons.	9
V	**ORTHOPEDIC MECHANICS** Mechanical properties of cartilage- diffusion properties of Articular cartilage- mechanicalproperties of bone- kinetics and kinematics of joints- lubrication of joints.	9
	Total Instructional Hours	45

Course Outcome

CO 1	Understand the principles of biofluid mechanics.
CO 2	Outline the flow properties of blood.
CO 3	Discuss on Cardiovascular and pulmanory system in human body .
CO 4	Explain blood properties ,especially the anatomy and physiology of soft tissues.
CO 5	Understand the concepts of orthopedic mechanics.

TEXT BOOK:

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

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

REFERENCES:

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

R2 Silver Frederick H. Biomaterials, Medical Devices & Tissue Engineering: Chapman & Ha London, 1994 .

Course Code &Name : 22BM5314& BIOFLUIDS AND DYNAMICS

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	1	1			1		1					1		
CO2	3	1	1			1		1					1		
CO3	3	1	1			1		1					1		
CO4	3	1	1			1		1					1		
CO5	3	1	1			1		1					1		
AVG	3	1	1			1		1					1		

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Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM5315	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 physiological systems.
3. To learn the concepts of modeling human thermal regulatory system.
4. To learn the concepts of modeling human respiratory system.
5. To study about 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, Loss of 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 .	9
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 of physiological systems
CO2 Have an in depth idea about different approaches in modeling physiologicalsystems
CO3 Design and develop the physiological model of human thermal regulatory system.
CO4 Design and develop the physiological model of human respiratory system
CO5 Gain in-depth knowledge about different types of neuron models and its electricalproperties

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 Neural systems* MIT Press

2. Vasilis Z Marmarelis, *Nonlinear Dynamic Modeling of Physiological systems* IEEE Press seriesin Biomedical Engineering,

Course Code&Name: 22BM5315\ PHYSIOLOGICAL MODELLING

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2									
CO2	3	2	1	1	1	2									
CO3	3	2	1	1	1	2									
CO4	3	2	1	1	1	2									
CO5	3	2	1	1	1	2									
AVG	3	2	1	1	1	2									

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5316	CARDIOVASCULAR ENGINEERING	3	0	0	3

Course Objective

The student should be able

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

Unit	Description	Instructional Hours
	INTRODUCTION TO CARDIOVASCULAR SYSTEM	
I	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, endocardium, interior of the heart.	9
	CARDIO CIRCULATORY SYSTEM	
II	Flow of blood through the heart, blood supply to heart, conducting system of the heart, factors affecting heart rate, the cardiac cycle, cardiac output. Circulation of the blood- pulmonary circulation, systemic circulation- aorta (different parts of aorta & their blood supply, in brief).	9
	CARDIAC EQUIPMENT	
III	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 pacemaker, Cardiac Defibrillators, Basic principles and comparison of different Defibrillators..	9
	MECHANISM OF BLOOD FLOW	
IV	Biofluidics: Biofluid mechanics, Flow properties of blood, Rheology of blood in microvessels, Mechanical properties of blood vessels: arteries, arterioles, capillaries, veins,Cardiovascular regenerative engineering	9
	CARDIOVASCULAR DISEASES	
V	Pericardial Disease, Atherosclerotic Disease, Ischemic Disease, Peripheral VascularDisease, Heart Failure, Arrhythmias, Valvular Disease, Pulmonary Vascular Disease	9
	Total Instructional Hours	45

Course Outcome

CO 1	Understanding detailed anatomy of the cardiovascular regions.
CO 2	Understanding various cardiac circulatory system.
CO 3	Understanding cardiac electrical activity with various equipment's used for heart analysis.
CO 4	Understanding the mechanism behind blood flow.
CO 5	Understanding cardiovascular diseases and its recovery.

TEXT BOOK:

T1 Archilles J. Pappano, Withrow Gil Wier, "Cardiovascular Physiology: Mosby Physiology Series",Elsevier; 11thedition, September 6, 2018.

T2 Michel R. Labrosse, "Cardiovascular Mechanics", 2021, CRC PRESS Taylor and Francis.

REFERENCES:

R1 Elaine N. Marie, "Essential of human anatomy and physiology", 11th edition, Pearson Education, New Delhi, 2021.

R2 Braunwald, Eugene. (2012) Heart Disease: A Textbook of Cardiovascular Medicine. 9th Ed W. B. SaundersCompany.

Course Code &Name : 22BM5316- CARDIOVASCULAR ENGINEERING

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	1								1			
CO2	3	2	3	1								1			
CO3	3	2	3	1				1	1			1			
CO4	3	2	3	1				1	1			1			
CO5	3	2	3	1								1			
AVG	3	2	3	1								1			

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Programme	Course code	Name of the course	L	T	P	C
B.E	22BM5317	ERGONOMICS	3	0	0	2

Course Objective	**The student should be able to**	
	CO1	To explain the general principles of human factors engineering.
	CO2	To explain the factors influencing performance and human response and errors.
	CO3	To explain physiological aspects of human at work.
	CO4	To explain work space layout and work station design
	CO5	To explain the interaction of humans and their working environment for improving worker performance and safety.

Unit	Description	Instructional Hours
I	**INTRODUCTION:** Brief history of human factors Engineering/Ergonomics – Interdisciplinary nature- Principles of Human factors Engineering- Biostatic and Biodynamic Mechanics.	9
II	**HUMAN PERFORMANCE:** Factors influencing performance – Information receiving and processing – Information theory and its application – Human response and errors – Signal detection theory.	9
III	**PHYSIOLOGICAL ASPECTS OF HUMAN AT WORK:** Metabolism – Physiological factors involved in muscular activity – Measurement of energy expenditure – Quantitative work load analysis – Physical work capacity and its evaluation – Physiological fatigue – Work and rest schedules – Physical fitness tests	9
IV	**WORK PLACE DESIGN:** Problems of body size, Anthropometry measures, Work posture – Work space layout and work station design – Design of displays, controls and VDT work stations – Hand tool design, illumination.	9
V	**OCCUPATIONAL HEALTH AND SAFETY:** Industrial accidents, Personnel Protective devices, Safety Management practices – Effect of Environment – heat, cold & noise – NIOSH regulations and Factories Act	9
	Total Instructional Hours	45

Course Outcome	CO1	Understood the fundamentals on of human factors Engineering/Ergonomics
	CO2	Understood about factors influencing performance and human response and errors.
	CO3	Shall gain knowledge on physiological factors involved in muscular activity.
	CO4	The Student should apply ergonomic principles to design workplaces for the improvement of human performance
	CO5	The Student should apply ergonomic principles to implement latest occupational health and safety to the work place.

TEXT BOOK:

T1	Bridger, R.S., "Introduction to Ergonomics", McGraw Hill, 1995.
T2	Martin Helander, "A guide to Ergonomics of Manufacturing", TMH, 2006

REFERENCES:

R1	Mecormik, T.J., "Human Factors Engineering", TMH, 1990.
R2	John Grimaldi, "Safety Management", A.I.B.S., 5th Edition, Hazard Control Technology 2003.

Course Code &Name : 22BM5317& ERGONOMICS

PO & PSO	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO3
CO1	3	3	3	3	3	-	-	-	-	-	-	2	2	1	1
CO2	2	2	3	2	2	-	-	-	-	-	-	2	2	2	2
CO3	2	3	2	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	22BM5318	HAPTICS	3	0	0	3

Course Objective	The student should be able to
	1 To Expose to basic principles of haptics and their property.
	2 To Give knowledge on machines in haptics.
	3 To Learn types of sensors and actuators.
	4 To understand suitable computation for haptics
	5 To understand basic concepts of human locomotion, biomechanical analysisusing Finite Element Analysis.

Unit	Description	Instructional Hours
I	**Human Haptics** Introduction to Haptics, Applications of Haptic Technology, Human Haptics, Somatosensory System, Motor System, Muscle Physiology, Haptics Psychophysical Experiments.	9
II	**Machine Haptic** Haptic Perception- Kinesthetic/Tactile, Multisensory Interactions, Psychophysics For Haptic Perception: Psychometric Function, Perceptual Thresholds, Laws Of Perception, Classical And Modern Psychophysical Methods	9
III	**Haptic sensors and actuators** Sensor, Nano Sensor, Human Sense, Types of Sensor, Application ofSensor, Actuator, Types of Actuator, Application of Actutor.	9
IV	**Computational haptics** Surface Haptics, Electrostatic Vs Ultrasonic; Mid-Air Haptics, HapticInteraction In Virtual And Augmented Reality (VR/AR)	9
V	**Haptics For Medical Applications** Applications: Telemedicine; Rehabilitation; Medical Simulations ForEducation	9
	Total Instructional Hours	45

Course Outcome		
	CO1	Explain the laws of principles of haptics for human
	CO2	Discuss the behavior of machines in haptics
	CO3	Analyse the suitable sensor and actuator for haptics
	CO4	Identify suitable computation for haptics
	CO5	Describe the finite element analysis, design the work station depending uponthe haptics

TEXT BOOK:

T1	Bhardwaj and S. Chaudhuri, Kinesthetic Perception: A Machine Learning Approach, SpringerPublishers, 2017.
T2	MC Lin and MA Otaduy (Eds), Haptic Rendering: Foundations, Algorithms, andApplicat s, AK Peters, Ltd; London: 2008.

REFERENCES:

R1	E. Steinbach, M. Strese, M. Eid, X. Liu, A. Bhardwaj, Q. Liu, M. Al-Jaa'afrah, T. Mahmoodi, R. Hassen, A. E. Saddik, and O. Holland, Haptic Codecs for the Tactile Internet [40pt], Proceedings of the IEEE, pp. 124, 2018.
R2	E. B. Goldstein, Sensation and Perception, 7th Ed., Thomson Wadsworth, Ch. 14, 2007

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	1	-	-	-	-	-	-	-	1	-	-
CO2	3	1	1	1	1	-	-	-	-	-	-	-	1	-	-
CO3	3	1	1	1	1	-	-	-	-	-	-	-	1	-	-
CO4	3	1	1	1	1	-	-	-	-	-	-	-	1	-	-
CO5	3	1	1	1	1	-	-	-	-	-	-	-	1	-	-
AVG	3	1	1	1	1	-	-	-	-	-	-	-	1	-	-

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B.E. BIOMEDICAL ENGINEERING (UG)
REGULATION-2019
For the students admitted during the academic year 2021-2022 and onwards

S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER VII REGULATION-2019											
Theory											
1.	21BM7201	Diagnostic and Therapeutic Equipment-II	PC	3	0	0	3	3	25	75	100
2.	21BM7202	Medical Image Processing	PC	3	0	0	3	3	25	75	100
3.	21BM7203	Hospital Management	PE	3	0	0	3	3	25	75	100
4.	21BM73XX	Professional Elective -III	OE	3	0	0	3	3	25	75	100
5.	21BM74XX	Open Elective II	OE	3	0	0	3	3	25	75	100
Practicals											
6.	21BM7001	Image Processing Laboratory	PCC	0	0	3	1.5	3	50	50	100
7.	21BM7002	Diagnostic and Therapeutic Equipment Laboratory	PC	0	0	3	1.5	3	50	50	100
EEC Courses(SE/AE)											
8.	21BM7901	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 summervacation/placement training and same will be evaluated in Semester VII.

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.

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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 respiratorysystem.
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
I	**INSTRUMENTS DEALING WITH BONES AND RESPIRATORY CARE** 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
II	**SENSORY DIAGNOSIS AND HEARING AID EQUIPMENTS** Mechanism of hearing, sound conduction system - basic audiometer, pure toneaudiometer - Speech audiometer, Bekesy audiometer system - Evoked response audiometry system - Hearing aids-cochlear implants - Tonometry - Measurement of basal skin response and galvanic skin response.	9
III	**DIATHERMY** 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

IV	**ULTRASONIC TECHNIQUE** 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
V	**PATIENT SAFETY** 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, Electricalsafety 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.

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	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
AVG	3	3	2	2		3	-	-	-	-	-	3	3	3	3

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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 Frequencydomain.
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 andGaussian 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 andenhancement.
CO3: Understand the restoration concepts and filtering techniques.
CO4: Learn the basics of segmentation, features extraction, compression andrecognition 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, ThirdEdition, 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 Processingusing 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

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	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
AVG	2	2	2	-	2	-	-	-	-	2	-	2	2	1	1

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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 managementTo learn the types of codes followed and applications

To explore various information management systems and relative supportive servicesLearn 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 ofHospitalsupport 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 Managementl, 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" OxfordPress, New Delhi, 2001

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	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
AVG	1	1	1.4	1	1	-	-	-	-	-	-	1.6	2	1	1

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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 ondiagnostic 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.

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	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
AVG	2	2	2	2	3	-	-	-	3	-	-	-	1	3	1

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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.

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	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
AVG	2	2	-	2	-	-	-	-	3	-	-	2	3	3	3

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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 on Fire - 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, DorlingKindersley, London

T2 American college of emergency physicians, First Aid manual, 5th edition, DorlingKindersley, 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 LivingStone,2007

R3Mahadevan, 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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Course Code&Name: 21BM7401\ FIRST AID IN EMERGENCY CARE

PO & PSO	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO 3
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	-
AVG	2	2	-	-	3	-	-	-	3	2	-	2	3	3	-

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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 deliverysystems.
  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 ,formui on 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 uterinedevice and application

COURSEOUTCOMES:

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

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

Textbooks:

1. Textbook Of Drug Delivery Systems (M.Pharm) Sem-I Paperback – 1 January 2020By 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, LongqinHu, 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 usingIoT
- To study the various IoT Protocols To
- study the various Physical DevicesTo
- 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 challengeCO5 :

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
I	**ANALYTICAL TECHNIQUES** 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
II	**ENZYMES AS A DIAGNOSTIC TOOL** 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 clinicallaboratory.	9
III	**RADIOISOTOPIC TECHNIQUES** 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 handlingisotopes-disposal of labeled compounds and radio dosimetry.	9
IV	**GENE THERAPY** 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 skindisease-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 ofNanotechnology, 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 press2008.

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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 ofdiseases.
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** Illustration 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 - Cocktailparty 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 EEGactivity - 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 EEGchannels - 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 – Transesoı ıgeal 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
		45
	TOTAL INSTRCTIONAL HOURS	

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 Wileyand sons, New York, 2009.

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Minor Specialization in Biomedical Instrumentation

(Regulation 2022)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	22BM5031	Basics of Anatomy and Physiology	MDC	3	0	0	3	3
2.	22BM6031	Biosensors and Medical Instrumentation	MDC	3	0	0	3	3
3.	22BM6032	Radiological Equipment's	MDC	3	0	0	3	3
4.	22BM7031	Biomaterials and Artificial Organs	MDC	3	0	0	3	3
5.	22BM7032	Medical Equipment Calibration and Trouble Shooting	MDC	3	0	0	3	3
6.	22BM8031	Wearable Devices	MDC	3	0	0	3	3

*MDC–Minor Degree Course

In addition to the above the following additional courses for Minor Degreecan also b given to the student's common to all the branches.

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM5301	Biomaterials and Artificial Organs	3	0	0	3

Course Objective

The student should be able

1 To study the characteristics and classification of biomaterials.
2 To understand the response of biomaterials in living system.
3 To learn about the polymeric materials and composites in tissue replacements.
4 To know the compatibility and functioning of artificial organs inside the living system.
5 To understand various kinds of artificial organs and their importance.

Unit	Description	Instructional Hours
I	**STRUCTURE OF BIO-MATERIALS AND BIO- COMPATIBILITY** Definition and classification of bio-materials, mechanical properties, viscoelasticity ,woundHealingprocess, body response to implants, blood compatibility, HLA compatibility.	9
II	**IMPLANTMATERIALS** Metallic implant materials, stainless steels, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite, glass ceramics, carbons, medical applications case study on bone replacement.	9
III	**POLYMERIC IMPLANTMATERIALS** 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 bloodoxygenation.	9
IV	**TISSUE REPLACEMENTIMPLANTS** Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft- tissue replacements, types of transplant by stem cell,sutures, surgical tapes ,Tissue adhesive/ glue. Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts,hard tissue replacementImplants, joint replacements, Pancreas replacement case study ontissuereplacement.	9
V	**ARTIFICIALORGANS** 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 heartvalve.	9
	Total Instructional Hours	45

Course Outcome

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 in living system.
CO4 Assess compatibility and functioning of artificial organs inside the living system.CO5 Design and develop biomaterial based scaffold for biomedical application.

TEXT BOOK:

T1 Sujata V.Bhatt,"Biomaterials",Narosa PublishingHouse, 7th Edition,2005.
T2 Joon B.Park JosephD. Bronzino,"Biomaterials-PrinciplesandApplications",CRCpress,2003.

REFERENCES:

R1 H.H.Willard, D.L. Merrit,""Instrument alMethodsof Analysis",CBS Publishers,1992.
R2 ParkJ.B.,"BiomaterialsScienceandEngineering'',PlenumPress,1984.

