KPR Institute of Engineering and Technology

Learn Beyond (Autonomous, NAAC "A")

Avinashi Road, Arasur, Coimbatore.

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B.E. Biomedical Engineering Curriculum and Syllabi Regulations – 2021

Department of Biomedical Engineering

KPR Institute of Engineering and Technology, Coimbatore

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Curriculum and Syllabi Comparison – Regulations 2021

Curriculum / Syllabi	Semester	Existing controlled copy of syllabus book (Prepared during June / July 2023)	Revised Controlled copy of syllabus book (Prepared during Nov / Dec 2023)
Curriculum & Syllabi	VI	U21BM603 Biomechanics L T P J C 3 0 0 2 4	U21BM603 Biomechanics L T P J C 2 0 2 0 3
Curriculum & Syllabi	VII	U21BM703 Rehabilitation Engineering L T P J C 3 0 0 2 4	U21BM703 Rehabilitation Engineering L T P J C 3 0 0 0 3
Curriculum & Syllabi	VII	-	Included U21BM705 Rehabilitation Laboratory L T P J C 0 0 4 0 2
Curriculum	VII	**U21BM705** Project Phase I	**U21BM706** Project Phase I (Subject code change)

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I. Vision and Mission of the Institute

Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of the industry, society, the nation and the world at large.

Mission

- Commitment to offer value-based education and enhancement of practical skills.
- Continuous assessment of teaching and learning processes through scholarly activities.
- Enriching research and innovation activities in collaboration with industry and institutes of repute.
- Ensuring the academic processes to uphold culture, ethics and social responsibilities.

II. Vision and Mission of the Department

Vision

To be the centre of excellence for dissemination of knowledge, research and development in biomedical and allied engineering fields to serve society with moral values.

Mission

The Mission of the Department is to

- To impart value-based education in biomedical engineering with state-of-the-art facilities.
- To build an integrated team of biomedical engineers to foster the technologies through research, development and innovation.
- To be in pace with healthcare industries by practicing lifelong learning with ethical and moral values.

III. Program Educational Objectives (PEOs)

The Program Educational Objectives (PEOs) of the Biomedical Engineering (BM) represent major accomplishments that the graduates are expected to achieve after three to five years of graduation.

PEO1: Implement the knowledge acquired through biomedical engineering in healthcare domain.

PEO2: Design and develop healthcare products and processes through continuous skill upgradation.

PEO3: Exhibit professional, ethical code of conduct and life long learning to address societal needs.

IV. Program Outcomes (POs)

Graduates of Biomedical Engineering will be able to

PO1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 Problem analysis: Identify, formulate, review research literature, and analyze complex Biomedical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 Design/ development of solutions: Design solutions for complex Biomedical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and

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modern engineering and IT tools including prediction and modeling to complex Biomedical engineering activities with an understanding of the limitations.

PO6 The engineer and society: Apply reasoning informed by the contextual knowledge to access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

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

V. Program Specific Outcomes (PSOs)

Graduates of Biomedical Engineering will be able to

PSO1: Design and develop medical devices with the knowledge acquired through biosensors, biomaterials, biomechanics, diagnostic and therapeutic equipment that help physicians and enhance the quality of service rendered to end user.

PSO2: Make use of their software skills acquired through bio-signal and image processing to develop algorithms for addressing healthcare solutions.

VI. PEO/PO Mapping

Following three levels of correlation should be used:

1: Low

2: Medium

3: High

PEOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	3	3	3	3	2	2	2	2	2	3	3	2
PEO2	3	3	3	3	3	2	1	2	2	3	3	3
PEO3	3	3	3	3	3	2	2	2	1	3	3	3

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VII. Mapping of Course Outcomes with Program Outcomes

SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
SEM I	Calculus and Differential Equations	✓	✓	-	-	-	-	-	-	-	-	-	✓	✓	-
	Basics of Electrical and Electronics Engineering	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	English for Technologists	-	-	-	-	-	-	-	✓	✓	✓	-	✓	-	-
	Engineering Physics	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
	Engineering Chemistry	✓	✓	-	-	-	-	✓	-	✓	-	-	✓	✓	-
	Problem Solving and C Programming	✓	✓	✓	✓	-	✓	-	✓	✓	✓	-	✓	-	✓
	Engineering Graphics	✓	✓	✓	-	✓	-	-	✓	-	✓	-	✓	-	✓
SEM II	Transforms and its Applications	✓	✓	-	-	-	-	-	-	-	-	-	-	-	✓
	Medical Physics	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Linear Integrated Circuits	✓	✓	✓	✓	✓	-	-	✓	-	-	-	-	✓	✓
	Personality Enhancement	-	-	-	-	-	-	-	✓	✓	✓	-	✓	-	-
	Python Programming	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	-	✓
	Fundamentals of Biochemistry	✓	✓	✓	-	-	-	✓	✓	✓	✓	-	✓	✓	-
	Linear Integrated Circuits Laboratory	✓	✓	✓	-	✓	-	-	-	✓	-	-	-	✓	✓
	Manufacturing Practices	✓	✓	✓	-	✓	-	✓	-	✓	✓	-	✓	✓	-
SEM III	Linear Algebra and Complex Analysis	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	✓
	Human Anatomy and Physiology	✓	-	-	-	-	✓	-	✓	✓	-	-	-	✓	-
	Biomaterials and Artificial Organs	✓	✓	✓	✓	✓	✓	-	-	-	-	-	✓	✓	-
	Digital Electronics	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	✓	✓
	Data Structures	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	-	✓
	Biomedical Sensors and	✓	✓	✓	-	-	-	✓	-	-	-	✓	✓	✓	-