Course Code &Name : 22BM5301- Biomaterials and Artificial Organs

PO & PSO	PO1	PO2	PO 3	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	1	2	2	2
CO2	3	2	2			3	1	2	1	1	2	1	2	2	2
CO3	3	2	2			3	1	2	1	1	2	1	2	2	2
CO4	3	2	2			3	1	2	1	1	2	1	2	2	2
CO5	3	2	2			3	1	2	1	1	2	1	2	2	2
AVG	3	2	2			3	1	2	1	1	2	1	2	2	2

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Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM7602	Medical Equipment Calibration and Trouble Shooting	3	0	0	3

Course Objective	The student should be able	
	1	Applying the fundamental concepts and principles of a product design and development.
	2	Applying the concept and principles of work place design in product design and development.
	3	Apply the concept and principles of equipment design in product design and development.
	4	Applying the concept and principles of human factor application in product design and development.
	5	To evaluate the trouble shooting and trouble shooting of the medical domain equipments

Unit	Descripti on	Instructional Hours
I	**INTRODUCTION TO MEDICAL INSTRUMENTATION: Design of Cardiac Equipments- ECG, Defibrillator. Neurological Equipments-** EEG system maintenance and troubleshooting. Respiratory measurement system- Working of Ventilators, Humidifiers, Nebulizers, Inhalators	9
II	**FUNDAMENTALS OF PRODUCT DEVELOPMENT:** Global Trends Analysis and Product decision - Social Trends - Technical Trends. Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies	9
III	**PRODUCT SPECIFICATIONS, CONCEPT GENERATION, SELECTION AND TESTING:** Establish Target and Final product specifications – Activities of Concept Generation -Concept Screening and Scoring - Concept Testing Methodologies.	9
IV	**DESIGN FOR MANUFACTURE, PROTOTYPING AND ROBUST DESIGN:** Definition -Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping – Prototyping technologies - Planning for prototypes - Robust design –Robust Design Process	9
V	**TROBLE SHOOTING AND COMPLIANCE HANDLING:** Overview of medical device troubleshooting and calibration, Tools used for troubleshooting and calibration, Application, Technical & Internal techniques of troubleshooting, Overview on Calibration Analyser Fluke and Rigel, NABH & NABL Standard and certification.	9
	Total Instructional Hours	45

Course Outcome		
	CO1	Apply the principles and working of all Biological equipments.
	CO2	Apply the basic fundamentals of product development.
	CO3	To enhance the understanding of setting product specifications and generate, select, screen, and testconcepts for new product design and development
	CO4	Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development.
	CO5	Applying the concepts and knowledge of Trouble Shooting and provide the component with propercertification

TEXT BOOK:

T1	John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd,New Delhi, 2015.
T2	Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011

REFERENCES:

R1	Bridger R S, "Introduction to Ergonomics", Taylor and Francis, London,2003

Course Code &Name : 22BM7602& Medical Equipment Calibration and Trouble Shooting

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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
AVG	2	2	-	-	3	-	-	-	2	2	-	-	2	2	2

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B.E- BIOMEDICAL ENGINEERING With Specialization In Advanced HealthcareAnd Devices (HONOURS)
(Regulation 2022 with amendments)

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

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Programme	Course code	Name of the course	L	T	P	C
B.e	21BM7203	QUALITY CONTROL AND REGULATORY ASPECTS OF MEDICAL DEVICES	3	0	0	3

Course Objective	The student should be able
1	To study the regulation of medical devices, process of development, ethical and quality considerations.
2	To learn the various ISO standards of quality and risk management for regulatory purposes
3	To explore the process of approval and marketing of medical devices.
4	To comprehend the regulatory process for medical devices in India, US, and EU.
5	To familiarize with clinical evaluation and investigation of medical devices.

Unit	Description	Instructional Hours
I	**MEDICAL DEVICE REGULATIONS:** History of medical device regulation, regulatory affairs professi al's roles, required competencies, medical device classification: scope, definitions, main classifications, Risk based classification, practical examples, labeling of medical devices: definition, elements, risk management, clinical evaluation and labeling, language level and intended users. differentiating medical devices IVDs and combination products from that of pharmaceuticals.	9
II	**ISO STANDARDS:** ISO 13485:2016: Requirements for regulatory purposes: Quality Management Systems, certification process. ISO 14971: Application of Risk management to medical Devices	9
III	**IEC, REGULATORY SYSTEMS IN USA & EU:** IEC international standards and conformity assessment for medical devices, Good submission process, medical device regulatory system in the USA and European Union.	9
IV	**INDIAN REGULATORY SYSTEM:** India: Medical device regulatory system: market environment, functions undertaken by DGGI, central government, FDA and state governments, guidance documents, details of key regulators, IMDRF and CDSCO, regulatory overview in India, product registration on conformity assessment, quality system regulation, technical material and labeling requirements, commercial aspects, upcoming regulation changes.	9
V	**CLINICAL TRIALS AND DIGITAL REGULATIONS:** Regulatory strategy and competitive advantage, Preclinical and Clinical Trial Design for Medical Devices in India; FDA approved devices, post-market surveillance/vigilance, Digital health regulations: Connected care, intelligent design control, reducing design time and cost with in-silico clinical trials	9
	Total Instructional Hours	45

Course Outcome		
	CO1	Define and explain the basic concepts of medical device regulations.
	CO2	Decipher the meaning of ISO standards from a regulatory perspective.
	CO3	Explain US-FDA, IEC and European regulations.
	CO4	Discuss regulations in India
	CO5	Explain the regulatory aspects of clinical trials and digital alternatives

TEXT BOOK:

T1	Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products, 3rd Edition, Taylor & Francis Group, 2021
T2	Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006.

REFERENCES:

R1	Medical Device Quality Assurance and Regulatory Compliance by Richard C Fries, CRC Press, 1998.
R2	Product Safety in the European Union by GaborCzitan, Attila Gutassy, Ralf Wilde, TUVRheinlandAkademia, 2008.

Course Code &Name : 21BM7203/ QUALITY CONTROL AND REGULATORY ASPECTS OF MEDICAL DEVICES

PO & PSO	PO 1	PO 2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSC 1	PSO 2	PSO 3
CO1	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO2	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO3	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO4	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO5	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
AVG	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-

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Programme	Course code	Name of the course	L	T	P	C
B.E	21BM7204	3D PRINTING	3	0	0	3

Course Objective	The student should be able
	1 To impart knowledge on various additive manufacturing systems
	2 To understand various 3D printing materials
	3 To know about inkjet technology in 3D printing
	4 To teach the selection of material for 3D printing
	5 To explore various applications of 3D printing

Unit	Description	Instructional Hours
I	**Introduction to 3D Printing** Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing Processes, Applications, Research achievements in printing deposition, Technical challenges in printing,Applications of Printing Processes.	9
II	**3D Printing Materials** Polymers, Metals, Non-Metals, Ceramics; Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desiredproperties, Polymers and their properties; Support Materials.	9
III	**Inkjet Technology** Printer - Working Principle, Positioning System, Print head, Print bed,Frames, Motion control; Print head Considerations – Continuous Inkjet, Thermal Inkjet, Piezoelectric Drop-On-Demand	9
IV	**Powder Based Systems** Selective Laser Sintering(SLS): Principle, process, Indirect and direct SLS- powder structures, modelling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies	9
V	**3D Printing Applications** Application in Design; Application in Engineering; Biomedical Application, Bone and Joint reconstruction, Bio Printing Artificial Organ and Tissues, 3D medical Printing for Dental Application - Case studies	9
	Total Instructional Hours	45

Course Outcome		
	CO1	Differentiate between additive and conventional manufacturing methods.
	CO2	Know various 3D printing materials
	CO3	Understand the Ink Jet technology used in the 3D printing.
	CO4	Correlate the selection of appropriate powder based techniques.
	CO5	Recognize various 3D printing applications in the real time industrial problems

TEXT BOOK:

T1	Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", 2ndedition, World Scientific Publishers, 2003.
T2	Ian M. Hutchings, Graham D. Martin, "Inkjet Technology for Digital Fabrication", JohnWiley & Sons, 2013.

REFERENCES:

R1	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, RapidTooling, Rapid Manufacturing", Hanser Publisher, 2011.
R2	Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi, 2010.

Course code & Name: 21BM7204& 3D Printing

PO & PSO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	1	2	1	2	1	2	-	2	1	3	1	2
CO2	2	1	2	1	1	1	-	-	-	-	1	1	2	1	1
CO3	3	2	3	1	2	1	2	1	1	-	2	2	2	3	2
CO4	3	1	2	1	1	1	-	-	2	-	2	1	2	1	1
CO5	2	1	2	1	-	-	-	-	-	-	1	2	1	1	2
AVG	2	1	3	1	1	1	2	1	-	-	2	1	2	1	2

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Over all Percentage of the course revised as per X Board of Studies: 32 %

New courses introduced as per X Board of Studies: 8

Programme	Name of the Course
BE	**Python Programming for Biomedical Application**

Course Objective	1. Understand the most important libraries of Python, and its recommended programming styles and idioms.	
	2. Learn core Python scripting elements such as variables and flow control structures.	
	3. Develop applications using Python for Biomedical Application	
Unit	**Description**	**Instructional Hours**
I	**INTRODUCTION TO PYTHON, DATA TYPES, EXPRESSIONS** Introduction to Python Programming - Running Code in the Interactive Shell - Data Types, String Literals, Escape Sequences, String Concatenation, Variables and the Assignment Statement - Numeric Data Types Module, The Main Module, Program Format and Structure and Running a Script from a Terminal Command Prompt	6
II	**LOOPS AND EXPRESSIONS** Iteration - for loop - Selection - Boolean Type, Comparisons, and Boolean Expressions, if-else Statements, One-Way Selection Statements, Multi-way if Statements, Logical Operators and Compound Boolean Expressions- Conditional Iteration - while loop	6
III	**LISTS AND DICTIONARIES** Creating Lists, Basic List Operations, Indexing and Slicing in Lists, Built-In Functions Used on Lists, List Methods, The del Statement - Creating Dictionary, Accessing and Modifying key, value Pairs in Dictionaries, Built-In Functions used on Dictionaries, Dictionary Methods.	6
IV	**TUPLES AND SETS** Creating Tuples, Basic Tuple Operations, Indexing and Slicing in Tuples, Built-In Functions Used on Tuples, Relation between Tuples and Lists, Relation between Tuples and Dictionaries, Tuple Methods, Using zip () Function, Sets, Set Methods, Traversing of Sets, Frozenset	6
V	**CASE STUDIES IN BIOMEDICAL ENGINEERING** NumPy and Pandas with Python, Graphing with Matplotlib pyplot: Line Graphs, Scatter Graph, Pie Charts, Bar Charts, Figures and Subplot, 3D Graphs Case Study: Bio-Signal Plotting using Matplotlib/Pandas Library, Medical Imaging, Speech Recognition, Genomics, Drug Discovery, Patient Health Monitoring, Predictive Analytics in Healthcare.	6
	Total Instructional Hours	**30**

Course Outcome	CO1	Understand the fundamental of Python syntax and be fluent in the use of Python control flow statements.
	CO2	Learn methods to create and manipulate Python programs by utilizing the data structures like dictionaries, tuples and sets.
	CO3	Understand the Pandas and Numpy library for data science operation and plotting various Bio signal using Matplotlib.

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VALUE ADDED COURSE ON MEDICAL EQUIPMENT TROUBLESHOOTING & CALIBRATION

Course description and objectives:
To integrate & educate students on clinical and Technical application of various medical equipments. The course provides a gentle introduction to the Biomedical Instrumentation and is intended for beginning users and those looking for a review. It is designed to give students a basic understanding of medical instrumentation design.
1. To transform Biomedical Engineers to Clinical Engineers. (Fresher into Professional)
2. To impart basic Technical knowledge about Critical care medical instruments.(Fundamental Knowledge & Principles)
3. To impart problem solving & troubleshooting knowledge about Critical care medical instruments.

The main objectives are:
This course focuses on the medical instrumentation design, basics of electronics, current scenario & career opportunities in biomedical industry. Ideally suited for engineering students and graduates with a basic understanding of electronics and basic biomedical engineering knowledge.

Upon successful completion of this course, the student should be able to:
1. Ability to understand the basic working principle of Critical care product.
2. Ability to comprehend the knowledge on the different instruments for the appropriate application.
3. Ability understands the technology & Components used on the each instruments & its function.

Prerequisites:
1. No specific prerequisites are needed.
2. Basic knowledge of biomedical instrumentation and an understanding of electronics.

SR No	Description	Hours of Training
1	**MODULE 1 - INTRODUCTION TO BIOMEDICAL INSTRUMENTATION** - Introduction to Biomedical Engineering - Current scenario of Biomedical Engineering - Motto of Biomedical Engineer - Things to be learned to enter into the biomedical Industry - Software tools to be known - career opportunities - List of companies available in Medical Industy - List of Departments available in Hospital - List of Diagnostic, monitoring, Therpeutic equipments and its application and principles. - Calibration	**DAY1**
2	**MODULE 2 - SENSORS USED IN MEDICAL EQUIPMENTS** - Sensors & Transducer - Role & Importance of sensors in medical equipments - Air bubble detector, Occlusion sensor, Piezoelectric sensor -Pressure sensor, Flow sensor, Humidity sensor -Temperature sensor, Photoelectric sensor, IR sensor -Load sensor, Oxygen sensor, Door sensor - Speed sensor, ECG sensor, Etco2 sensor - Proximity sensor, Accelerometer sensor	**DAY1**
3	**MODULE 3 - BASICS OF ELECTRONICS** - Electrical & Electronics, Power Distribution system - AC, DC, Voltage, Current, Power - Resistor, Capacitor, Inductor, Diode, Transistor - Amplifier & filter - Prototype development	**DAY2**
SR No	**Description**	**Hours of Training**
4	**MODULE 4 - NEBULISER & SUCTION PUMP** - Overview of Nebuliser & suction pump - Sensors used in Nebuliser & suction pump - Application, Technical & Internal parts of devices - Functionality of each parts & troubleshooting	**DAY2**
5	**MODULE 5 - 'RINGE PUMP, INFUSION PUMP & PATIENT MONITOR** - Overview of Syringe Pump, Infusion pump & Patient monitor - Sensors used in Syringe pump, Infusion pump & Patient monitor - Application, Technical & Internal parts of devices - Functionality of each parts & troubleshooting	**DAY3**
6	**MODULE 6 - ECG MACHINE & DIATHERMY** - Overview of ECG Machine & Diathermy - Sensors used in ECG Machine & Diathermy - Application, Technical & Internal parts of devices - Functionality of each parts & troubleshooting	**DAY3**
7	**MODULE 7 - CPAP, BIPAP & DEFIBRILLATOR** - Overview of CPAP, BIPAP & Defibrillator - Sensors used in CPAP, BIPAP & Defibrillator - Application, Technical & Internal parts of devices - Functionality of each parts & troubleshooting	**DAY4**

8	**MODULE 8 - OXYGEN CONCENTRATOR & VENTILATOR** - Overview of Oxygen concentrator & Ventilator - Sensors used in Oxygen concentrator, Ventilator - Application, Technical & Internal parts of devices - Functionality of each parts & troubleshooting	**DAY4**
9	**MODULE 9 - TROUBLESHOOTING & CALIBRATION** - Overview of medical device troubleshooting and calibration - Tools used for troubleshooting and calibration - Application, Technical & Internal techniques of troubleshooting - Overview on Calibration Analyser Fluke and Rigel - NABH & NABL Standard and certification	**DAY5**
	Total Hours	**30Hours**

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VALUE ADDED COURSE ON EMBEDDED SYTEMS FOR MEDICAL APPLICATIONS

Course description and objectives:

To integrate & educate students on clinical and Technical application of various medical sensors. The course provides a gentle introduction to the sensors used in medical industry and is intended for beginning users and those looking for a review. It is designed to give students a basic understanding of physiological parameter acquisition & medical instrumentation design with embedded systems using STM32.

1. To transform Biomedical Engineers to Clinical Engineers. (Fresher into Professional)
2. To impart basic Technical knowledge about sensors and measurement.(Fundamental Knowledge & Principles)
3. To impart data acquisition, measurement, problem solving & troubleshooting knowledge about medical sensors with microcontroller.

The main objectives are:

This course focuses on the medical sensors, data acquisition, sensors interface & measurement, instrumentation design, basics of electronics, current scenario & career opportunities in biomedical industry. Ideally suited for biomedical engineering students and graduates with a basic understanding of electronics and basic biomedical engineering knowledge.

Upon successful completion of this course, the student should be able to:

1. Ability to understand the basic working principle of embedded systems.
2. Ability to comprehend the knowledge on the different sensors for the appropriate application.
3. Ability to understands the technology & components used on the each sensors & its function.

Prerequisites:

1. No specific prerequisites are needed.
2. Basic knowledge of biomedical instrumentation and an understanding of electronics and basics microcontroller Architecture.

SR No	Description	Hours of Training
1	MODULE 1 - INTRODUCTION TO EMBEDDED SYSTEM	DAY 1
2	MODULE 2 - EMBEDDED SYSTEM ARCHITECTURE	DAY 1
3	MODULE 3 - ARDUINO & STM32 ARCHITECTURE	DAY 2
	MODULE 4 - DATA ACQUISITION VIA ARDUINO AND STM32	DAY 2
4	MODULE 5 - ADC, DATA PROCESSING & CONTROL	DAY 3
5	MODU 6 - ANALOG READ, DIGITAL READ, DIGITAL WRITE, UART, I2C, SERIAL COMMUNICATION	DAY 4
6	MODULE 7 - DISPLAY INTERFACING	DAY 5
	Total Days	5 Days

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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 even semester for the batch

2024-2028(R2022)

2023-2027(R2022)

2022-2026(R2022)

2021-2025(R19 with Amendments)

(Board of Studies Meeting On 09.12.2024)

(Academic Council Meeting Held on 19.12.2024)

VISION OF THE INSTITUTE:

IV1: To become a premier institution by producing professionals with strong technical knowledge, innovative research skills and high ethical values.

MISSION OF THE INSTITUTE

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 OF THE DEPARTMENT

DV1: 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 OF THE DEPARTMENT

DM1: To provide a value-based biomedical engineering education utilizing contemporary technologies and equipment.

DM2: To Assemble a cohesive group of biomedical engineers to promote technologies via research and development and creativity.

DM3: To offer solutions to the healthcare industry that are infused with moral principles and lifelong learning.

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 compone or processes that meet the specified needs with appropriate considerationfor the public health and safety, and the cultur 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 assesssocietal, 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 andnorms of the engineerin 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 an with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clearinstructions.

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

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

PROGRAM SPECIFIC OUTCOMES (PSOs)

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.

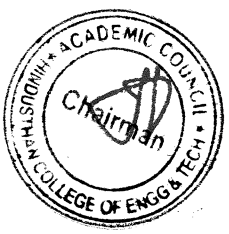
CURRICULUM R2022

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 2024-2025 and onwards
SEMESTER I

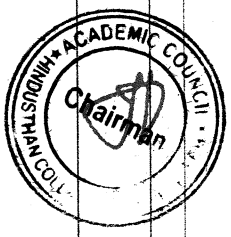
S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
			SEMESTER I								
Theory											
1.	22MA1101	Matrices and Calculus	BSC	3	1	0	4	4	40	60	100
Theory with Lab Component											
3.	22CY1151	Chemistry For Circuit Engineering	BSC	2	0	2	3	4	50	50	100
4.	22HE1151	English for Engineers	HSC	2	0	2	3	4	50	50	100
5.	22IT1151	Python Programming and practices	ESC	2	0	2	3	4	50	50	100
6	22BM1151	Introduction to Biomedical Engineering	ESC	2	0	2	3	4	50	50	100
			EEC Courses(SE/AE)								
7.	22HE1072	Entrepreneurship &Innovation	AEC	1	0	0	1	1	100	0	100
8.	22HE1073	Introduction To Soft Skills (Common to all branches)	SEC	2	0	0	0	1	100	0	100
			Mandatory Courses								
9.	22MC1093/ 22MC1094	தமிழர் மரபு / HERITAGE OF TAMIL	MC	2	0	0	1	2	40	60	100
10.	22MC1095	UNIVERSAL HUMAN VALUES (Common to all branches)	MC	2	0	0	0	2	100	0	100
			TOTAL	**16**	**1**	**8**	**19**	**26**	**380**	**320**	**700**

SEMESTER II

S. NO	COURSE CODE	COURSE TITLE	COURSE CATEGORY	L	T	P	C	TCP	CIA	ESE	TOTAL
THEORY											
1	22MA2105	PARTIAL DIFFERENTIAL EQUATIONS , FOURIER SERIES AND TRANSFORMS (BME, CIVIL & FT)	BSC	3	1	0	4	4	40	60	100
2	22CY2101	ENVIRONMENTAL STUDIES(Common to all branches except CSE, IT ,CS & AIML)	ESC	2	0	0	2	3	40	60	100
3	22BM2101	MEDICAL PHYSICS (BME)	BSC	2	0	0	2	3	40	60	100
THEORY WITH LAB COMPONENT											
4	22PH2152	PHYSICS FOR BIOLOGICAL SCIENCE (BME)	BSC	2	0	2	3	4	50	50	100
5	22HE2151	EFFECTIVE TECHNICAL COMMUNICATION (Common to all branches)	HSC	2	0	2	3	4	50	50	100
6	22CS2256	PROBLEM SOLVING USING C PROGRAMMING (BME,AIML)	PCC	2	0	2	3	4	50	50	100
PRACTICAL											
7	22ME2001	ENGINEERING PRACTICES (Common to all branches)	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 தொழில்நுட்பமும் / 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	16	1	10	**22**	**29**	370	430	1000

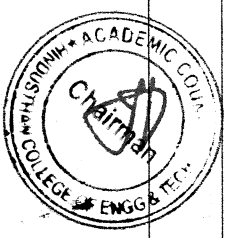


S.No.	Course Code	Course Title	Category	L	T	P	C	CP	CIA	ESE	TOTAL
SEMESTER III											
Theory											
1.	22BM3201	Signals and Systems	PCC	3	1	0	4	4	40	60	100
2.	22BM3202	Electron Devices and Circuits	PCC	3	0	0	3	3	40	60	100
3.	22BM3203	Medical Biochemistry	PCC	3	0	0	3	3	40	60	100
4.	22BM3204	Human Anatomy and Physiology	PCC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5.	22MA3151	Statistics and Numerical Methods With 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
			TOTAL	**17**	**1**	**12**	**25**	**30**	**480**	**420**	**900**

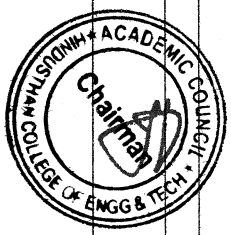


S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
			SEMESTER IV								
Theory											
1.	22HE4101	IPR and Start-ups	HSC	2	0	0	2	2	40	60	100
2.	22BM4201	BioSignal Conditioning Circuits	PCC	3	0	0	3	3	40	60	100
3.	22BM4202	Pathology and Microbiology	PCC	3	0	0	3	3	40	60	100
4.	22BM4203	Biosensors and Transducers	ESC	2	0	0	2	3	40	60	100
Theory with Lab Component											
5.	22BM4251	Microprocessor and Microcontrollers Medical Applications	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 PhysiologyLaboratory	PCC	0	0	4	2	4	60	40	100
8.	22BM4002	Biosignal Conditioning Circuits Lab	PCC	0	0	4	2	4	60	40	100
			Mandatory courses								
9.	22MC4091	Indian Constitution	MC	2	0	0	0	0	100	0	0
			EEC Courses(SE/AE)								
10.	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											
Theory											
1	22BM5201	Embedded Systems and IoMT	PCC	3	0	0	3	3	40	60	100
2	22BM53XX	Professional Elective-1	PEC	3	0	0	3	3	40	60	100
3	22BM53XX	Professional Elective-2	PEC	3	0	0	3	3	40	60	100
4	22BM53XX	Professional Elective-3	PEC	3	0	0	3	3	40	60	100
Theory with Lab Component											
5	22BM5251	Virtual Instrumentation for Biomedical Signals using Lab VIEW.	PCC	2	0	2	3	4	50	50	100
6	22BM5252	Biomechanics	PCC	2	0	2	3	4	50	50	100
Practical											
7.	22BM5001	Embedded Systems Lab	PCC	0	0	4	2	4	60	40	100
EEC Courses(SE/AE)											
8.	22HE5071	Soft Skills -4/Foreign languages	EEC	1	0	0	1	1	100	0	100
			TOTAL	**18**	**1**	**6**	**22**	**25**	**410**	**390**	**800**

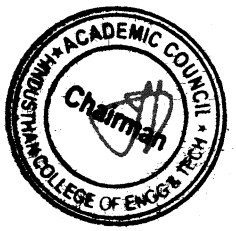


S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
			SEMESTER VI								
Theory											
1.	22BM6201	Diagnostic and therapeutic Equipments	PCC	3	0	0	3	3	40	60	100
2.	22BM6202	Biosignal Processing	PCC	3	0	0	3	3	40	60	100
3.	22HE6101	Professional Ethics(Common)	HSC	3	0	0	3	3	40	60	100
4.	22BM63XX	Professional Elective-4	PEC	3	0	0	3	3	40	60	100
5.	22BM63XX	Professional Elective-5	PEC	3	0	0	3	3	40	60	100
6.	22BM64XX	Open Elective–1*	OEC	3	0	0	3	3	40	60	100
Practical											
7.	22BM6001	Bio signal processing lab	PCC	0	0	4	2	4	60	40	100
8.	22BM6002	Diagnostic and therapeutic Equipment lab	PCC	0	0	4	2	4	60	40	100
EEC Courses(SE/AE)											
9.	22HE6071	SoftSkills-5	EEC	2	0	0	2	2	100	0	100
			TOTAL	**20**	**0**	**8**	**24**	**28**	**460**	**440**	**900**



S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
SEMESTER VII											
Theory											
1.	22BM7201	Medical Image Processing	PCC	3	0	0	3	3	40	60	100
2.	22BM7202	Radiological Equipments	PCC	3	1	0	4	4	40	60	100
3.	22BM73XX	Professional Elective-6	PEC	3	0	0	3	3	40	60	100
4.	22BM7403	Open Elective–3*	OEC	3	0	0	3	3	40	60	100
5.	22BM7404	Open Elective–4*	OEC	3	0	0	3	3	40	60	100
Practical											
6.	22BM7001	Medical Image Processing lab	PCC	0	0	4	2	4	60	40	100
EEC Courses(SE/AE)											
7.	22BM7701	Internship*	EEC	-	-	-	2	1	100	0	100
			TOTAL	**15**	**1**	**4**	**20**	**21**	**360**	**340**	**700**

* - 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.



SEMESTER VIII

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21BM83XX	**Professional Elective –IV**	PE	3	0	0	3	25	75	100
2	21BM 83XX	**Professional Elective- V**	PE	3	0	0	3	25	75	100
PROJECT WORK										
3	21BM8901	Project Work – Phase II	EEC	0	0	16	8	100	100	200
			Total	**6**	**0**	**16**	**14**	**150**	**250**	**400**

PROFESSIONAL ELECTIVE IV										
1	21BM8301	Biofluids 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	Cardiovasular Engineering	PE	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE V										
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**TOTAL**
1	21BM8306	Rehabilitation Engineering	PE	3	0	0	3	25	75	100
2	21BM8307	Virtual Reality in Medicine	PE	3	0	0	3	25	75	100
3	21BM8308	Biophotonics	PE	3	0	0	3	25	75	100
4	21BM8309	Telemedicine	PE	3	0	0	3	25	75	100
5	21BM8310	Biometric Systems	PE	3	0	0	3	25	75	100

ote:

* 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.

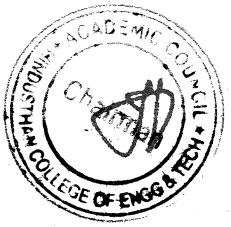
2.NCC course level 1& Level 2 will be added in the list of open elective subjects in the appropriate semester.Further, the students' who have opted NCC subjects in Semester I, II, III & IV are eligible to undergo NCC Open Elective Subjects.

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

OPEN ELECTIVE I
(VI SEMESTER – COMMON LIST FOR ALL THE PROGRAMS)
(EMERGING TECHNOLOGIES)

dents must choose an open elective course from the given list. The content of the course should not be related to their cu program of study.

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	Strength
				L	T	P			
1	22AI6401	Artificial Intelligence and Machine Learning Fundamentals	OEC	3	0	0	3	3	65
2	22CS6401	Block chain Technology Fundamentals	OEC	3	0	0	3	3	130
3	22EC6402	IoT Concepts and Applications	OEC	3	0	0	3	3	130
4	22IT6401	Data Science and Analytics Fundamentals	OEC	3	0	0	3	3	130
5	22BM6401	3D printing	OEC	3	0	0	3	3	65
6	22AE6401	Space Science	OEC	3	0	0	3	3	65
7 8	22MT6401	Introduction to Industrial Engineering	OEC	3	0	0	3	3	65
9	22MT6402	Industrial Safety and Environment	OEC	3	0	0	3	3	65
10	22CE6401	Climate Change and its Impact	OEC	3	0	0	3	3	65
11	22CE6402	Environment and Social Impact Assessment	OEC	3	0	0	3	3	65
12	22ME6401	Renewable Energy System	OEC	3	0	0	3	3	65
13	22ME6402	Additive Manufacturing systems	OEC	3	0	0	3	3	65
14	22EI6401	Introduction to Industrial Instrumentation and Control	OEC	3	0	0	3	3	65
15	22AU6401	Basics of Automobile Engineering	OEC	3	0	0	3	3	65
16	22EE6401	Fundamentals of Electric vehicles	OEC	3	0	0	3	3	65
17	22FT6401	Traditional Foods	OEC	3	0	0	3	3	65
18	22AG6401	Urban Agriculture and Organic Farming	OEC	3	0	0	3	3	65
19	22CH6401	Waste to Energy conversion	OEC	3	0	0	3	3	65
20		NCC Level - I	OEC	3	0	0	3	3	65



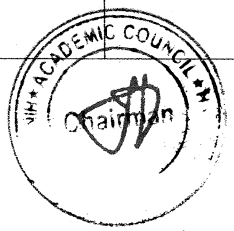
OPEN ELECTIVE II
(VII SEMESTER - COMMON LIST FOR ALL THE PROGRAMS)
LIFE SKILL COURSES

Students shall choose any one of the Life Skill courses from the open elective courses listed below.

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	Stre
				L	T	P			
1	22LS7401	General studies for competitive examinations	OEC	3	0	0	3	3	1
2	22LS7402	Human Rights, Women Rights and Gender equity	OEC	3	0	0	3	3	1
3	22LS7403	Indian ethos and Human values	OEC	3	0	0	3	3	1
4	22LS7404	Financial independence and management	OEC	3	0	0	3	3	1
5	22LS7405	Yoga for Human Excellence	OEC	3	0	0	3	3	1
6	22LS7406	Democracy and Good Governance	OEC	3	0	0	3	3	1
7	22LS7407	NCC Level - II	OEC	3	0	0	3	3	1
8	22LS7408	Cybercrime and Awareness	OEC	3	0	0	3	3	1
9	22LS7409	First Aid and Emergency care	OEC	3	0	0	3	3	1
10	22LS7410	Business Communication	OEC	3	0	0	3	3	1

PROFESSIONALELECTIVECOURSES:VERTICALS

Vertical I Bio Engineering	Vertical II Medical Device Innovation and Development	Vertical III Mechanics	Vertical IV Management (Healthcare)	Vertical V Signal and Image Processing	Verticals VI Communication
22BM5301 Biomaterials and Artificial Organs	22BM5307 Foundation Skills in integrated product Development	22BM5313 Biocontrol systems	22BM6301 Medical Device Regulations	22BM6307 Advanced Digital Signal Processing	22BM7301 Rehabilitation Engineering
22BM5302 Cancer Biology	22BM5308 Artificial neural networks	22BM5314 Biofluids and dynamics	22BM6302 Hospital Planning andmanagement	22BM6308 Artificial neural networks	22BM7302 Medical data analytics
22BM5303 Biomedical Optics and Photonics	22BM5309 Patient safety, Standards and Ethics	22BM5315 Physiological modelling	22BM6303 Medical waste Management	22BM6309 Speech and audio signal Processing	22BM7303 Body Area Networks
22BM5304 Neural Engineering	22BM5310 Wearable Devices	22BM5316 Cardio Vascular Engineering	22BM6304 Economics and management for Engineers	22BM6310 Medical Imaging Systems	22BM7304 Virtual reality a Augmented Real in Healthcare



22BM5305 Principles of Tissue Engineering	22BM5311 Bio MEMS and Nanotechnology	22BM5317 Ergonomics	22BM6305 Bio Statistics	22BM6311 Brain Computer Interface and Applications	22BM7305 Tele health Technology
22BM5306 Advanced Bio-analytical and therapeutic techniques	22BM5312 Medical Informatics	22BM5318 Haptics	22BM6306 Forensic Science in healthcare	22BM6312 Biometrics	22BM7306 Medical device design

Students are permitted to choose all Professional Electives from a particular vertical or from different verticals.

PROFESSIONAL ELECTIVE COURSES VERTICALS

DETAILS OF VERTICAL I-Bio Engineering

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	TCP	CIA	ESE	TOTAL
1	22BM5301	Bio materials and ArtificialOrgans	PEC	3	0	0	3	3	40	60	100
2	22BM5302	Cancer Biology	PEC	3	0	0	3	3	40	60	100
3	22BM5303	BiomedicalOptics and Photonics	PEC	3	0	0	3	3	40	60	100
4	22BM5304	Neural Engineering	PEC	3	0	0	3	3	40	60	100
5	22BM5305	Principles ofTissue Engineering	PEC	3	0	0	3	3	40	60	100
6	22BM5306	Advanced Bio-analytical and therapeutic techniques	PEC	3	0	0	3	3	40	60	100

DETAILS OF VERTICAL II-Medical Device Innovation and Development

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C	TCP	CIA	ESE	TOTAL
1	22BM5307	Foundation Skills in integrated product Development	PEC	3	0	0	3	3	40	60	100
2	22BM5308	Artificial neural networks	PEC	3	0	0	3	3	40	60	100
3	22BM5309	Patient safety, Standardsand Ethics	PEC	3	0	0	3	3	40	60	100
4	22BM5310	Wearable Devices	PEC	3	0	0	3	3	40	60	100
5	22BM5311	Bio MEMS and Nanotechnology	PEC	3	0	0	3	3	40	60	100

6	22BM5312	Medical device design	PEC	3	0	0	3	3	40	60	100
DETAILS OF VERTICAL III-Mechanics											
1	22BM5313	Biomechanics	PEC	3	0	0	3	3	40	60	100
2	22BM5314	Biofluids anddynamics	PEC	3	0	0	3	3	40	60	100
3	22BM5315	Physiological modelling	PEC	3	0	0	3	3	40	60	100
4	22BM5316	Cardio Vascular Engineering	PEC	3	0	0	3	3	40	60	100
5	22BM5317	Ergonomics	PEC	3	0	0	3	3	40	60	100
DETAILS OF VERTICAL IV-Management(Healthcare)											
1	22BM6301	Medical Device Regulations	PEC	3	0	0	3	3	40	60	100
2	22BM6302	Hospital Planning and management	PEC	3	0	0	3	3	40	60	100
3	22BM6303	Medical waste Management	PEC	3	0	0	3	3	40	60	100
4	22BM6304	Economics and management forEngineers	PEC	3	0	0	3	3	40	60	100
5	22BM6305	Bio Statistics	PEC	3	0	0	3	3	40	60	100
6	22BM6306	Forensic Science in healthcare	PEC	3	0	0	3	3	40	60	100
DETAILS OF Vertical V Signal and ImageProcessing											
1	22BM6307	Bio signal Processing	PEC	3	0	0	3	3	40	60	100
2	22BM6308	Artificial neuralnetworks	PEC	3	0	0	3	3	40	60	100
3	22BM6309	Speech and audiosignal Processing	PEC	3	0	0	3	3	40	60	100
4	22BM6310	Medical ImagingSystems	PEC	3	0	0	3	3	40	60	100

5	22BM6311	Brain ComputerInterface and Applications	PEC	3	0	0	3	3	40	60	100
6	22BM6312	Bio-metrics	PEC	3	0	0	3	3	40	60	100
Verticals VI Communication											
1	22BM7301	Rehabilitation Engineering	PEC	3	0	0	3	3	40	60	100
2	22BM7302	Medical data analytics	PEC	3	0	0	3	3	40	60	100
3	22BM7303	Body AreaNetworks	PEC	3	0	0	3	3	40	60	100
4	22BM7304	Virtual reality and Augmented Reality in Healthcare	PEC	3	0	0	3	3	40	60	100
5	22BM7305	Tele health Technology	PEC	3	0	0	3	3	40	60	100
6	22BM7306	Medical Informatics	PEC	3	0	0	3	3	40	60	100

Enrollment for B.E./B.TECH.(HONOURS)/Minor Degree(optional)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech.(Honours) or Minor Degree.For B.E./B.Tech.(Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only. For minor degree a student shall register for the additional courses (18 credits) from semester V onwards.All the courses have to be in a particular vertical from anyone of the other programmes.