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	Instrumentation														
	Biomedical Sensors and Instrumentation Laboratory	-	-	✓	✓	✓	✓	-	-	✓	-	-	-	✓	✓
	Human Anatomy and Physiology Laboratory	-	-	✓	-	✓	-	-	-	✓	-	-	-	✓	-
SEM IV	Probability and Stochastic Processes	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	✓
	Microbiology and Pathology	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	✓
	Artificial Intelligence and Machine Learning	✓	✓	✓	-	-	-	-	-	-	-	✓	-	-	✓
	Java Programming	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	✓	-	✓
	Biophysical Signals and Systems	✓	✓	-	✓	✓	-	-	-	✓	-	-	✓	-	✓
	Microbiology and Pathology Laboratory	-	-	✓	-	✓	-	-	-	✓	-	-	-	✓	✓
	Soft Skills – I	-	-	-	-	-	-	-	-	✓	✓	-	✓	-	-
SEM V	Microcontroller and its Applications	✓	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓
	Biosignal Processing	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	-	✓
	Biocontrol Systems	✓	✓	-	✓	✓	-	-	-	-	-	-	-	-	✓
	Soft Skills – II	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-
	Microcontroller Laboratory	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	✓	✓
SEM VI	Diagnostic and Therapeutic Equipment	✓	✓	✓	✓	✓	-	✓	-	-	-	-	-	✓	-
	Hospital Management	✓	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓
	Biomechanics	✓	✓	✓	✓	✓	-	-	-	✓	-	-	✓	✓	✓
	Soft Skills – III	-	-	-	-	-	-	-	✓	✓	✓	-	✓	-	-
	Diagnostic and Therapeutic Equipment Laboratory	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	✓	-
SEM VII	Radiological Equipment	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
	Medical Image Processing	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	-	✓

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	Rehabilitation Engineering	✓	✓	✓	✓	✓	-	-	✓	✓	-	-	-	✓	✓
	Medical Image Processing Laboratory	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	-	✓
	Rehabilitation Laboratory	✓	✓	✓	✓	✓	-	-	✓	✓	✓	-	✓	✓	✓
	Project work Phase - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SEM VIII	Project work Phase - II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VERTICAL I	Nanotechnology in Medicine	✓	✓	✓	-	-	✓	✓	-	-	-	-	-	✓	-
	Advances in Drug Delivery	✓	✓	✓	-	-	✓	-	-	-	-	-	-	✓	-
	Immunoengineering	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Biosensors	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-
	Tissue Engineering	✓	✓	✓	-	-	-	✓	✓	-	-	-	-	✓	-
	Bioprinting	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-	-	✓	-
	Biophotonics	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
	Ethical Issues and Intellectual Property Rights	✓	-	-	-	-	✓	✓	✓	-	-	-	✓	✓	-
VERTICAL II	Foundation Skills in Integrated Product Development	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	✓
	Medical Device Design	✓	✓	✓	-	-	-	-	✓	✓	✓	✓	-	-	-
	Quality management and Accreditations in Healthcare	✓	✓	-	✓	-	✓	✓	✓	-	-	-	-	-	-
	Patient safety, Standards and Ethics	✓	-	-	-	-	✓	✓	✓	-	-	-	-	✓	-
	Medical Device Regulations	✓	✓	-	-	-	✓	✓	-	-	-	-	-	✓	-
	Healthcare Data Analytics	✓	-	✓	-	✓	-	-	-	-	-	-	-	-	✓
	Medical Waste Management	✓	-	-	-	-	✓	✓	✓	-	-	-	✓	✓	-
	Testing and Calibration	✓	✓	-	✓	-	✓	-	✓	-	-	-	✓	✓	-
VERTICAL III	Sports Biomechanics	✓	✓	✓	✓	✓	✓	-	✓	-	-	-	✓	✓	-
	Biofluids	-	-	✓	-	✓	-	-	-	-	-	-	✓	✓	-