Clause 4.10 of Regulation 2022 is applicable for the Enrolment of B.E. / B. TECH. (HONOURS) /Minor Degree(Optional).

VERTICALS FORM MINOR DEGREE

- Heads are requested to provide one vertical from their program to offer for other program students to register for additional courses (18 Credits) to become eligible for the B.E./B.Tech. Minor Degree.

Biomedical Engineering Offering Minor Degree

Note: Each programme should provide verticals for minor degree

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.

VERTICAL I FINTECH

AND BLOCK CHAIN

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	22MB5XX	Financial Management	MDC	3	0	0	3	3
2.	22MB6XX	Fundamentals of Investment	MDC	3	0	0	3	3
3.	22MB6XX	Banking, Financial Services and Insurance	MDC	3	0	0	3	3
4.	22MB7XX	Introduction to Block chain And its Applications	MDC	3	0	0	3	3
5.	22MB7XX	Fintech Personal Finance and Payments	MDC	3	0	0	3	3
6.	22MB8XX	Introduction of Fintech	MDC	3	0	0	3	3

VERTICAL II

ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	22MB5XX	Foundations of Entrepreneurship	MDC	3	0	0	3	3

2.	22MB6XX	Team Building &Leadership Management for Business	MDC	3	0	0	3	3
3.	22MB6XX	Creativity & Innovation in Entrepreneurship	MDC	3	0	0	3	3
4.	22MB7XX	Principles of Marketing Management For Business	MDC	3	0	0	3	3
5.	22MB7XX	Human Resource Management for Entrepreneurs	MDC	3	0	0	3	3
6.	22MB8XX	Financing New Business Ventures	MDC	3	0	0	3	3

VERTICAL III ENVIRONMENT AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	22CE5XX	Sustainable infrastructure Development	MDC	3	0	0	3	3
2.	22AG6XX	Sustainable Agriculture and Environmental Management	MDC	3	0	0	3	3
3.	22BM6XX	Sustainable Bio Materials	MDC	3	0	0	3	3
4.	22ME7XX	Materials for Energy Sustainability	MDC	3	0	0	3	3
5.	22CE7XX	Green Technology	MDC	3	0	0	3	3
6.	22CE8XX	Environmental Quality Monitoring and Analysis	MDC	3	0	0	3	3

B.E- BIOMEDICAL ENGINEERING (HONOURS)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	22BM5371	Modeling of physiological systems	HDC	3	0	0	3	3
2	22BM6371	Artificial intelligence and machine learning	HDC	3	0	0	3	3
3	22BM6372	Robotics in medicine	HDC	3	0	0	3	3

4	22BM7371	Quality control and regulatory aspects of medical devices	HDC	3	0	0	3	3
5	22BM7372	3D Printing	HDC	3	0	0	3	3
6	22BM8371	Medical product development and Troubleshooting	HDC	3	0	0	3	3

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	10	9	-	**67**
5	PEC	-	-	-	-	9	6	3	-	**18**
6	OEC	-	-	-	-	-	3	6	-	**9**
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 R2022

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

Chairman BoS
BME - HiCET

Chairman

Dean (Academics)
HiCET

SEMESTER II

S. NO	COURSE CODE	COURSE TITLE	COURSE CATEGORY	L	T	P	C	TCP	CIA	ESE	TOTAL
THEORY											
1	22MA2105	PARTIAL DIFFERENTIAL EQUATIONS , FOURIER SERIES AND TRANSFORMS (BME, CIVIL & FT)	BSC	3	1	0	4	4	40	60	100
2	22CY2101	ENVIRONMENTAL STUDIES(Common to all branches except CSE, IT ,CS & AIML)	ESC	2	0	0	2	3	40	60	100
3	22BM2101	MEDICAL PHYSICS (BME)	BSC	2	0	0	2	3	40	60	100
THEORY WITH LAB COMPONENT											
4	22PH2152	PHYSICS FOR BIOLOGICAL SCIENCE (BME)	BSC	2	0	2	3	4	50	50	100
5	22HE2151	EFFECTIVE TECHNICAL COMMUNICATION (Common to all branches)	HSC	2	0	2	3	4	50	50	100
6	22CS2256	PROBLEM SOLVING USING C PROGRAMMING (BME,AIML)	PCC	2	0	2	3	4	50	50	100
PRACTICAL											
7	22ME2001	ENGINEERING PRACTICES (Common to all branches)	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 தொழில்நுட்பமும் / 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	16	1	10	**22**	**29**	370	430	1000

SYLLABUS

SEMESTER II

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

Course Objective	**The learner should be able to** 1. Compute the solution of first order partial differential equations. 2. Understand 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.

PO& O	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
01	3	3	3	3	3	1	1	-	-	1	2	2
02	3	3	3	2	2	1	1	-	-	1	2	2
03	3	3	3	2	3	1	1	-	-	1	2	2
04	3	3	3	3	3	1	1	-	-	1	2	2
05	3	3	3	3	3	1	1	-	-	1	3	2
VG	3	3	3	2.6	2.8	1	1	-	-	1	2.2	2

Chairman BoS
BME - HiCET

Dean (Academics)
HiCET

HINDUSTHAN ACADEMIC COUNCIL
Chairman
HINDUSTHAN COLLEGE OF ENGG & TECH

Programme / Semester	Course Code	Name of the Course	L	T	P	C
B.E. / II	22PH2152	**Physics for Biological Science (For B.E. Bio Medical Engineering)**	2	0	2	3

Course Objective	The learner should be able to : 1. Have knowledge on Miller indices and d spacing on cubic system. 2. Acquire knowledge on basics of Laser. 3. Enhance the fundamental knowledge in wave optics. 4. Adequate knowledge on mechanics. 5. Acquire knowledge on Ultrasound and their applications.

Unit	Description	Instructional Hours
I	**CONDENSED MATTER PHYSICS** Crystalline and Amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, characteristics of unit cell – number of atoms per unit cell, coordination number, atomic radius and Packing factor for SC, BCC, FCC and HCP structures – Miller indices and interplanar d spacing on ubic system.	6
II	**PHOTONICS** Characteristics of Laser - Principle of spontaneous emission and stimulated emission - Active medium - Types of laser -.Principle, Construction, Working, Properties, Merits, Demerits and applications of Nd-YAG laser – CO_2 Laser – Applications – Holography (3D profiling).Medical applications of laser. **Determination of Wavelength and particle size using Laser** **Visit to IDA lab.**	9
III	**WAVE OPTICS** Interference -Conditions for sustained Interference – air wedge and its applications. Determination of thickness of a thin wire – Interaction of radiation with matter – matter waves and its properties - Optical microscope, Scanning electron microscope - Transmission electron microscope. **Determination of thickness of a thin wire – Air wedge method.**	9
IV	**MECHANICS OF MATERIALS** Elasticity – Hooke's law –stress-strain diagram – bending moment – depression of a cantilever – derivation 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** **Determination of Rigidity modulus – Torsion pendulum**	12
V	**FOUNDATIONS OF ULTRASONICS** Production – Piezoelectric generator – Properties of Ultrasonic waves. Determination of velocity using acoustic grating -Cavitation –Industrial applications – Drilling and welding – Nondestructive testing (pulse echo system). Medical applications – Ultrasound Scanner – A – mode – B- mode and C –mode **Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer**	9
	Total Instructional Hours	**45**

Course Outcome	At the end of the course, the learner will be able to CO1: Gain knowledge on crystal systems and Miller indices. CO2: Relate the advanced technology of LASER in the field of Engineering. CO3: Illustrate the fundamental on wave nature and microscopes. CO4: Illustrate the fundamental properties of materials CO5: Relate the Ultrasound and their applications.

TEXT BOOKS:

T1 - Balasubramaniam, R. "Callister's Materials Science and Engineering". Wiley India Pvt. Ltd., 2014.

T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2018.

REFERENCE BOOKS:

R1 - M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company ltd., New Delhi 2018

R2 - Askeland, D. "Materials Science and Engineering". Brooks/Cole, 2010.

EB REFERENCES

1. **https://nptel.ac.in/courses/112106227/**
2. **https://nptel.ac.in/courses/105105177/**
3. **https://en.wikipedia.org/wiki/Aerospace_materials/**
4. **https://nptel.ac.in/courses/104104085/**
5. **https://nptel.ac.in/courses/108106135/**

PO&PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	1	1	1	-	1	-	1	2
CO2	2	3	3	2	2	1	1	-	1	-	2	2
CO3	2	3	3	2	2	1	1	-	1	-	2	2
CO4	2	3	2	1	2	1	1	-	2	-	2	3
CO5	2	2	2	2	1	1	1	-	1	-	1	2
AVG	2	2.6	2.4	1.8	1.6	1	1	-	1.2	-	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 to** 1. Improve essential business communication skills. 2. Enrich employability knowledge. 3. Acquire the crucial organizing ability in official forum. 4. Develop study skills and communication skills in formal and informal situations. 5. Improve the language proficiency of students in English with an emphasis on Vocabulary, Grammar, Reading and Writing skills

Unit	Description	Instructiona Hours
I	**Language Proficiency**: Sentence Pattern, Writing definitions **Writing**: Describing product, work place and service (purpose, appearance, function) **Vocabulary** – Words on Nature **Practical Component:** **Listening**-Watching and interpreting advertisements /short films **Speaking**- Extempore / Public Speaking, Difference between Extempore / Public Speaking, Communication Guidelines for Practice	7+2
II	**Language Proficiency**: The Concept of Word Formation, 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	7+2
III	**Language Proficiency**: Homophones and Homonyms, Question Tag **Writing**: Preparing a detail plan for an official visit, Schedule and Itinerary, Spotting Errors **Vocabulary**– Words on Society **Practical Component :** **Listening**- Listening-paraphrasing the listened content **Speaking**-Group Discussion with preparation	5+4
IV	**Language Proficiency**: Idioms, Commonly Confused Words **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	5+4
V	**Language Proficiency** :Relative Pronoun , Regular and Irregular verb **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.	6+3
	Total Instructional Hours	45

Course Outcome	**At the end of the course, learners will be able to** CO1: Use English Language effectively in spoken and written forms CO2: Make oral and written presentation in corporate forum. CO3: Acquire basic proficiency in English including reading and listening comprehension, Writing and speaking skills. CO4: Take an effective role and manage in an organizational sector. CO5: Prepare and demonstrate a professional presentation

TEXTBOOKS:

T1- Technical Communication by Gajendra Singh Chauhan and Et al, Cengage learning India Pvt Limited [Latest Revised Edition] - 2019

T2-Raymond Murphy, "Essential English Grammar", 5 the Edition Cambridge University Press, 2019.

T3-Technical Communication – Principles and Practice, Third Edition by Meenakshi Raman and Sangeetha Sharma, Oxford University Press 2017.

REFERENCEBOOKS:

R1- A Course in Technical English–D Praveen Sam, KN Shoba, Cambridge University Press – 2020

R2-English Language Communication Skills – Lab Manual cum Workbook, Cengage learning India Pvt Limited [Latest Revised Edition] – 2019.

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

Course Objective	1. Introduce the basic concepts of environment, ecosystems, and biodiversity and emphasize on the biodiversit of India and its conservation. 2. Impart knowledge on the causes, effects, and control or prevention measures of environmental pollution and natural disasters. 3. Facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation, and measures to preserve them. 4. Gain knowledge on the scientific, technological, economic and political solutions to environmental problem 5. Familiarize the concept of sustainable development goals and appreciate the interdependence of economic a social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit, and the challenges of environmental management.

Unit	Description	Instruction Hours
I	**ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY** Scope and objectives of environmental studies-Importance of environment – need for public awareness - Eco-system and Energy flow–ecological succession- Structure and function of the forest and ponds ecosystem – Types of biodiversity:– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity – endangered and endemic species of India – conservation of biodiversity: Insitu and ex-situ.	6
II	**UNIT II ENVIRONMENTAL POLLUTION** 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.	6
III	**UNIT III RENEWABLE SOURCES OF ENERGY** Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.	6
IV	**SOCIAL ISSUES AND THE ENVIRONMENT** 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 effec and ozone layer depletion – Disaster Management – Tsunami and cyclones.	6
V	**SUSTAINABILITY AND MANAGEMENT** Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols. Sustainable Development Goals-targets, indicators and intervention areas. Climate change- Global, Regional, and local environmental issues and possible solutions (global warming, acid rain and ozone layer depletion). Concept of Carbon Footprint.	6
	Total Instructional Hours	**45**

Course Outcome	CO1: Recognize and understand the functions of environment, ecosystems and biodiversity and their conservation. CO2: Identify the causes, effects of environmental pollution and natural disasters and contribute to the prevent measures in the society. CO3: Identify and apply the understanding of renewable and non-renewable resources and contribute sustainable measures to preserve them for future generations. CO4: Demonstrate an appreciation for need for sustainability, management and understand the various social issues and solutions to solve the issues. CO5: Recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.

EXTBOOKS

1 - Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers 2018.

2 - Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.

EFERENCES

1 – Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.

2 - Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	2	3	-	-	-	-	2
CO2	3	2	-	-	-	3	3	-	-	-	-	2
CO3	3	-	1	-	-	2	2	-	-	-	-	2
CO4	3	2	1	1	-	2	2	-	-	-	-	2
CO5	3	2	1	-	-	2	2	-	-	-	-	1
AVG	2.8	1.8	1	1	-	2.2	2.4	-	-	-	-	1.8

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Dean (Academics)
HiCET

ACADEMIC COUNCIL Chairman

Programme	Course code	Name of the course	L	T	P	C
B.E	22BM2101	Medical Physics	2	0	0	2

Course Objective	The student should be able
	1 To understand the basic physics of light and sound .
	2 To Understand the essential principles of nuclear physics related to natural and artificial radioactivity.
	3 To Understand the types of radionuclides used in radio diagnosis and radiotherapy.
	4 To explore the effects of radiation in matter.
	5 To get the complete understanding of Radiation Effects.

Unit	Description	Instructional Hours
I	**Physics of Light and sound: Light** - Physics of light, Intensity of light, limits of Vision and color vision, Applications of Laser in Medical field. **Sound** - Physics of sound , Normal sound levels – Ultrasound fundamentals-Generation of ultrasound (Ultrasound Transducer) – Interaction of Ultrasound with Materials-Reflection and Refraction – Absorption and Scattering	6
II	**Radiation Physics: Radioactive Decay** – Spontaneous Emission – Isometric Transition - Gamma ray emission, alpha, beta, positron decay, electron capture **Principles of Nuclear Physics** – Natural radioactivity, Decay series, type of radiation and their applications.	6
III	**Principles Of Radioactive Nuclides:** Cyclotron produced Radionuclide - Reactor produced Radionuclide – fission and electron Capture reaction, Radionuclide Generator – Milking Process - Linear accelerator, Radionuclides used in Medical field.	6
IV	**Interaction of Radiation with Matter:** Interaction of charged particles with matter – Specific ionization , linear energy transfer range, Bremsstrahlung , Annihilation Interaction of Gamma radiations with matter – Photoelectric effect , Compton Scattering ,pair Production, Attenuation of Gamma Radiation, Interaction of neutron with matter.	6
V	**Radiation Effects:** Acute Radiation Effects: The concept of LD 50 – Radiation syndromes- Central nervous system syndrome- Gastro-intestinal syndrome –Bone Marrow syndrome -Delayed Effects of Radiation: Stochastic and Deterministic effects – Late Deterministic effect in different organs and tissues.	6
	Total Instructional Hours	30 hrs

Course Outcome		
	CO1	Explain the fundamental principles of light and sound, including their wave properties, behavior, and interactions with materials.
	CO2	Explain the fundamental concepts of radioactive decay processes, including the different types of decay and principles of nuclear physics.
	CO3	Discuss the role of radionuclides in nuclear medicine, such as their use in diagnostic imaging and therapeutic applications.
	CO4	Explain the effect of radiation with matter.
	CO5	Recognize the difference between acute and delayed radiation effects and their underlying biological mechanisms.

TEXT BOOK:

T1	B.H Brown , PV Law ford, R H Small wood , D R Hose , D C Barber , "Medical Physics and Biomedical Engineering", CRC Press 1999
T2	Gopal B.Saha "Physics and Radiobiology of Nuclear Medicine" Springer, 3rd ed, 2006

REFERENCES:

R1	John R. Cameron and James G. Skofronick, "Medical Physics", John–Wiley & Sons, 1978
R2	RF Farr and PJ Allisy –Roberts , "Physics for Medical Imaging" Saunders, 1997
R3	P.Uma Devi , A. Nagarathnam , B.S Satish Rao, "Introduction to Radiation Biology" B.I .Churchill Livingstone pvt ltd, 2000
R4	S.Webb, "The Physics of Medical Imaging", Taylor and Francis, 1988

urse Code &Name: 22BM2101& MEDICAL PHYSICS

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2			1		1				1	2		
CO2	3	2	2			1		1				1	2		
CO3	3	2	2			1		1				1	2		
CO4	3	2	2			1		1				1	2		
CO5	3	2	2			1		1				1	2		
AVG	3	2	2			1		1				1	2		

Chairman BoS
BME - HiCET

Dean (Academics)
HiCET

HINDUSTHAN ACADEMIC COUNCIL COLLEGE OF ENG... Chairman

MANDATORY COURSES
FOR II SEMESTER

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

பாடத்தின்முடிவு	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.

ய்வுவாரியதலைவர்டீன் கல்வியாளர் / முதல்வர்

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	22MC2094/2095	TAMILS AND TECHNOLOGY	2	0	0	1

Course Objectives:

The student should be able to
Acquiring knowledge of industry during the Sangam Period.
Collaborate learning about house design, sculpture and temples during Sangam Period.
Develop Knowledge in metallurgical studies as a source of historical and archaeological evidence.
Acquiring knowledge about ancient techniques used in agriculture and agro processing
Knowledge of Tamil language literature.

UNIT I WEAVING AND CERAMIC TECHNOLOGY

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteri

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY

Designing and Structural construction House & Designs in household materials during Sangam Age – Building materials a Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram – Sculptures and Temples of Mamallapur Great Temples of Cholas and other worship places – Temples of Nayaka Period – Type study (Madurai Meenakshi Templ Thirumalai Nayakar Mahal – Chetti Nadu Houses, Indo – Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY

Art of Ship Building – Metallurgical studies – Iron industry – Iron smelting, steel -Copper and goldCoins as source of hist – Minting of Coins – Beads making-industries Stone beads -Glass beads – Terracotta beads -Shell beads/ bone beats – Archeological evidences – Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry – Wells designed for c use – Agriculture and Agro Processing – Knowledge of Sea – Fisheries – Pearl – Conche diving – Ancient Knowledge of Ocean – Knowledge Specific Society.

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING

Development of Scientific Tamil – Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

Course Outcome:

After completion of the course the learner will be able to
CO1:Recognize ancient business
CO2: Distinguish Sangam period building material and types of sculpture.
CO3: Identify the source of historical and archaeological
CO4: Demonstrate the techniques used in agriculture and agro processing.
CO5:Understand the new software of Tamil language

[C2094/2095TAMILS AND TECHNOLOGY

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO1 2
CO1	2	3	3	-	-	-	-	-	2			2
CO2	2	3	3	-	-	-	-	-	2			2
CO3	2	3	3	-	-	-	-	-	2			2
CO4	2	3	-	-	-	-	-	-	2			2
CO5	2	3	-	-	-	-	-	-	2			2
AVG	2	3	1.8	-	-	-	-	-	2			2

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	22MC2093	SOCIAL SERVICES AND COMMUNITY DEVELOPMENT	1	0	0	1

Course Objectives:	The student should be able to Acquire the knowledge and active participate in social service and community development activities. Understand the concept of disaster management and role of NCC cadets in disaster management.. Understand the concept thinking and reasoning process.. Understand about maps and use of bearing and service protector 5. Know about the principles of flight and Aero foil structure and ATC procedures.

Unit	Description	Instructional Hours
I	**SOCIAL SERVICES AND COMMUNITY DEVELOPMENT** Basics of social services and its need - Rural development programs - Contribution of youth towards social welfare - NGOs in social services SwachbharathAbhiyan - Social evils - Mission Indradanush - BetibachoBetipado - Digital awareness - Constitution day.	3
II	**DISASTER MANAGEMENT** Organization of Disaster management -Types of emergencies - Natural and manmade disasters - fire service and fire fighting - prevention of fire.	3
III	**PERSONALITY DEVELOPMENT** Introduction to personality development - public speaking Intra and Inter personal skills -self awareness - critical thinking - Decision making and problem solving.	3
IV	**MAP READING** Types of maps - conventional signs - scales and Grid system - relief and contour gradient - cardinal points - Types of North - types of bearing and use of service protector - Prismatic compass and its uses - setting of map - finding North and own position.	3
V	**PRINCIPLES OF FLIGHT AND AIRMANSHIP** Introduction to principle of flight - Forces acting on the aircraft - Angle of attack - Angle of incidence - Newton's - law of motion - Bernauli's theorem and Venturi effect - Aerofoil - Airfield layout - ATC (Air Traffic Control) - circuit procedures - Aviation medicine.	3
Total Instructional Hours		15

Course Outcome:	After completion of the course the learner will be able to CO1:Perform the social services on various occasions for better community and social life CO2:Appreciate the need and requirement for disaster management and NCC role in disaster management activities. CO3: Define thinking, reasoning, critical thinking and creative thinking CO4:Use of bearing and service protector and locate the places and objects on the ground. CO5:Understand the principles of flight and Aerofoil structure

Reference:

1. UGC and AICTE circulated syllabus.

Text Books :

1. NCC cadet Guide (SD/SW) Army
2. NCC cadet Guide (SD/SW) Airforce.
3. ANOs Guide (SD/SW) by DG NCC, Ministry of Defence, New Delhi
4. Digital Forum App 1.0 & 2.0, by DG NCC DG NCC, Ministry of Defence, New Delhi

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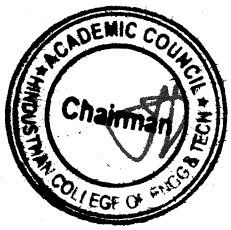

Programme/ Sem BE/B.TECH II	Course Code 22HE2072	Name of the Course SOFT SKILLS AND APTITUDE	L 1	T 0	P 0	C 1

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

Course Objective

The student should be able to
To expose students to the design process
To develop and test innovative ideas through a rapid iteration cycle.
To provide an authentic opportunity for students to develop teamwork and leadership skills

Unit	Description	Instructi 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	**30**

Instructional Hours

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.

Course Code & Name: 22HE2071 Design Thinking

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

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S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
			SEMESTER IV								
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	Microprocessor and Microcontrollers Medical Applications	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 PhysiologyLaboratory	PCC	0	0	4	2	4	60	40	100
8.	22BM4002	Biosignal Conditioning Circuits Lab	PCC	0	0	4	2	4	60	40	100
			Mandatory courses								
9.	22MC4091	Indian Constitution	MC	2	0	0	0	0	100	0	0
			EEC Courses(SE/AE)								
10.	22HE4071	Soft Skills-3	EEC	1	0	0	1	1	100	0	100
			TOTAL	**16**	**1**	**12**	**23**	**28**	**480**	**420**	**900**

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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 desigus 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	-
Avg.	3	-	3	-	-	3	-	-	-	-	-	3	2	2

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Programme	Course code	Name of the course	L	T	P	C
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 aspects 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 forelectron 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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO7	PO 8	PO 9	PO 10	PO1 1	PO1 2	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	Interpret 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

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	PO1 0	PO1 1	PO1 2	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, ECG. **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 voltametric 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 physiological 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.	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 opdmp 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 Millman&Halkias, "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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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	22BM4001	HUMAN PHYSIOLOGY LABORATORY	0	0	4	2

Course Objective

CO1: Understand the microscope functional components
CO2: Understand the basics principle of preparation of blood smear, RBC & WBC Count.
CO3: Understand the estimation of hemoglobin
CO4:Understand the basics knowledge of vital parameter monitoring
CO5: Understand the simulation of human physiology parameters virtually.

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., NewYork, 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.
CO4	Demonstrate the vital parameters of the patient.
CO5	Evaluate the simulation of human physiology parameters virtually.

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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", 4th Edition, Tata Mc Graw Hill, 2016

Course Outcome	CO1	Summaries the principles of various digital ICs
	CO2	Identify and apply the amplifiers and various signal conditioning circuits for biosignals acquisition.
	CO3	Demonstrate the basic concepts for filtering of bio signals
	CO4	Design and build various analog and digital interfaces for signal conversion
	CO5	Select suitable circuits to design various biomedical devices.

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	22HE4071	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. Crack mock interviews with ease

Unit	Description	Instructional Hours
I	**Logical Reasoning** Logical Connectives - Syllogisms - Venn Diagrams: Interpretation - Venn Diagrams - Solving- Critical Reasoning	6
II	**Quantitative Aptitude** Logarithm - Arithmetic Progression - Geometric Progression - Surds and Indices - Geometry - Mensuration - Heights and Distance- Coded inequalities - Quadratic Equations - Permutation, Combination: Fundamental Counting Principle, Permutation and Combination, Computation of Permutation, Circular Permutations, Computation of Combination - Probability	14
III	**Verbal Ability** Idioms and Phrasal Verbs, Collocations, Gerund and Infinitives - Reading Comprehension for placements: Types of questions, Comprehension strategies - Articles.	6
IV	**Recruitment Essentials** 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	4
	Total Instructional Hours	30

Course Outcome:

CO1:	Students will excel in the complex reasoning.
CO2:	Students will be proficient to create and verify their own conjectures.
CO3:	Imbibe effective relevant knowledge in English.
CO4:	Students will identify different life skills required in personal and professional life.

REFERENCE BOOKS:

R1:	Logical Reasoning and Data Interpretation for CAT by Nishit K. Sinha
R2:	A Modern Approach To Verbal Reasoning by R S Aggarwal.
R3:	Quantitative Aptitude for Competitive Examinations (5th Edition) - Abhjit Guha
R4:	Verbal Ability & Reading Comprehension by Ajay Singh

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Programme	Course Code	Course Title	L	T	P	C
BE/BTECH	22HE4071	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. Crack mock interviews with ease

Unit	Description	Instructional Hours
I	**Logical Reasoning** Logical Connectives - Syllogisms - Venn Diagrams: Interpretation - Venn Diagrams - Solving- Critical Reasoning	6
II	**Quantitative Aptitude** Logarithm - Arithmetic Progression - Geometric Progression - Surds and Indices - Geometry - Mensuration - Heights and Distance- Coded inequalities - Quadratic Equations - Permutation, Combination: Fundamental Counting Principle, Permutation and Combination, Computation of Permutation, Circular Permutations, Computation of Combination - Probability	14
III	**Verbal Ability** Idioms and Phrasal Verbs, Collocations, Gerund and Infinitives - Reading Comprehension for placements: Types of questions, Comprehension strategies - Articles.	6
IV	**Recruitment Essentials** 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	4
	Total Instructional Hours	30

Course Outcome:

CO1:	Students will excel in the complex reasoning.
CO2:	Students will be proficient to create and verify their own conjectures.
CO3:	Imbibe effective relevant knowledge in English.
CO4:	Students will identify different life skills required in personal and professional life.

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R2:	A Modern Approach To Verbal Reasoning by R S Aggarwal.
R3:	Quantitative Aptitude for Competitive Examinations (5th Edition) - Abhjit Guha
R4:	Verbal Ability & Reading Comprehension by Ajay Singh

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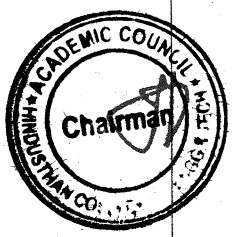
S.No.	Course Code	Course Title	Category	L	T	P	C	TCP	CIA	ESE	TOTAL
			SEMESTER VI								
Theory											
1.	22BM6201	Diagnostic and therapeutic Equipments	PCC	3	0	0	3	3	40	60	100
2.	22BM6202	Biosignal Processing	PCC	3	0	0	3	3	40	60	100
3.	22HE6101	Professional Ethics(Common)	HSC	3	0	0	3	3	40	60	100
4.	22BM63XX	Professional Elective-4	PEC	3	0	0	3	3	40	60	100
5.	22BM63XX	Professional Elective-5	PEC	3	0	0	3	3	40	60	100
6.	22BM64XX	Open Elective–1*	OEC	3	0	0	3	3	40	60	100
Practical											
7.	22BM6001	Bio signal processing lab	PCC	0	0	4	2	4	60	40	100
8.	22BM6002	Diagnostic and therapeutic Equipment lab	PCC	0	0	4	2	4	60	40	100
EEC Courses(SE/AE)											
9.	22HE6071	SoftSkills-5	EEC	2	0	0	2	2	100	0	100
			TOTAL	**20**	**0**	**8**	**24**	**28**	**460**	**440**	**900**



DETAILS OF VERTICAL IV-Management(Healthcare)											
1	22BM6301	Medical Device Regulations	PEC	3	0	0	3	3	40	60	100
2	22BM6302	Hospital Planning and management	PEC	3	0	0	3	3	40	60	100
3	22BM6303	Medical waste Management	PEC	3	0	0	3	3	40	60	100
4	22BM6304	Economics and management forEngineers	PEC	3	0	0	3	3	40	60	100
5	22BM6305	Bio Statistics	PEC	3	0	0	3	3	40	60	100
6	22BM6306	Forensic Science in healthcare	PEC	3	0	0	3	3	40	60	100
DETAILS OF Vertical V Signal and ImageProcessing											
1	22BM6307	Bio signal Processing	PEC	3	0	0	3	3	40	60	100
2	22BM6308	Artificial neuralnetworks	PEC	3	0	0	3	3	40	60	100
3	22BM6309	Speech and audiosignal Processing	PEC	3	0	0	3	3	40	60	100
4	22BM6310	Medical ImagingSystems	PEC	3	0	0	3	3	40	60	100
5	22BM6311	Brain ComputerInterface and Applications	PEC	3	0	0	3	3	40	60	100
6	22BM6312	Bio-metrics	PEC	3	0	0	3	3	40	60	100

ACADEMIC COUNCIL
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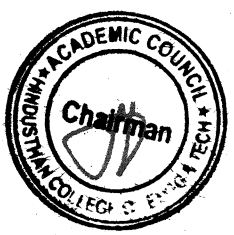
OPEN ELECTIVE I
(VI SEMESTER – COMMON LIST FOR ALL THE PROGRAMS)
(EMERGING TECHNOLOGIES)

Students must choose an open elective course from the given list. The content of the course should not be related to their cu program of study.

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	Strengtl
				L	T	P			
1	22AI6401	Artificial Intelligence and Machine Learning Fundamentals	OEC	3	0	0	3	3	65
2	22CS6401	Block chain Technology Fundamentals	OEC	3	0	0	3	3	130
3	22EC6402	IoT Concepts and Applications	OEC	3	0	0	3	3	130
4	22IT6401	Data Science and Analytics Fundamentals	OEC	3	0	0	3	3	130
5	22BM6401	3D printing	OEC	3	0	0	3	3	65
6	22AE6401	Space Science	OEC	3	0	0	3	3	65
7 8	22MT6401	Introduction to Industrial Engineering	OEC	3	0	0	3	3	65
9	22MT6402	Industrial Safety and Environment	OEC	3	0	0	3	3	65
10	22CE6401	Climate Change and its Impact	OEC	3	0	0	3	3	65
11	22CE6402	Environment and Social Impact Assessment	OEC	3	0	0	3	3	65
12	22ME6401	Renewable Energy System	OEC	3	0	0	3	3	65
13	22ME6402	Additive Manufacturing systems	OEC	3	0	0	3	3	65
14	22EI6401	Introduction to Industrial Instrumentation and Control	OEC	3	0	0	3	3	65
15	22AU6401	Basics of Automobile Engineering	OEC	3	0	0	3	3	65
16	22EE6401	Fundamentals of Electric vehicles	OEC	3	0	0	3	3	65
17	22FT6401	Traditional Foods	OEC	3	0	0	3	3	65
18	22AG6401	Urban Agriculture and Organic Farming	OEC	3	0	0	3	3	65
19	22CH6401	Waste to Energy conversion	OEC	3	0	0	3	3	65
20		NCC Level - I	OEC	3	0	0	3	3	65



Programme	Course code	Name of the course	L	T	P	C
B.E	22BM6201	DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS	3	0	0	4

Course Objective	The student should be able
1	To understand basic knowledge about measurements of parameters related to bones and intensive care equipment
2	To Learn measurement techniques of sensory responses and Hearing Aid Equipment
3	To know the working of coronary care equipment
4	To Discuss the of the extra corporeal and special diagnostic equipment
5	To describe different types and uses of diathermy units

Unit	Description	Instructional Hours
sI	**INSTRUMENTS DEALING WITH BONES INTENSIVE CARE** Patient Monitoring system- Infusion Pump- 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
II	**SENSORY DIAGNOSIS AND HEARING AID EQUIPMENTS** 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
III	**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.	9
IV	**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, Lithotripsy, Cryogenic technique, Thermography – Recording Principle and clinical application- Endoscopy- Labroscopy	9
V	**DIATHERMY** 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
	Total Instructional Hours	45

Course Outcome		
	CO1	Explain about measurements of parameters related to bones and intensive care equipment

	CO2	Describe the measurement techniques of sensory responses.
	CO3	Discuss about the various coronary care equipment used in hospitals.
	CO4	Outline the working of extra corporeal and special diagnostic equipment
	CO5	Analyze different types and uses of diathermy units.

TEXT BOOK:

T1	Khandpur. R.S.,"Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003.
T2	John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd,New Delhi, 2015

REFERENCES:

R1	Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012
R2	L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.