	Physiological modelling	✓	✓	-	-	-	-	-	-	-	-	-	✓	-	✓
	Assistive Technology	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
	Ergonomics	✓	✓	✓	-	✓	✓	-	-	-	-	-	-	✓	-
	Haptics	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-
	Implant Selection and Development	✓	✓	✓	-	✓	-	-	-	-	-	-	✓	✓	-
	Bone Remodeling	✓	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓
VERTICAL IV	Internet of Medical Things	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	-	✓	✓	-
	AI for Medical Diagnostics	✓	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓
	Virtual reality in Healthcare	✓	✓	✓	-	-	✓	-	-	-	-	-	-	-	✓
	Data mining and Pattern Recognition	✓	✓	✓	✓	✓	-	-	-	-	-	-	-	-	✓
	Brain Computer Interface and Applications	✓	✓	✓	✓	✓	-	-	-	-	-	-	✓	✓	✓
	Wearable devices	✓	✓	✓	-	-	-	-	-	-	-	-	-	✓	-
	Virtual Instrumentation and DAQ Systems	✓	✓	✓	-	✓	-	-	-	-	-	-	-	-	✓
	Bioinformatics	✓	✓	-	-	✓	-	-	-	-	-	-	-	-	✓
VERTICAL V	BioMEMs	✓	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-
	Critical Care Equipment	✓	✓	-	-	-	-	✓	-	-	-	-	✓	✓	-
	Human Assist Devices	✓	-	-	-	-	-	-	-	-	-	-	✓	-	-
	Communication Network Systems	✓	✓	✓	-	-	-	-	-	-	-	-	✓	-	-
	Robotics in Medicine	✓	✓	✓	-	✓	-	-	✓	-	-	-	-	-	✓
	Nuclear Medicine	✓	✓	-	-	-	-	✓	-	-	-	-	-	-	-
	Embedded Systems for Biomedical Applications	✓	✓	✓	✓	-	-	-	-	-	✓	✓	✓	✓	-
	VLSI for Medical Devices	✓	✓	✓	-	-	✓	-	-	-	-	-	✓	✓	-

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B.E. BIOMEDICAL ENGINEERING

REGULATIONS – 2021

For the students admitted in 2021

CHOICE BASED CREDIT SYSTEM

CURRICULUM FOR I - VIII SEMESTERS

SEMESTER I

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA101	Calculus and Differential Equations	BSC	3	1	0	0	4
2	U21EEG01	Basics of Electrical and Electronics Engineering	ESC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
3	U21EN101	English for Technologists	HSMC	1	0	2	0	2
4	U21PH101	Engineering Physics	BSC	2	0	2	0	3
5	U21CY101	Engineering Chemistry	BSC	2	0	2	0	3
6	U21CSG01	Problem Solving and C Programming	ESC	2	0	2	0	3
	LABORATORY COURSES							
7	U21MEG01	Engineering Graphics	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
8	U21MYC01	Induction program	MNC	Three Weeks				
			TOTAL	13	1	12	0	20

SEMESTER II

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA202	Transforms and its Applications	BSC	3	0	0	0	3
2	U21PH202	Medical Physics	BSC	3	0	0	0	3
3	U21BM201	Linear Integrated Circuits	ESC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
4	U21EN201	Personality Enhancement	HSMC	1	0	2	0	2
5	U21CSG02	Python Programming	ESC	2	0	2	0	3
6	U21CY201	Fundamentals of Biochemistry	BSC	2	0	2	0	3
	LABORATORY COURSES							
7	U21BM202	Linear Integrated Circuits Laboratory	ESC	0	0	4	0	2
8	U21MEG02	Manufacturing Practices	ESC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
9	U21MYC02	Environmental Sciences	MNC	1	0	0	0	0
			TOTAL	15	0	14	0	21

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SEMESTER III

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA302	Linear Algebra and Complex Analysis	BSC	3	1	0	0	4
2	U21BM301	Human Anatomy and Physiology	PCC	3	0	0	0	3
3	U21BM303	Biomaterials and Artificial Organs	PCC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
4	U21ECG01	Digital Electronics	ESC	2	0	2	0	3
5	U21CSG03	Data Structures	ESC	2	0	2	0	3
	THEORY COURSE WITH PROJECT COMPONENT							
6	U21BM302	Biomedical Sensors and Instrumentation	PCC	3	0	0	2	4
	LABORATORY COURSES							
7	U21BM304	Biomedical Sensors and Instrumentation Laboratory	PCC	0	0	4	0	2
8	U21BM305	Human Anatomy and Physiology Laboratory	PCC	0	0	4	0	2
	MANDATORY NON CREDIT COURSES							
9	U21MYC03	Essence of Indian Traditional Knowledge	MNC	1	0	0	0	0
			TOTAL	17	1	12	2	24