Course Code &Name : DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS

PO & SO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	1	-	1	-	-	-	-	1	-	1	1	-	1
CO2	3	2	1	-	1	-	-	-	-	1	-	1	1	-	1
CO3	3	2	1	-	1	-	-	-	-	1	-	1	1	-	1
CO4	3	2	1	-	1	-	-	-	-	1	-	1	1	-	1
CO5	3	2	1	-	1	-	-	-	-	1	-	1	1	-	1
AVG	3	2	1	-	1	-	-	-	-	1	-	1	1	-	1

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM6202	BIOSIGNAL PROCESSING	3	0	0	3

Course Objective	The student should be able
	1 To introduce the concept of analyzing discrete time signals and systems in the time and frequency domain through mathematical representation.
	2 To describe 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 enumerate the basic design and structure of FIR and IIR filters with desired frequency responses and design digital filters
	5 To interpret ECG and EEG signal processing.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO DIGITAL SIGNAL PROCESSING** 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–Convolution,Correlation(Auto,Cross) of signals- Review of sampling and reconstruction – Anti-aliasing filtering	9
II	**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),Pan Tompkins algorithm-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 Outcomes		
	CO1	Ability to understand signals and systems by their mathematical representation
	CO2	Ability to perform system representation using transforms

	CO3	Implement the various filter structures and effects of rounding errors
	CO4	Design a digital filter for a given specification
	CO5	Analyse the ECG and EEG signals

TEXT BOOK:	
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.
T3	"Digital Signal Processing, 2nd edition A Practical Approach" by Emmanuel Ifeachor and Barrie W. Jervis
REFERENCES:	
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.

Course Code & Name : 22BM6202 / BIOSIGNAL PROCESSING

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	-	-	-	-	-	-	-	-	-	2	2	1	2
CO2	1	1		-	-	-	-	-	-	-	-	2	2	1	2
CO3	1	1	1	1	-	1	-	-	-	-	-	2	2	2	2
CO4	0	0	1	1	-	1	-	-	-	-	-	1	2	2	1
CO5	0	0	-	-	-	-	-	-	-	-	-	2	2	1	2
AVG	1	1	-	-	-	-	-	-	-	-	-	2	2	1	2

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Programme	Course code	Name of the Course	L	T	P	C
BE	22HE6101	Professional Ethics	3	0	0	3

Course Objective

1. To foster ethical behavior and life skills for holistic development.
2. To educate the value of Engineering Ethics
3. To inculcate the social responsibility of an engineer.
4. To impart knowledge on issues related to safety, responsibility and rights
5. To educate on professional practice on global issues

Unit	Description	Instructional Hours
I	**VALUE EDUCATION** Moral values and Right understanding- Holistic development and the Role of Value Education- Understanding Value Education- Self-exploration as the process for value Education- Integrity -Work Ethics- Empathy- Spirituality	9
II	**ENGINEERING ETHICS** Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.	9
III	**ENGINEERING AS SOCIAL EXPERIMENTATION:** Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.	9
IV	**SAFETY, RESPONSIBILITIES AND RIGHTS** Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.	9
V	**GLOBAL ISSUES** Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility	9
	Total Instructional Hours	**45**

Course Outcomes

CO1: Understand the importance of various components of human values
CO2: Apply ethics in society
CO3: Discuss the ethical issues related to engineering and
CO4: Realize the responsibilities and rights in the society
CO5: Apply professional ethics in solving global issues

TEXT BOOKS:

T1 - Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata Mc Graw Hill, New Delhi, 2003.
T2 - Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2009.

REFERENCES BOOKS:

R1 - Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
R2 - John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
R3 - Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001

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Programme	Course Code	Name of the Course	L.	T	P	C
B.E.	22BM6001	BIOSIGNAL PROCESSING LABORATORY	0	0	4	2

The student should be able

1. To study about fundamentals of signal processing and MATLAB
2. To understand about filter designing concepts
3. To learn about processing of basic biosignals
4. To demonstrate biosignal analysis
5. To develop algorithms for ECG and EEG signal analysis

Description of Experiments

1. Generation of Elementary signals-Continuous and Discrete time
2. To perform Convolution of biosignals
3. To perform auto and cross correlation of signals
4. Implementation of filters-Active low-pass, High-pass and band-pass filters.
5. Computation of DFT and IDFT
6. Preprocessing of biosignals
7. IIR and FIR filter implementation of biosignals
8. Detection of QRS wave in ECG signal using Pan-Tompkins algorithm
9. Development of algorithm for Arrhythmia detection in ECG signal
10. Analysis of EEG signal and band separation
11. Miniproject

Total Practical Hours: 45

REFERENCES:

1. https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/downloads/bsp.pdf
2. https://www.avit.ac.in/lab/Digital_signal_processing_lab/download/17BMCC84/lab_manual.pdf

Course Outcome

CO1	Perform basic signal processing using MATLAB
CO2	Design filters for processing the signals
CO3	Acquire knowledge about the basic biosignals like ECG and EEG
CO4	Demonstrate the biosignal analysis
CO5	Develop algorithms for biosignal analysis

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PROGRAMME	COURSE CODE	COURSE NAME OF THE COURSE	L	T	P	C
B.E	22BM6002	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.

LIST OF EXPERIMENTS:

1. Acquisition of blood flow graph using PC based Vascular Doppler.
2. Detect and study the working of Radiant heat warmer.
3. To record the lung flow, volume and capacities graph using PC based Spirometer.
4. Exemplify the working of Ultrasound Scanner.
5. Examine the working of Nebulizer
6. Execute the performance of Drug Delivery Device.
7. Measurement of vital parameters from Real time Patient Monitoring System.
8. To demonstrate the Pacemaker System with Patient Simulator
9. To illustrate the operation of Defibrillator.
10. To record and plot the sound wave through Phonocardiograph
11. Measurement of Oxygen Saturation and Heart Rate using Pulse-oximeter
12. To Study and demonstrate the working of Respiratory Ventilator.

TOTAL INSTRCTIONAL HOURS

COURSE OUTCOME

CO1: Describe design requirements of basic biomedical system used for therapy
CO2: Express the measurement methods available for measuring respiration rate and heart sound.
CO3: Design of ultrasound scanning system and baby incubator system
CO4: Analyze drug delivery systems and visualization of internal organs
CO5: Design real time patient monitoring system and sterilization techniques

TEXTBOOKS

1. Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", CRCPRESS.201
2. R.S. Khandpur, "Hand book of Bio-Medical Instrumentation", Tata McGraw Hill Publishing Co Ltd, New Delhi.2015.

REFERENCES

1.Joseph E.Parrillo, "Critical Care Medicine: Principles of Diagnosis and Management in the Adult", Elsevier 4th edition, 2014

Course Code &Name : 22BM6002&Diagnostic And Therapeutic Equipment Lab

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	P07	PO8	PO9	PO10	P011	P012	PSO1	PSO2	PSO3
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
AVG	2	2	-	2	-	-	-	-	3	-	-	2	3	3	3

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PROFESSIONAL ELECTIVE-4

Programme	Course code	Name of the course	L	T	P	C
B.E	22BM6301	MEDICAL DEVICE REGULATIONS	3	0	0	3

Course Objective	**The student should be able**	
	1	To study the regulation of medical devices, process of development, ethical and quality considerations.
	2	To learn the various ISO standards of quality and risk management for regulatory purposes
	3	To explore the process of approval and marketing of medical devices
	4	To comprehend the regulatory process for medical devices in India, US, and EU.
	5	To familiarize with clinical evaluation and investigation of medical devices.

Unit	Description	Instructional Hours
I	**MEDICAL DEVICE REGULATIONS:** History of medical device regulation, regulatory affairs professional's roles, required competencies, medical device classification: scope, definitions, main classifications, Risk based classification, practical examples, labeling of medical devices: definition, elements, risk management, clinical evaluation and labeling, language level and intended users.	9
II	**ISO STANDARDS:** ISO 13485:2016: Requirements for regulatory purposes: Quality Management Systems, certification process. ISO 14971: Application of Risk management to medical Devices	9
III	**IEC, REGULATORY SYSTEMS IN USA & EU:** IEC international standards and conformity assessment for medical devices, Good submission process, medical device regulatory system in the USA and European Union.	9
IV	**INDIAN REGULATORY SYSTEM:** India: Medical device regulatory system: market environment, functions undertaken by DGGI, central government, FDA and state governments, guidance documents, details of key regulators, IMDRF and CDSCO, regulatory overview in India, product registration on conformity assessment, quality system regulation, technical material and labeling requirements, commercial aspects, upcoming regulation changes	9
V	**CLINICAL TRIALS AND DIGITAL REGULATIONS:** Regulatory strategy and competitive advantage, Preclinical and Clinical Trial Design for Medical Devices in India; FDA approved devices, post-market surveillance/vigilance, Digital health regulations: Connected care, intelligent design control, reducing design time and cost with in-silico clinical trials	9
	Total Instructional Hours	45

Course Outcome	CO1	Define and explain the basic concepts of medical device regulations
	CO2	Decipher the meaning of ISO standards from a regulatory perspective
	CO3	Explain US-FDA, IEC and European regulations.
	CO4	Discuss regulations in India
	CO5	Explain the regulatory aspects of clinical trials and digital alternatives

TEXT BOOK:

T1	Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products, 3rd Edition, Taylor & Francis Group, 2021
T2	Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006

REFERENCES:

R1	Product Safety in the European Union by GaborCzitan, Attila Gutassy, Ralf Wilde, TUV RheinlandAkademia, 2008.
R2	Regulatory requirements for medical devices including in vitro diagnostics in India (Version 2.0), IIT Madras, Prof. Arun B.Ramteke, Prof. Aseem Sahu, Prof. Malay Mitra. https://nptel.ac.in/courses/127106136

Course Code &Name : 22BM6301& MEDICAL DEVICE REGULATIONS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO2	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO3	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO4	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO5	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
AVG	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-

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Course code	HOSPITAL PLANNING AND MANAGEMENT	L	T	P	C
22BM6302		3	0	0	3

Course Objective:

The student should be made to:

1. To understand the fundamentals of hospital administration and management
2. To learn the types of codes followed and applications
3. To explore various information management systems and relative supportive services
4. Learn the procedures of Clinical Engineering
5. 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 of Hospital 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 Lectures	**45 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

Course Code &Name : 22BM6302& HOSPITAL PLANNING AND MANAGEMENT

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO2	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO3	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO4	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
CO5	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-
AVG	3	2	1	1	1	-	-	2	-	1	-	1	1	-	-

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Programme	Course Code	Name of the Course	L	T	P	C
BME	22BM6303	Medical Waste Management	3	0	0	3

Course Objectives

To teach how to manage biomedical waste
To provide knowledge about various biomedical management and handling rules
To learn the treatment and disposable techniques used for biomedical management
To educate biomedical waste management rules
To instruct the standards of Biomedical waste

Unit	Description	Instructional Hours
I	**MANAGEMENT OF BIOMEDICAL WASTE:** Waste disposal management, Hospital waste management, Bio-safety- regulatory framework for Genetically Modified Organisms (GMOs) Bioethics and its socio economic impact, Hazards associated with poor health care waste management	9
II	**VARIOUS BIOMEDICAL MANAGEMENT AND HANDLING RULES:**Characterization of medical waste- Bio-medical wastes (Management and Handling) Rules, 1998, Amendments and guidelines, segregation, packaging, storage, transport of infectious waste. Techniques of Biomedical waste management. Health and safety rules. Protocols, issues, and challenges in transportation of Biomedical waste.	9
III	**DISPOSABLE TECHNIQUES USED FOR BIOMEDICAL MANAGEMENT:**Treatment method-Autoclave, Hydroclave, Microwave, Chemical Disinfection, Solidification and stabilization, Bio remediation, Thermal Conversion technologies, accumulation and storage of hazardous waste, land disposal of hazardous waste, other treatment and disposal.method. Common Hazardous Waste Treatment Facilities (TSDF).	9
IV	**RULES FOR BIOMEDICAL WASTE MANAGEMENT :** Biomedical waste management rules: Biomedical wastes categories and their segregation, collection, treatment, processing, and disposal options.	9
V	**STANDARDS OF BIOMEDICAL WASTE:**Standards for Treatment and Disposal of Bio-Medical wastes, Standards for autoclaving of bio-medical waste, standards of microwaving, standards for deep burial, standards for the efficacy of chemical disinfection, standards for dry heat sterilization, standards for liquid waste.	9
	Total Instructional Hours	**45**

Course Outcomes

CO1	Understand how to manage biomedical waste
CO2	Know various biomedical management and handling rules
CO3	Learn the treatment and disposable techniques of biomedical management
CO4	Aware the various biomedical waste management rules.
CO5	Familiar with various biomedical waste management standards

TEXT BOOKS:

T1 "Biomedical Waste Management" R. Radharisham
T2 "Hospital Waste Management's-A guide for self-assessment and review" ShishirBasarkar
T3 "Hospital Administration and Human Resource Management", R.C.Goyal, PHI – Fourth Edition, 2006

REFERENCE BOOKS:

R1 "Biomedical Waste Disposal" Anantpreet Singh and Sukhjit Kaur
R2 "Medical Waste Management and disposal", V.J. Landrum, Elsevier, 1991

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Programme	Course code	Name of the course	L	T	P	C
B.E	22BM6304	ECONOMICS AND MANAGEMENT FOR ENGINEERS	3	0	0	3

Course Objective	The student should be able	
	1	To understand the concepts of Economics and basic problems
	2	To learn economics with respect to the demand and supply analysis
	3	To analyze the theory of production and the analysis of the cost parameter
	4	To understand skills, roles and responsibilities in evolution of management
	5	To familiarize with principles and effective planning

Unit	Description	Instructional Hours
I	**INTRODUCTION TO ECONOMICS:** Introduction to Economics – Scope of Economics – Positive and Normative Science – Methodology of Economics – Economic Laws - Economy and its basic problems: Economy and its working – Kinds of economy systems – Basic problems of economy.	9
II	**DEMAND AND SUPPLY ANALYSIS:** The Law of Demand – The Law of Supply – Elasticities of Demand and Supply: Price Elasticity of Demand - Price Elasticity and Consumption Expenditure- Cross Elasticity of Demand – Income Elasticity of Demand – The Elasticity of Price Expectations – The uses of Elasticity– Price Elasticity of Supply	9
III	**THEORY OF PRODUCTION AND ANALYSIS OF COST:** Meaning of Production – Production concepts – Production Function – Laws of Production – Cost Concepts - Short-Run Cost Output Relations – Long Run Cost output relations – Economics of Scale.	9
IV	**INTRODUCTION TO MANAGEMENT :** Management: Overview – Management Defined – Managerial skills – Managerial roles – Management responsibilities – Management functions. Evolution of Management: Classical approaches to Management – Contemporary Management Perspectives.	9
V	**PLANNING:** Planning and Forecasting: Importance of Planning – Principles of effective Planning – Planning process – Types of Plans. Strategic Planning: Strategic Planning process – Rational decision making.	9
	Total Instructional Hours	45

Course Outcome	CO1	Describe the basic concepts and problem related to economics
	CO2	Explain about demand and supply process for a market analysis
	CO3	Interpret short run and long run costs in the process of production for carrying out a business
	CO4	Apply managerial skills to make decisions and solve problems for achieving organizational objectives
	CO5	Express the principles of effective planning methods

TEXT BOOK:

T1	D.N.Dwivedi, "Principles of Economics", Second Edition, Vikas Publishing House (P) Limited, New Delhi, 2012.
T2	J.S.Chandan, "Management Concepts and Strategies", Vikas Publishing House (P) Limited, New Delhi, 2003.

REFERENCES:

R1	RanbirSingh,"Principles of Engineering Economics and Management", S.K.Kataria& Sons, New Delhi, 2013.
R2	Manish Varshney and VidhanBanerjee,"Engineering and Managerial Economics",First Edition, CBS Publishers and Distributors Pvt. Ltd., 2015.

Course Code &Name :22BM6304& ECONOMICS AND MANAGEMENT FOR ENGINEERS

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	-	-	-	1	1	1	-	-
CO2	3	-	2	-	-	-	2	-	-	-	1	1	1	-	-
CO3	3	-	2	-	-	-	2	-	-	-	1	1	1	-	-
CO4	3	-	2	-	-	-	2	-	-	-	1	1	1	-	-
CO5	3	-	2	-	-	-	2	-	-	-	1	1	1	-	-
AVG	3	-	2	-	-	-	2	-	-	-	1	1	1	-	-

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Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM6305	BIOSTATISTICS	3	0	0	3

Course Objective	At the end of the course ,students will be able to
	1 Understanding the concepts of biostatics
	2 Interpreting the Concepts Of Random Variables
	3 Evaluating the Functions Of Random Variables
	4 Infering the Real Clinical Data Sets Using Inequalities Function.
	5 Summarizing the Basic Of Discrete And Continuous Distributions Function

Unit	Description	Instructional Hours
I	Introduction:: Statistics, Biostatistics, Frequency distribution Measures of central tendency: Mean, Median, Mode- Pharmaceutical examples Measures of dispersion: Dispersion, Range, standard deviation, Pharmaceutical problems Correlation: Definition, Karl Pearson's coefficient of correlation, Multiple correlation - Pharmaceuticals examples	9
II	Random variables (discrete and continuous), Distribution function and its properties, Relation of distribution function with uniform variate. Review of univariate discrete and continuous distributions with special reference to biostatistics; Bernoulli, Binomial, Poisson, Hyper-geometric, Geometric.	9
III	Functions of random variables, their distributions in case of univariate random variables and its applications. Exponential family of distributions.Location and scale families, non-regular families.Symmetric distributions, properties of symmetric distributions, non-regular families, location and scale families and examples.	9
IV	Expectation and moments, probability generating function, moment generating function, convolution and examples. Moment inequalities: Markov, Chebychev, Holder, Minkowski and Jensen inequalities with their applications. Basic inequality of Liapunov's.	9
V	Bivariate discrete and continuous distributions, marginal and conditional distributions. Distribution function of bivariate random variable using Jacobian of transformation. Multinomial distribution, Bivariate Poisson, Bivariate exponential (Marshall and Olkin), Bivariate Normal distributions and their properties.	9
	Total Instructional Hours	45

Course Outcome		
	CO1	Summarze the statistical methods to assess relationships between variables .
	CO2	Analyze categorical data and interpret results from Random variables
	CO3	Interpret the Functions Of Random Variables

	CO4	Comprehend the Real Clinical Data Sets Using Inequalities Function.
	CO5	Conduct Bivariate discrete and continuous distributions models.
TEXT BOOK:		
T1	Rohtagi V.K. and. Saleh A. K. M. E (2015): An Introduction to Probability Theory and Mathematical Statistics, 3rd Edition, Wiley.	
T2	Miller I. and Miller M. (1999): Mathematical Statistics, 6th Edition, Oxford & IBH Pub.	
REFERENCES:		
R1	Ross S. M. (2014): Introduction to Probability Models, 11th Edition, Academic Press.	
R2	Dudewicz E. J. and S. N. Mishra S. N. (1988): Modern Mathematical Statistics, Wiley International Student Edition.	

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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
AVG	3	3	3	3		3	-	-	-	-	-	2	3	3	3

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22BM6306	FORENSIC SCIENCE IN HEALTHCARE	L T P C 3 0 0 3

COURSE OBJECTIVE:

By the end of the course each student will be familiar with:

- the history of the forensic sciences and its place in popular culture
- the roles of different types of professionals involved in evaluating a crime scene and thecollected evidence
- forensic microscope and Anthropology
- The Blood stain identification
- the methodology of collecting & interpreting data for fingerprint application

UNIT I BASICS OF FORENSIC SCIENCE 9

Forensic science, Introduction to the Forensic Sciences, History and Development of Forensic Science, Deductive Reasoning, Organization of a Crime Laboratory Case Studies: The Enrique Camarena Case. A Forensic Nightmare Organization of forensic science laboratories of center and state -NCRA AND NICFS, fundamental rights, criminal profiling, concept of quality control management in forensic institutions.

UNIT- II OBSERVATION AND CRIME SCENE 9

Observational Skills - Sherlock Holmes and Deductive Reasoning - Observations by Witnesses. Case Studies. The Crime Scene -Locard's Exchange Principle, Securing and Recording the Crime Scene, Legal Considerations at the Crime Scene, Evidence Collection and Recordation Techniques. Mock Crime Scene: Processing and Documenting a Crime Scene

UNIT III FORENSIC MICROSCOPE AND ANTHROPOLOGY 9

Forensic Use of the Microscope -The Compound, Comparison, and Stereoscopic Microscope, The Scanning Electron Microscope (SEM). Forensic Anthropology- Introduction, Human Anatomy–The Skeletal System, Skeletal Determination of Demographic Data from Skeletal Remains, Determining Types of Trauma and Disease from Skeletal Remains, Case Studies.

UNIT IV BLOOD STAIN IDENTIFICATION 9

Detection and identification of Blood stains, Determination of species of origin, Blood Groupsystems, Techniques of Determination of Blood groups of Blood stains, Determination of seminal and other fluids and their Blood Grouping, DNA, DNA Phenotyping and RNA Profiling & their applications. Wildlife forensics.

UNIT V FINGERPRINT APPLICATION 9

Fingerprints -Fundamental Principles of Fingerprint Analysis, Classification of Fingerprints, Collection of Fingerprint Evidence, Automated Fingerprint Identification Systems (AFIS), Track marks, Case Studies.

COURSE OUTCOMES:

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

CO1: Define the significance of forensic sciences

CO2: Observe and document crime scenes

CO3: Determine Trauma and Diseases.

CO4: Describe the various sources of medical data related to forensic science.

CO5: Demonstrate the visual analytical procedure of finger print application.

TEXT BOOKS

1. Nanda, B.B. and Tewari, R.K. (2001) Forensic Science in India: A vision for the twenty firstcentury Select Publisher, New Delhi.

2. James, S.H and Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press,

REFERENCES

1. Saferstein : Criminalistics (1976) Prentice Hall Inc., USA.
2. Deforest, Gansellen & Lee : Introduction to Criminalistics.
3. Sharma, B.R. (1974) Forensic Science in Criminal Investigation and Trials, Central LawAgency, Allahabad, 1974

CO's- PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	1	1	-	-	1	-	1	-	-	-	-	1	-	-
2	3	1	1	-	-	1	-	1	-	-	-	-	1	-	-
3	3	1	1	-	-	1	-	1	-	-	-	-	1	-	-
4	3	1	1	-	1	1	-	1	-	-	-	-	1	-	-
5	3	1	1	-	1	1	-	1	-	-	-	-	1	-	-
AVg.	3	1	1	-	1	1	-	1	-	-	-	-	1	-	-

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HiCET

ACADEMIC COUNCIL * HINDUSTHAN COLLEGE OF ENGG & TECH * Chairman

PROFRESSIONAL ELECTIVE-5

Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM6307	ADVANCED DIGITAL 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** Illustration 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

DATA COMPRESSION

V Lossless & Lossy- Heart Rate Variability – Time Domain measures – Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals. 9

NEUROLOGICAL APPLICATIONS

V 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.

Course Code&CourseName:22BM6307& Advanced Digital Signal Processing															
PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
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
AVG	3	2	2	3	3	-	-	-	1	-	-	-	3	3	2

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Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM6308	ARTIFICIAL NEURAL NETWORKS	3	0	0	3

Course Objective	**The student should be able**	
	1	To understand the role of neural networks in engineering, artificial intelligence, and cognitive modelling.
	2	To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning
	3	To Evaluate whether neural networks are appropriate to a particular application
	4	To design appropriate machine learning algorithms for problem solving
	5	To understand about the basic concepts of associative memories.

Unit	Description	Instructional Hours
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- Neural network applications	9
	Total Instructional Hours	45

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

TEXT BOOK:

T1	Laurene Fausett, "Fundamentals of Neural Networks", Pearson Education,2004.
T2	Simon Haykin, "Neural Networks- A comprehensive foundation", Pearson Education, 2003.

REFERENCES:

R1	S. Rajasekharan and G. A. Vijayalakshmi pai, "Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications", PHI Publication, 2004.
R2	Timothy J. Ross. " Fuzzy Logic With Engineering Applications", Tata McGraw-Hill Inc. 2000.

Course Code&CourseName:22BM6308& ARTIFICIAL NEURAL NETWORKS

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	-	1	2	1	1	3	-	3	1	2	1	2
CO2	2	2	3	-	1	3	1	2	3	-	3	1	2	1	2
CO3	2	2	3	-	3	2	1	2	3	-	3	1	2	1	2
CO4	1	2	3	-	3	2	2	2	3	-	3	1	2	1	2
CO5	2	2	3	-	2	2	2	2	3	-	3	1	2	1	2
AVG	2	2	3	-	1	2	1	2	3	-	3	1	2	1	2

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Programme	Course code	Name of the course	L	T	P	C
B.E	22BM6309	SPEECH AND AUDIO SIGNAL PROCESSING	3	0	0	3

Course Objective	The student should be able
	1 To understand the basics of speech sounds.
	2 To understand the analysis and synthesis of Speech and Audio signals
	3 To understand the speech coding, speech enhancement and speaker recognition algorithms for speech and audio processing.
	4 To understand the methods for speech enhancement and speech coding for speech signals.
	5 To understand the speech recognition.

Unit	Description	Instructional Hours
I	**Introduction:** Anatomy and physiology of speech production, categorization of speech sounds, Prosody, Parameters of Speech: Pitch and Formants.	9
II	**Analysis and Synthesis of Speech and Audio signals:** Spectral Analysis Models. Linear Predictive Coding Model for Speech Recognition, The autocorrelation method, The covariance method, Short-Time Fourier Transform Analysis and Synthesis, Short-Time Fourier Transform Magnitude, Filter Bank Summation method, Overlap-Add method.	9
III	**Frequency Domain Pitch Estimation:** A correlation-based Pitch Estimator, Pitch Estimation based on Comb Filter, Pitch Estimation based on a Harmonic Sine wave Model.	9
IV	**Speech Coding and Enhancement of Speech and Audio Signals** Vector Quantization, Frequency-Domain Coding, Model-based Coding. Spectral subtraction, Cepstral Mean Subtraction, Wiener Filtering.	9
V	**Speaker Recognition:** Spectral Features required for Speaker Recognition, Minimum Distance classifier, Gaussian Mixture Model.	9
	Total Instructional Hours	45

Course Outcome		
	CO1	Comprehend the speech production and hearing models.
	CO2	Design and apply models for speech and audio signal processing.
	CO3	Apply speech coding, speech enhancement and speaker recognition algorithms for speech and audio processing.
	CO4	Implement the methods for speech enhancement and speech coding for speech signals.
	CO5	Implement the methods for speech recognition.

TEXT BOOK:

T1	T.F. Quartieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall
T2	L.R.Rabiner, R.W.Schafer, Theory and Applications of Digital Speech Processing, Prentice Hall

REFERENCES:

R1	B. Gold, N. Morgan, D. Ellis, Speech and Audio Signal Processing: Processing and Perception of Speech and Music, Wiley-Blackwell
R2	T. Dutoit, F. Marqués, L.R. Rabiner, Applied signal processing: a MATLAB-based Proof of Concept, Springer

course Code &Name :22BM6309& SPEECH AND AUDIO SIGNAL PROCESSING

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
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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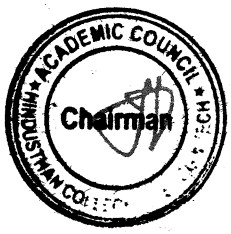

Programme	Course Code	Name of the Course	L	T	P	C
BME	22BM6310	MEDICAL IMAGING SYSTEMS	3	0	0	3

Course Objectives	To study the Production of X-rays and its applications to different medical Imaging techniques
	To learn the different types of radio diagnostic techniques. □
	To educate the special imaging techniques used for visualizing the cross sections of the body. □
	To understand the imaging of soft tissues using ultrasound technique
	To know about the principle and working of MRI and AI technique.

Unit	Description	Inst
I	**PRINCIPLES OF RADIOGRAPHIC EQUIPMENT**: X-Ray tubes, cooling systems, removal of scatters, Fluoroscopy- construction of image Intensifier tubes, angiographic setup, mammography, digital radiography, DSA.	8
II	**COMPUTED TOMOGRAPHY:** Need for sectional images, Principles of sectional scanning, Generation in CT, CT detectors, Methods of Reconstruction-Iterative, Back projection, convolution and Back-Projection and central slice theorem. Artifacts, Principle of 3D imaging	9
III	**RADIO ISOTOPIC IMAGING:** Alpha, Beta and Gamma radiation, Radiation detectors, Radio isotopic imaging equipment, Radio nuclides for imaging, Gamma camera, scanners, Positron Emission tomography, SPECT, PET/CT.	8
IV	**ULTRASOUND IMAGING SYSTEMS:** Wave propagation and interaction in Biological tissues, Acoustic radiation fields, continuous and pulsed excitation, Transducers and imaging systems, Scanning methods, Imaging Modes, Principle and theory of image generation, Applications. Doppler Ultrasound, Ultrasound Image Quality and Artifacts.	10
V	**MAGNETIC RESONANCE AND AI IMAGING:** NMR, Principle of MRI, Relaxation processes and their measurements, Pulse sequencing and MR image acquisition, MRI Instrumentation, MR Artifacts, Magnetic Resonance Spectroscopy, Functional MRI. Principle of AI, Analyze X-rays, CT scans, and MRIs images using AI, Detecting abnormalities of disease in cancer using AI: Case Study.	10
	Total Instructional Hours	**45**

Course Outcomes	CO1	Discuss the principle and working of various radiography equipment.
	CO2	Explain the tomography concept and image reconstruction techniques.
	CO3	Describe the concept of nuclear imaging techniques and radiation detectors
	CO4	Explicate basic principle involved in Ultrasound Imaging technique.
	CO5	Demonstrate the basic principle and working of MRI and AI technique

EXT BOOKS:

T. Bushberg, J.Anthony Seibert, Edwin M. Leidholdt, John M. Boone, The Essential Physics of Imaging, Lippincott Williams and Wilkins; Third Edition, 2012.

esney and M.O.Chesney, Radio graphic imaging, CBS Publications, New Delhi, 1987.

W., R.D.Ferimarch, MRI for Technologists, 2nd Edition, McGraw Hill Medical, 2000.

rra, Silvia Delsanto, Loredana Correale, Artificial Intelligence in Medical Imaging, CRC, 2021.

EFERENCE BOOKS:

obice, Elizabeth A.Moore, Martin J.Grave and Martin R.Prince, MRI from picture to proton, 2nd ambridge University press, New York 2006.

Prince and Jonathan M.Links, Medical Imaging Signals and Systems- Pearson Education Inc.

ourse Code &Name :

22BM6310	MEDICAL IMAGING SYSTEMS

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
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
AVG	2	2	2	-	2	-	-	-	-	2	-	2	2	1	1

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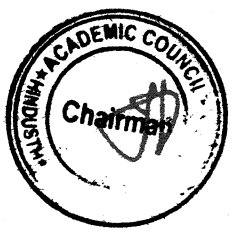


22BM6312 BIOMETRIC SYSTEMS

L T P C
3 0 0 3

COURSE OBJECTIVES:

o Study about:

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impactand issues.
- To understand the general principles of design of biometric systems and the underlyingtrade-offs.
- To study the technologies of fingerprint, iris, face and speech recognition.
- To study of evaluation of biometrics systems.

NIT I **INTRODUCTION TO BIOMETRICS** **9**

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

NIT II **FINGERPRINT TECHNOLOGY** **9**

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

NIT III **FACE RECOGNITION AND HAND GEOMETRY** **9**

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

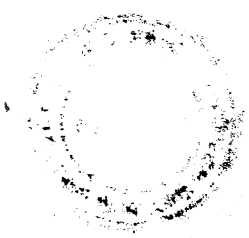
NIT IV **IRIS RECOGNITION** **9**

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

NIT V **VOICE SCAN AND MULTIMODAL BIOMETRICS** **9**

Voice scan, speaker features, short term spectral feature extraction, Mel frequency cepstral coefficients,

speaker matching, Gaussian mixture model, NIST speaker Recognition Evaluation Program, Introduction to multimodal biometric system – Integration strategies – Architecture – levelof fusion – combination strategy, examples of multimodal biometric systems, Securing and trusting a biometric transaction – matching location – local host - athentication server – match on card (MOC).



COURSE OUTCOMES:

On successful completion of this course, the student will be able toCO1: Demonstrate the principles of biometric systems.

CO2: Develop fingerprint recognition technique.

CO3: Design face recognition and hand geometry system.

CO4: Design iris recognition system.

CO5: Develop speech recognition and multimodal biometric systems.

TEXT BOOKS

TOTAL:45 PERIODS

1. James Wayman& Anil Jain, "Biometric Systems-Technology Design and PerformanceEvaluation", SPRINGER (SIE), 1st Edition, 2011
2. Paul Reid, "Biometrics for Network Security", Pearson Education, 2004
3. S.Y. Kung, S.H. Lin, M.W., "Biometric Authentication: A Machine Learning Approach",Prentice Hall, 2004

REFERENCES

1. Nalini K Ratha, Ruud Bolle, "Automatic fingerprint recognition system'', Springer, 2003.
2. L C Jain, I Hayashi, S B Lee, U Halici, "Intelligent Biometric Techniques in Fingerprint and Face Recognition", CRC Press, 1st Edition, 1999.
3. John Chirillo, Scott Blaul, "Implementing Biometric Security", John Wiley & Sons, 2003.

CO's-PO's & PSO's MAPPING

CO's	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
2	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
3	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
4	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
5	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1
AVg.	3	2	1	1	2	-	-	1	-	-	-	-	1	-	1

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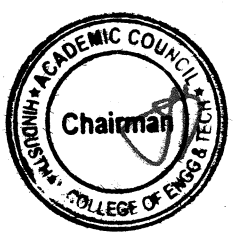

Programme	Course code	Name of the course	L	T	P	C
B.E.	22BM6311	BRAIN COMPUTER INTERFACE	3	0	0	3

Course Objective	1	Applying the basic concepts of brain computer interface.
	2	Study the various signal acquisition methods.
	3	Learn about the signal processing methods used in BCI.
	4	Summarize the various machine learning methods of BCI.
	5	Learn the various applications of BCI.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO BCI** Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.	9
II	**BRAIN ACTIVATION** Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks	9
III	**FEATURE EXTRACTION METHODS** Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering - Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization and coherence.	9
IV	**MACHINE LEARNING METHODS FOR BCI** Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis	9
V	**APPLICATIONS OF BCI** Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs:P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.	9
	Total Instructional Hours	45

Course Outcome	CO1	Comprehend the significance and role of this course in the present contemporary world.
	CO2	Evaluate the basic concept of BCI.
	CO3	Analyze the functions appropriately to the human and to the machine.
	CO4	Analyze the appropriate feature extraction methods.
	CO5	Apply the machine learning algorithms for translation.

TEXT BOOK:

T1	Rajesh.P.N.Rao, —Brain-Computer Interfacing: An Introduction‖, Cambridge University Press, First edition, 2013.Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach‖, Universities Press, 2015.
T2	Jonathan Wolpaw, Elizabeth Winter Wolpaw, —Brain Computer Interfaces: Principles and practice‖, Oxford University Press, USA, Edition 1, January 2012.

REFERENCES:

R1	Ella Hassianien, A &Azar.A.T (Editors), —Brain-Computer Interfaces Current Trends and Applications‖, Springer, 2015.
R2	Bernhard Graimann, Brendan Allison, GertPfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010.