SEMESTER IV

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21MA406	Probability and Stochastic Processes	BSC	3	0	0	0	3
2	U21BM401	Microbiology and Pathology	PCC	3	0	0	0	3
3	U21AMG04	Artificial Intelligence and Machine Learning	ESC	3	0	0	0	3
4		Open Elective - I	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
5	U21CSG04	Java Programming	ESC	2	0	2	0	3
6	U21BM402	Biophysical Signals and Systems	PCC	2	0	2	0	3
	LABORATORY COURSES							
7	U21BM403	Microbiology and Pathology Laboratory	PCC	0	0	4	0	2
8	U21SSG01	Soft Skills – I	HSMC	0	0	2	0	1
	MANDATORY NON CREDIT COURSES							
9	U21MYC04	Indian Constitution	MNC	1	0	0	0	0
			TOTAL	17	0	10	0	21

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SEMESTER V

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21BM501	Microcontroller and its Applications	PCC	3	0	0	0	3
2		Professional Elective - I	PEC	3	0	0	0	3
3		Professional Elective - II	PEC	3	0	0	0	3
4		Open Elective – II	OEC	3	0	0	0	3
THEORY WITH LABORATORY COMPONENT								
5	U21BM502	Biosignal Processing	PCC	2	0	2	0	3
THEORY COURSE WITH PROJECT COMPONENT								
6	U21BM503	Biocontrol Systems	PCC	3	0	0	2	4
	LABORATORY COURSES							
7	U21SSG02	Soft Skills – II	HSMC	0	0	2	0	1
8	U21BM504	Microcontroller Laboratory	PCC	0	0	4	0	2
MANDATORY NON CREDIT COURSE								
9	U21MYC05	Cyber Security Essentials	MNC	1	0	0	0	0
			TOTAL	**18**	**0**	**8**	**2**	**22**

SEMESTER VI

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21BM601	Diagnostic and Therapeutic Equipment	PCC	3	0	0	0	3
2	U21BM602	Hospital Management	HSMC	3	0	0	0	3
3		Professional Elective – III	PEC	3	0	0	0	3
4		Professional Elective – IV	PEC	3	0	0	0	3
5		Open Elective – III	OEC	3	0	0	0	3
	THEORY COURSE WITH LABORATORY COMPONENT							
6	U21BM603	Biomechanics	PCC	2	0	2	0	3
	LABORATORY COURSES							
7	U21SSG03	Soft Skills – III	HSMC	0	0	2	0	1
8	U21BM604	Diagnostic and Therapeutic Equipment Laboratory	PCC	0	0	4	0	2
MANDATORY NON CREDIT COURSE								
9	U21MYC06	Introduction to UN SDGs: An Integrative Approach	MNC	1	0	0	0	0
			TOTAL	**18**	**0**	**8**	**0**	**21**

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SEMESTER VII

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
	THEORY COURSES							
1	U21BM701	Radiological Equipment	PCC	3	0	0	0	3
2	U21BM702	Medical Image Processing	PCC	3	0	0	0	3
3	U21BM703	Rehabilitation Engineering	PCC	3	0	0	0	3
4		Professional Elective – V	PEC	3	0	0	0	3
5		Professional Elective - VI	PEC	3	0	0	0	3
6		Open Elective - IV	OEC	3	0	0	0	3
	LABORATORY COURSES							
7	U21BM704	Medical Image Processing Laboratory	PCC	0	0	4	0	2
8	U21BM705	Rehabilitation Laboratory	PCC	0	0	4	0	2
8	U21BM706	Project work Phase - I	EEC	0	0	0	4	2
			TOTAL	**18**	**0**	**8**	**4**	**24**

SEMESTER VIII

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BM801	Project work Phase - II	EEC	0	0	0	20	10
			TOTAL	**0**	**0**	**0**	**20**	**10**

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMI01	Industrial Training / Internship*	EEC	0	0	0	0	2
			TOTAL	**0**	**0**	**0**	**0**	**2**

***Four Weeks during any semester vacation from III to VI Semester**

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NCC CREDIT COURSES:

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21NCC01	National Cadet Corps I	-	1	0	2	0	2
2	U21NCC02	National Cadet Corps II	-	1	0	2	0	2
3	U21NCC03	National Cadet Corps III	-	1	0	2	0	2
4	U21NCC04	National Cadet Corps IV	-	2	0	2	0	3
5	U21NCC05	National Cadet Corps V	-	1	0	2	0	2
6	U21NCC06	National Cadet Corps VI	-	2	0	2	0	3
			TOTAL	8	-	12	-	14

NCC Credit Course (Level 1 – Level 6) are offered for NCC students only. The grades earned by the students will be recorded in the mark sheet, however the same shall not be considered for the computation of CGPA.