Course Code &Name : 22BM6311&Brain Computer Interface

PO& PSO	O1	O2	O3	O4	O5	O6	O7	O8	O9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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
AVG	3	3	3	3		3						2	3	3	3

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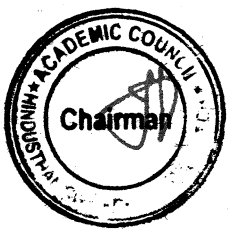

OPEN ELECTIVE

Programme	Course code	Name of the course	L	T	P	C
B.E	21BM6451	3D PRINTING	3	0	0	3

Course Objective	**The student should be able**	
	1	To impart knowledge on various additive manufacturing systems
	2	To understand various 3D printing materials
	3	To know about inkjet technology in 3D printing
	4	To teach the selection of material for 3D printing
	5	To explore various applications of 3D printing

Unit	Description	Instructional Hours
I	**Introduction to 3D Printing** Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing Processes, Applications, Research achievements in printing deposition, Technical challenges in printing, Applications of Printing Processes.	9
II	**3D Printing Materials** Polymers, Metals, Non-Metals, Ceramics; Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties; Support Materials.	9
III	**Inkjet Technology** Printer - Working Principle, Positioning System, Print head, Print bed, Frames, Motion control; Print head Considerations – Continuous Inkjet, Thermal Inkjet, Piezoelectric Drop-On-Demand	9
IV	**Powder Based Systems** Selective Laser Sintering(SLS): Principle, process, Indirect and direct SLS- powder structures, modelling of SLS, materials, post processing, post curing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies	9
V	**3D Printing Applications** Application in Design; Application in Engineering; Biomedical Application, Bone and Joint reconstruction, Bio Printing Artificial Organ and Tissues, 3D medical Printing for Dental Application - Case studies	9
	Total Instructional Hours	45

Course Outcome	CO1	Differentiate between additive and conventional manufacturing methods.
	CO2	Know various 3D printing materials
	CO3	Understand the Ink Jet technology used in the 3D printing.
	CO4	Correlate the selection of appropriate powder based techniques.
	CO5	Recognize various 3D printing applications in the real time industrial problems

TEXT BOOK:

T1	Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", 2nd edition, World Scientific Publishers, 2003.
T2	Ian M. Hutchings, Graham D. Martin, "Inkjet Technology for Digital Fabrication", John Wiley & Sons, 2013.

REFERENCES:

R1	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.
R2	Khanna Editorial, "3D Printing and Design", Khanna Publishing House, Delhi, 2010.

Course Code &Name :

21BM6451	3D PRINTING

PO& PSO	O1	O2	O3	O4	O5	O6	O7	O8	O9	PO10	PO11	PO12	PSO1	PSO2	PSO3
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
AVG	3	3	3	3		3						2	3	3	3

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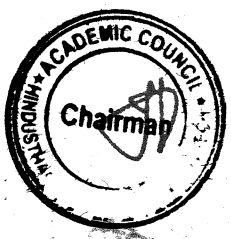


VERTICALS FORM MINOR DEGREE

- Heads are requested to provide one vertical from their program to offer for other program students toregister for additional courses (18 Credits) to become eligible for the B.E./B.Tech. Minor Degree.

Biomedical Engineering Offering Minor Degree

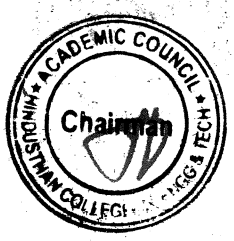
Note: Each programme should provide verticals for minor degree

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 follc wing additional courses for Minor Degree can also be given to thestudent's common to all the branches.



Programme	Course code	Name of the course	L	T	P	C
B.E	22BM6601	BIOSENSOR AND MEDICAL INSTRUMENTATION	3	0	0	3

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. Ultrasound basics, generation and detection of ultrasound, resolution.	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	Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata McGraw Hill.
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 : 22BM6601 & 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	22BM6602	Radiological Equipments	3	0	0	3

Course Objective	The student should be able
1	To understand the generation of x-rays and its uses in imaging.
2	To describe the principle of Computed Tomography.
3	To know the techniques used for visualizing various sections of the body through MRI.
4	To understand the basic principles and theories behind nuclear medicine, including the use of radioactive isotopes and radiation in medical imaging and treatment
5	To discuss the radiation therapy techniques and radiation safety

Unit	Description	Instructional Hours
I	**X-RAY EQUIPMENT:** Nature of X-Rays - X-ray Absorption - Tissue Contrast. X-Ray Equipment (Block Diagram)-X Ray machine working principle-Digital Radiography – discrete digital detectors, storage phosphor and film Scanning. X-Ray Image intensifier tubes –Fluoroscopy- Angiography-Mammography.	9
II	**COMPUTER TOMOGRAPHY:** Principles of Tomography - First to Fourth generation scanners – Image reconstruction technique- Back projection and Iterative method. Spiral CT Scanning - Ultra fast CT Scanners- X-Ray Sources – Collimation – X-Ray Detectors – Viewing System.	9
III	**MRI:** Fundamentals of Magnetic Resonance- Interaction of nuclei with static Magnetic Field and Radio frequency wave – Rotation and Precession –induction of a magnetic resonance signal – bulk Magnetization – Relaxation Processes T1 and T2. Block diagram approach of MRI system- System Magnet (Permanent, Electromagnet and super conductors) , generation of Gradient magnetic Fields , Radio Frequency coils (sending and receiving) Shim coils, Electronic components.	9
IV	**NUCLEAR MEDICINE:** Radio isotopes- Radio pharmaceuticals. Radiation detectors - Gas filled ionization Chambers, proportional counter, GM counter and Scintillation Detectors. Gamma Camera- Principles of SPECT and PET.	9
V	**RADIATION THERAPY AND RADIATION SAFETY:** Radiation therapy-Linear accelerator, Betatron, Cyclotron, Cobalt-60 units, Caesium-137 therapy units. Radiation measuring instruments-Dosimeter, film Badges, Thermo luminescent dosimeters.	9
	Total Instructional Hours	45

Course Outcome		
	CO1	Describe the working principle of X ray machine and its application.
	CO2	Illustrate the principle computed tomography.
	CO3	Interpret the technique used for visualizing various sections of the body using magnetic resonance imaging
	CO4	Familiar with the different types of nuclear medicine equipment, radioactive isotopes and its applications
	CO5	Outline the methods of radiation safety and working of Radiation therapy equipment

TEXT BOOK:

T1	Steve webb, Physics of Medical Imaging, Taylor and Francis, 1988.
T2	R. Hendee and Russell Ritenour "Medical Imaging Physics"–William, Wiley, Fourth Edition 2002.

REFERENCES:

R1	Physics and Radiobiology of Nuclear Medicine –Third edition – Gopal B.Saha –Publisher – Springer, 2006.
R2	Khandpur R.S, Handbook of Biomedical Instrumentation, , Tata McGraw-Hill, New Delhi, 2 Edition,2003.
R3	Standard handbook of Biomedical Engineering and Design – Myer Kutz Publisher – McGraw – Hill, 2003.
R4	P.Raghunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine" Concepts and Techniques, Orient Longman, 2007.

Course Code &Name :22BM6602 & Radiological Equipments

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3		1		1				1	2	1	1
CO2	3	3	2	3		1		1				1	2	1	1
CO3	3	3	2	3		1		1				1	2	1	1
CO4	3	3	2	3		1		1				1	2	1	1
CO5	3	3	2	3		1		1				1	2	1	1
AVG	3	3	2	3		1		1				1	2	1	1

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B.E- BIOMEDICAL ENGINEERING (HONOURS)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TCP	CREDITS
				L	T	P		
1	22BM5371	Modeling of physiological systems	HDC	3	0	0	3	3
2	22BM6371	Artificial intelligence and machine learning	HDC	3	0	0	3	3
3	22BM6372	Robotics in medicine	HDC	3	0	0	3	3
4	22BM7371	Quality control and regulatory aspects of medical devices	HDC	3	0	0	3	3
5	22BM7372	3D Printing	HDC	3	0	0	3	3
6	22BM8371	Medical product development and Troubleshooting	HDC	3	0	0	3	3

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Programme	Course code	Name of the course	L	T	P	C
B.E	21BM6371	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
I	**Introduction to Machine Learning** 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
II	**Supervised and Unsupervised Learning** 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
III	**Introduction to Artificial Neural Network** 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
IV	**Types of Neural Network** 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
V	**Fuzzy Logic and Genetic Algorithm** 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

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Programme	Course Code	Name of the Course	L	T	P	C
BE	22BM6372	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
I	**Introduction of Robotics:** Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom,configurations and concept of workspace,Automation,Mechanisms and movements, Dynamic stabilization-Applications of robotics in medicine	9
II	**Actuators ,Grippers and Manipulators:** Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, varioustypes 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.	9
III	**Basic Kinematics:** Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse kinematic Problems.	9
IV	**Power Source and Sensors:** 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
V	**Medical robotics:** 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	
	Identify the concepts of robotics,motion,joints
	Summarize the principles of sensors and actuators for robots
	Use the software tools for designing and analysing the robot motion
	Classify the performance to various sensors to its environment
	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 [illegible]"Surgical Robotics:System Applications & visions", Springer201[illegible]

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SEMESTER VIII

SEMESTER VIII

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	21BM83XX	**Professional Elective –IV**	PE	3	0	0	3	25	75	100
2	21BM 83XX	**Professional Elective- V**	PE	3	0	0	3	25	75	100
PROJECT WORK										
3	21BM8901	Project Work – Phase II	EEC	0	0	16	8	100	100	200
			Total	**6**	**0**	**16**	**14**	**150**	**250**	**400**

PROFESSIONAL ELECTIVE IV										
1	21BM8301	Biofluids 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	Cardiovasular Engineering	PE	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE V										
S.No.	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**C**	**CIA**	**ESE**	**TOTAL**
1	21BM8306	Rehabilitation Engineering	PE	3	0	0	3	25	75	100
2	21BM8307	Virtual Reality in Medicine	PE	3	0	0	3	25	75	100
3	21BM8308	Biophotonics	PE	3	0	0	3	25	75	100
4	21BM8309	Telemedicine	PE	3	0	0	3	25	75	100
5	21BM8310	Biometric Systems	PE	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE IV

Programme	CourseCode	NameoftheCourse	L	T	P	C
BE	21BM8301	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	Instruction 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

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: 22BM8301 | 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	21BM8302	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	Instruction 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

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: 22BM8302 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	-	2	-	1
CO4	3	-	2	-	-	-	2	-	-	-	3	-	2	-	1
CO5	3	-	-	-	-	-	-	-	-	-	3	-	-	-	1
Avg	3	1	2	-	-	-	3	-	-	-	3	-	3	-	1

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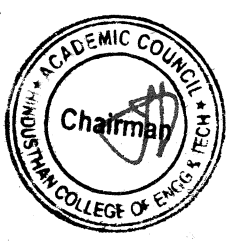

Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM8303	MEDICAL INFORMATICS	3	0	0	3

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

TEXT BOOKS:

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

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

REFERENCE BOOKS:

1.Mohan BansalMS,—Medical Informaticsl,TataMcGraw Hill,NewDelhi,2002.

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

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

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

Course Code & Name: 22BM8303 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	-	3	-	-	2	-	2	-	3	-	1
CO3	-	-	-	3	-	-	-	-	3	-	1	-	3	-	1
CO4	-	1	-	3	-	3	-	-	2	-	-	-	3	-	1
CO5	-	1	-	1	-	-	-	-	-	-	-	-	1	-	1
Avg	-	1	-	3	-	3	-	-	2	-	1	-	3	-	1

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Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM8304	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 Measarement-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	22BM8305	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

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,Peripheease,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: 22BM8305 Cardiovascular 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	-	3	-	-	3	-	-	2	-	3	-	1
CO2	-	-	3	-	2	-	-	3	-	-	-	-	-	-	1
CO3	2	-	1	-	3	-	-	3	-	-	1	-	-	-	1
CO4	2	-	1	-	3	-	-	-	-	-	-	-	-	-	1
CO5	-	-	-	-	3	-	-	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	21BM8306	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 hapties, Robotics and Virtual Reality Applications in Mobility Rehabilitation	9

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

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.

			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	3
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	21BM8307	VIRTUAL REALITY IN MEDICINE	3	0	0	3

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:tive

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

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:: 22BM8307 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	-	-	-	3	-	-	-	-	-	-	-	-	-	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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ACADEMIC COUNCIL * HINDUSTHAN COLLEGE OF ENGG & TECH * Chairman

Programme	Course Code	Name of the Course	L	T	P	C
B.E/B.Tech	21BM8308	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

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 22BM8308 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	1	-	3	2	3	-	-	-	2	1
CO3	-	-	-	-	1	1	-	3	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	21BM8309	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

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: 22BM8309 **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	21BM8310	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

(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 Evaluationl, Springer, 2005.

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

REFERENCE BOOKS:

l Reid, —Biometrics for Network Securityl, Pearson Education, 2004.
ini K Ratha, Ruud Bolle, —Automatic fingerprint Recognition Systeml, Springer, 2003
Jain, I Hayashi, S B Lee, U Halici, —Intelligent Biometric Techniques in Fingerprint and Face Recognitionl CRC Press, 1999.
n Chirillo, Scott Blaul, —Implementing Biometric Securityl, John Wiley, 2003.

TBOOKS:

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

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

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

Course Code & Name: 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

Chairman BoS
BME - HiCET

Dean (Academics)
HiCET

ACADEMIC COUNCIL * HINDUSTHAN COLLEGE OF ENGG & TECH * Chairman

B.E- BIOMEDICAL ENGINEERING (HONOURS)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	21BM5371	Modeling of physiological systems	HDC	3	0	0	3	3
2	21BM6371	Artificial intelligence and machine learning	HDC	3	0	0	3	3
3	21BM6372	Robotics in medicine	HDC	3	0	0	3	3
4	21BM7371	Quality control and regulatory aspects of medical devices	HDC	3	0	0	3	3
5	21BM7372	3D Printing	HDC	3	0	0	3	3
6	21BM8371	Medical product development and Troubleshooting	HDC	3	0	0	3	3

VERTICALS FORM MINOR DEGREE

- Heads are requested to provide one vertical from their program to offer for other program students to register for additional courses (18 Credits) to become eligible for the B.E./B.Tech. Minor Degree.

Biomedical Engineering Offering Minor Degree

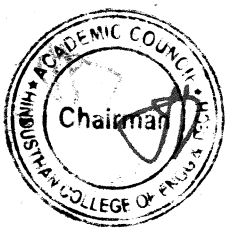
Note: Each programme should provide verticals for minor degree

Minor Specialization in Biomedical Instrumentation.

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	21BM5601	Basics of Anatomy and Physiology	MDC	3	0	0	3	3
2.	21BM6601	Biosensors and Medical Instrumentation	MDC	3	0	0	3	3
3.	21BM6602	Radiological Equipment's	MDC	3	0	0	3	3
4.	21BM7601	Biomaterials and Artificial Organs	MDC	3	0	0	3	3
5.	21BM7602	Medical Equipment Calibration and Trouble Shooting Laboratory	MDC	3	0	0	3	3
6.	21BM8601	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.



Programme	Course Code	Name of the Course	L	T	P	C
BE	21BM8371	MEDICAL PRODUCT DEVELOPMENT AND TROUBLESHOOTING	3	0	0	3

Course Objective	The student should be able	
	1	Applying the fundamental concepts and principles of a product design and development.
	2	Applying the concept and principles of work place design in product design and development.
	3	Apply the concept and principles of equipment design in product design and development.
	4	Applying the concept and principles of human factor application in product design and development.
	5	To evaluate the trouble shooting and trouble shooting of the medical domain equipments

Unit	Description	Instructional Hours
I	**INTRODUCTION TO PRODUCT DEVELOPMENT** Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economic Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development	9
II	**REQUIREMENTS AND SYSTEM DESIGN** Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling – SOFTWARES Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.	9
III	**DESIGN FOR MANUFACTURE, PROTOTYPING AND ROBUST DESIGN:** Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Concept Screening & Evaluation - Component Design and Verification, Layout and Hardware Testing– Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation	9
IV	**SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT** Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL- EoL Disposal	9
V	**BUSINESS HANDLING** Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes- Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.	9
	Total Instructional Hours	45

Course Outcome	CO1	To understand the methodologies of product development
	CO2	Apply the knowledge of design and modelling of a medical equipment
	CO3	To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development
	CO4	Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development.
	CO5	Applying the concepts and knowledge of Business Handling through the above principles

TEXT BOOK:

T1	John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd,New Delhi, 2015.
T2	Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011

REFERENCES:

R1	Bridger R S, "Introduction to Ergonomics", Taylor and Francis, London.2003

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	3	-	1	2	1	1	3	-	3	1	2	1	2
CO2	2	2	3	-	1	3	1	2	3	-	3	1	2	1	2
CO3	2	2	3	-	3	2	1	2	3	-	3	1	2	1	2
CO4	1	2	3	-	3	2	2	2	3	-	3	1	2	1	2
CO5	2	2	3	-	2	2	2	2	3	-	3	1	2	1	2
AVG	2	2	3	-	1	2	1	2	3	-	3	1	2	1	2

Chairman BoS
BME - HiCET

Dean (Academics)
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HINDUSTHAN ACADEMIC COUNCIL COLLEGE OF ENGG & TECH Chairman

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)
Valley Campus, Pollachi Highways, Coimbatore, Tamil Nadu.

DETAILS OF CHANGES CARRIED OUT IN CURRICULUM & SYLLABUS

CBCS PATTERN

UNDERGRADUATE PROGRAMMES

B.E. BIOMEDICAL ENGINEERING

REGULATION-2019 with Amendments and REGULATION-2022

No of Courses revised for the Academic year 2024-2025	
Total No of Course	57
No of Courses revised	16
Percentage of Course revised	28%

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HINDUSTHAN ACADEMIC COUNCIL Chairman HINDUSTHAN COLLEGE OF ENGG & TECH