TOTAL CREDITS: 165

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PROFESSIONAL ELECTIVES COURSES: VERTICALS

Vertical I Bio Engineering	Vertical II Medical Device Development and Management	Vertical III Mechanics	Vertical IV Medical Data Processing	Vertical V Advanced Healthcare Systems
Nanotechnology in Medicine	Foundation Skills in Integrated Product Development	Sports Biomechanics	Internet of Medical Things	BioMEMs
Advances in Drug Delivery	Medical Device Design	Biofluids	AI for Medical Diagnostics	Critical Care Equipment
Immunoengineering	Quality management and Accreditations in Healthcare	Physiological modelling	Virtual reality and Augmented Reality in Healthcare	Human Assist Devices
Biosensors	Patient safety, Standards and Ethics	Assistive Technology	Data mining and Pattern Recognition	Communication Network Systems
Tissue Engineering	Medical Device Regulations	Ergonomics	Brain Computer Interface and Applications	Robotics in Medicine
Bioprinting	Healthcare Data Analytics	Haptics	Wearable devices	Nuclear Medicine
Biophotonics	Medical Waste Management	Implant Selection and Development	Virtual Instrumentation and DAQ Systems	Embedded Systems for Biomedical Engineers
Ethical Issues and Intellectual Property Rights	Testing and Calibration	Bone Remodeling	Bioinformatics	VLSI for Medical Devices

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VII. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VII.

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTIVAL I: BIO ENGINEERING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMP01	Nanotechnology in Medicine	PEC	3	0	0	0	3
2	U21BMP02	Advances in Drug Delivery	PEC	3	0	0	0	3
3	U21BMP03	Immunoengineering	PEC	3	0	0	0	3
4	U21BMP04	Biosensors	PEC	3	0	0	0	3
5	U21BMP05	Tissue Engineering	PEC	3	0	0	0	3
6	U21BMP06	Bioprinting	PEC	3	0	0	0	3
7	U21BMP07	Biophotonics	PEC	3	0	0	0	3
8	U21BMP08	Ethical Issues and Intellectual Property Rights	PEC	3	0	0	0	3

VERTIVAL II: MEDICAL DEVICE DEVELOPMENT AND MANAGEMENT

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMP09	Foundation Skills in Integrated Product Development	PEC	3	0	0	0	3
2	U21BMP10	Medical Device Design	PEC	3	0	0	0	3
3	U21BMP11	Quality management and Accreditations in Healthcare	PEC	3	0	0	0	3
4	U21BMP12	Patient safety, Standards and Ethics	PEC	3	0	0	0	3
5	U21BMP13	Medical Device Regulations	PEC	3	0	0	0	3
6	U21BMP14	Healthcare Data Analytics	PEC	3	0	0	0	3
7	U21BMP15	Medical Waste Management	PEC	3	0	0	0	3
8	U21BMP16	Testing and Calibration	PEC	3	0	0	0	3

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VERTIVAL III: MECHANICS

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMP17	Sports Biomechanics	PEC	3	0	0	0	3
2	U21BMP18	Biofluids	PEC	3	0	0	0	3
3	U21BMP19	Physiological modelling	PEC	3	0	0	0	3
4	U21BMP20	Assistive Technology	PEC	3	0	0	0	3
5	U21BMP21	Ergonomics	PEC	3	0	0	0	3
6	U21BMP22	Haptics	PEC	3	0	0	0	3
7	U21BMP23	Implant Selection and Development	PEC	3	0	0	0	3
8	U21BMP24	Bone Remodeling	PEC	3	0	0	0	3

VERTIVAL IV: MEDICAL DATA PROCESSING

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMP25	Internet of Medical Things	PEC	3	0	0	0	3
2	U21BMP26	AI for Medical Diagnostics	PEC	3	0	0	0	3
3	U21BMP27	Virtual reality in Healthcare	PEC	3	0	0	0	3
4	U21BMP28	Data mining and Pattern Recognition	PEC	3	0	0	0	3
5	U21BMP29	Brain Computer Interface and Applications	PEC	3	0	0	0	3
6	U21BMP30	Wearable devices	PEC	3	0	0	0	3
7	U21BMP31	Virtual Instrumentation and DAQ Systems	PEC	3	0	0	0	3
8	U21BMP32	Bioinformatics	PEC	3	0	0	0	3

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VERTIVAL V: ADVANCED HEALTHCARE SYSTEMS

Sl.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMP33	BioMEMs	PEC	3	0	0	0	3
2	U21BMP34	Critical Care Equipment	PEC	3	0	0	0	3
3	U21BMP35	Human Assist Devices	PEC	3	0	0	0	3
4	U21BMP36	Communication Network Systems	PEC	3	0	0	0	3
5	U21BMP37	Robotics in Medicine	PEC	3	0	0	0	3
6	U21BMP38	Nuclear Medicine	PEC	3	0	0	0	3
7	U21BMP39	Embedded Systems for Biomedical Applications	PEC	3	0	0	0	3
8	U21BMP40	VLSI for Medical Devices	PEC	3	0	0	0	3

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OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories).

OPEN ELECTIVES – I (SEMESTER: IV)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMX01	Virtual Instrumentation	OEC	3	0	0	0	3
2	U21BMX02	Biometric Systems	OEC	3	0	0	0	3

OPEN ELECTIVES – II (SEMESTER: V)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMX03	Biomedical Visualization	OEC	3	0	0	0	3
2	U21BMX04	Food as Medicine	OEC	3	0	0	0	3

OPEN ELECTIVES – III (SEMESTER: VI)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMX05	Medical informatics	OEC	3	0	0	0	3
2	U21BMX06	Telemedicine	OEC	3	0	0	0	3

OPEN ELECTIVES – IV (SEMESTER: VII)

SI.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	J	C
1	U21BMX07	Biomedical Instrumentation	OEC	3	0	0	0	3
2	U21BMX08	First aid and Safety for Human	OEC	3	0	0	0	3

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Scheme of Credit distribution – Summary

S.No	Stream	Credits/Semester								Credits
		I	II	III	IV	V	VI	VII	VIII	
1.	Humanities and Social Sciences including Management (HSMCC)	2	2	-	1	1	4	-	-	10
2.	Basic Science Courses (BSC)	10	9	4	3	-	-	-	-	26
3.	Engineering Science Courses (ESC)	8	10	6	6	-	-	-	-	30
4.	Professional Core Courses (PCC)	-	-	14	8	12	8	13	-	55
5.	Professional Elective Courses (PEC)	-	-	-	-	6	6	6	-	18
6.	Open Elective Courses (OEC)	-	-	-	3	3	3	3	-	12
7.	Employability Enhancement Courses (EEC)	-	-	-	-	-	-	2	10	12
8.	Industrial Training/ Internship	-	-	-	-	-	-	-	2	2
9.	Mandatory Non-Credit Course (MNC)	-	-	-	-	-	-	-	-	-
Total		**20**	**21**	**24**	**21**	**22**	**21**	**24**	**10+2**	**165**

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SEMESTER I

		Category: BSC				
U21MA101	**CALCULUS AND DIFFERENTIAL EQUATIONS** (Common to AD, BM, CE, CH, CS, CS(AIML), EC, IT, ME, MI)	**L**	**T**	**P**	**J**	**C**
		3	1	0	0	4

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of matrices and calculus which will enable them to model and analyze physical phenomena involving continuous change
- To understand the methodologies involved in solving problems related to fundamental principles of calculus
- To develop confidence to model mathematical pattern and give appropriate solutions

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the knowledge of matrices with the concepts of eigenvalues to study their problems in core areas (Apply)

CO2: Apply the basic techniques and theorems of functions of several variables in other areas of mathematics (Apply)

CO3: Analyze the triple integrals techniques over a region in two dimensional and three dimensional geometry (Apply)

CO4: Apply basic concepts of integration to evaluate line, surface and volume integrals (Apply)

CO5: Solve basic application problems described by second and higher order linear differential equations with constant coefficients (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	2	2	-	-	-	-	-	-	-	-	-	-	1	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I MATRICES **9 + 3**

Eigenvalues and eigenvectors – Properties (without proof) – Cayley Hamilton theorem (without proof) – Diagonalization using orthogonal transformation – Applications

UNIT II FUNCTIONS OF SEVERAL VARIABLES **9 + 3**

Partial derivatives – Total derivative – Jacobians – Taylor's series expansion – Extreme values of functions of two variables – Lagrange multipliers method

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UNIT III MULTIPLE INTEGRALS 9 + 3

Double integrals – Change of order of integration – Triple integrals – Applications in area and volume

UNIT IV LINE AND SURFACE INTEGRALS 9 + 3

Line integrals – Surface integrals – Green's theorem in a plane – Gauss divergence theorem – Stokes' theorem (excluding proofs)

UNIT V ORDINARY DIFFERENTIAL EQUATIONS 9 + 3

Second and higher order linear differential equations with constant coefficients – Variable coefficients – Euler Cauchy equation – Legendre's equation – Method of variation of parameters – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: 15 Periods Practical: – Periods Project – Periods

Total 60 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd, New Delhi, 2018
2. Grewal B S, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2017

REFERENCES:

1. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th Edition, Laxmi Publications, 2016
2. Thomas G B and Finney R L, "Calculus and Analytic Geometry", 14th Edition, Pearson Education India, 2018
3. Maurice D Weir, Joel Hass and Christopher Heil, "Thomas Calculus", 14th Edition, Pearson Education, India, 2018
4. James Stewart, "Calculus: Early Transcendental", 7th Edition, Cengage Learning, New Delhi, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / MCQ	Written Test	*Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

		Category: ESC				
		L	T	P	J	C
U21EEG01	BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING (Common to AD, AM, BM, CB, CS and IT)	3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To solve an electric network by applying basic laws
- To acquire the knowledge of operating principle, characteristics, starting, methods of DC and AC Machines
- To acquire the knowledge of construction, operating principle, characteristics of semiconductor devices and its applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Solve an electric network by applying basic laws (Apply)
CO2: Acquire the knowledge of operating principles, characteristics, starting, and speed control methods of DC motors (Understand)
CO3: Explain the operating principles of AC motor and characteristics, starting methods of induction motor (Understand)
CO4: Summarize the construction, principle and characteristics of semiconductor devices (Understand)
CO5: Interpret the applications of semiconductor devices (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I BASIC CONCEPTS OF ELECTRIC CIRCUITS 9

Active elements – Passive elements – Sources – Elements in series and parallel connections – Star and delta conversion – Ohm's law and Kirchhoff's laws – Mesh and Nodal analysis in DC Networks

UNIT II DC MOTOR 9

DC motor – Construction, principle of operation, types, torque equation, characteristics and applications – Starters for DC motor: Two point – Three point – Speed control – Armature and field control (Qualitative Analysis only)

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UNIT III TRANSFORMER AND AC MOTOR 9

Single phase transformer – Three phase induction motor – Construction, principle of operation, characteristics and applications – Starters – DOL, Star–delta. (Qualitative Analysis only).

UNIT IV SEMICONDUCTOR DEVICES 9

Construction, operation and characteristics: PN Junction, Zener Diode – BJT – FET

UNIT V APPLICATIONS OF SEMICONDUCTOR DEVICES 9

Rectifier– Half wave, Full wave – Filters – Voltage regulator – Series and shunt – CE, CB and CC Configuration

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", McGraw–Hill Education, New Delhi, 5th Edition, Jul 2017
2. R.K.Rajput, "Electrical Machines", Laxmi Publications, 6th Edition, Jan 2016
3. V.K Metha and Rohit Metha, "Principles of Electronics", S.Chand Publications, 12th Edition, 2020

REFERENCES:

1. J William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", McGraw–Hill Education, New Delhi, 8th Edition, Aug 2013.
2. S.K. Bhattacharya, "Electrical Machines", McGraw–Hill Education, New Delhi, 4th Edition, July 2017
3. R.S.Sedha, "A text book of Applied Electronics", S.Chand Publications, Revised Edition, Jul 2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21EN101	ENGLISH FOR TECHNOLOGISTS (Common to AD, BM, CH, CE, CS, CS(AIML), EE, EC, ME, MI, IT)	Category: HSMC				
		L	T	P	J	C
		1	0	2	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To infer and interpret the meaning of Technical, Business, Social and Academic contexts
- To enhance the listening skills and facilitate effective pronunciation
- To make effective presentation and conversation in technical and professional environment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Comprehend language and learn strategies for error-free communication (Understand)

CO2: Improve speaking skills in academic and social contexts (Apply)

CO3: Enhance both reading and writing skills to excel in professional career (Analyse)

CO4: Evaluate different perspectives on a topic (Analyse)

CO5: Develop listening skills to understand complex business communication in a variety of global English accents through Personality Development (Understand)

CO-PO MAPPING:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO3	-	-	-	-	-	-	-	-	2	3	-	1	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO5	-	-	-	-	-	-	-	2	-	3	-	1	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I SUBJECTIVE INTROSPECTION 9

Module:1 Vocabulary Building

Activity: Word Puzzles, Snappy words, Word Sleuthing

Module:2 Introducing and Sharing Information

Activity: Get to know oneself, Introducing Peer Members

Module:3 Opinion Paragraph

Activity: Note making, analyzing and writing a review

UNIT II CAREER ENHANCEMENT 9

Module:4 Reading Comprehension

Activity: Reading Newspaper articles/Blogs, Sentence completion

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Module:5 E-mail Communication

Activity: Drafting personal and professional emails

Module:6 Career Profiling

Activity: Resume Writing & Digital Profiling

UNIT III LANGUAGE ADEPTNESS 9

Module:7 Rewriting passages

Activity: Conversion of voices & Rephrasing Articles

Module:8 Enhancing Pronunciation skills

Activity: Listening to short technical Reels and reproducing it

Module:9 Making Conversations

Activity: Role play & Narrating Incidents

UNIT IV TECHNICAL WRITING 9

Module:10 Spotting Errors

Activity: Proof reading, Rewriting sentences

Module:11 Data interpretation

Activity: Interpretation of Graphics/Charts/Graphs

Module:12 Expository Writing

Activity: Picture inference, Captions for Posters& Products

UNIT V LANGUAGE UPSKILLING 9

Module:13 Listening for Specific Information

Activity: TED talks/Announcement/Documentaries

Module:14 Presentation

Activity: Extempore & Persuasive Speech

Module:15 Team Communication

Activity: Team building activities, Group Discussion

LIST OF EXERCISES

1. Introducing oneself
2. Role play
3. Listening to short technical Reels
4. Listening to TED Talks/ Announcements/ Documentaries
5. Presentation
6. Group Discussion

Contact Periods:

Lecture: 15 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Ashraf Rizvi, "Effective Technical Communication", 2nd Edition, Mc Graw – Hill. India 2017
2. Rod Ellis, "English for Engineers & Technologists", Vol. II: (English for Engineers and Technologist: A Skills Approach). 2nd Edition, Orient Black Swan, 1990

REFERENCES:

1. Raymond Murphy, "Intermediate English Grammar", 2nd Edition, Cambridge University Press, 2009
2. Thomas L Means, "English and Communication for Colleges", 4th Edition, Cengage 2017

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3. Using English: "A Coursebook for Undergraduate Engineers and Technologists", 1st Edition, Orient Black Swan, 2017

EVALUATION PATTERN:

<table>
<tr><td colspan="4">Continuous Internal Assessments</td><td>End Semester Examinations</td></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="2">Practical Examinations

(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>Individual Assignment / Seminar / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>50</td></tr>
<tr><td colspan="4">50</td><td>50</td></tr>
<tr><td colspan="5">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

		Category: BSC				
U21PH101	ENGINEERING PHYSICS (Common to all branches)	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the fundamental principles of laser and fibre optics with their applications
- To acquire the knowledge of ultrasonic waves, thermal conductivity and properties of liquids
- To understand the concepts of crystals

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Demonstrate the types of laser for various industrial and medical applications (Understand)

CO2: Apply the concepts of fibre optics in engineering (Understand)

CO3: Understand the production methods of ultrasonic waves and uses in engineering and medicine (Understand)

CO4: Apply the concepts of thermal conductivity in hybrid vehicles and viscosity of liquids in engineering applications (Understand)

CO5: Explain the basic concepts of crystals and its growth techniques (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I LASER 6

Laser characteristics – Spontaneous and stimulated emission – Pumping methods – CO_2 laser – Semiconductor laser – Material Processing – Selective laser Sintering – Hologram – Medical applications (Opthalmology)

UNIT II FIBER OPTICS 6

Total internal reflection – Numerical aperture and acceptance angle – Classification of optical fibers (Materials, modes and refractive index profile) – Fiber optical communication system – Displacement and temperature sensor – Medical Endoscopy

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UNIT III ULTRASONICS 6

Properties of ultrasonic waves – Piezoelecrtic generator – Acoustic grating – Applications of ultrasonics in industry– SONAR – NDT – Ultrasonic scanning methods – Fetal heart movement

UNIT IV THERMAL PHYSICS AND PROPERTIES OF FLUIDS 6

Modes of heat transfer – Thermal conductivity – Lee's disc method – Solar thermal power generation – Hybrid vehicles – Microwave oven – Surface tension and coefficient of viscosity – Poiseuille's flow experiment

UNIT V CRYSTAL PHYSICS 6

Unit cell – Bravais lattices – SC, BCC, FCC structures – Miller indices – d spacing in cubic lattice – Crystal growth from melt: Bridgeman Technique – Silicon ingots from Czochralski method – Silicon wafers from ingots and its applications.

LIST OF EXPERIMENTS

1. Determination of the wavelength of a given laser source
2. Determination of acceptance angle and numerical aperture of an optical fibre
3. Determination of velocity of sound and compressibility of a liquid using Ultrasonic interferometer
4. Determination of thermal conductivity of a bad conductor using Lee's disc method
5. Determination of viscosity of the given liquid using Poiseuille's flow method

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project:	– Periods
			Total:	60 Periods

TEXT BOOKS:

1. Bhattacharya D K and Poonam Tandon, "Engineering Physics", 2nd Edition, Oxford University Press, Chennai, 2017
2. Marikani A, "Engineering Physics", 3rd Edition, PHI publishers, Chennai, 2021

REFERENCES:

1. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", 2nd Edition, Pearson India Education Services Private Limited, Chennai, 2018
2. Avadhanulu M N, Kshirsagar P G and Arun Murthy TVS, "A Text book of Engineering Physics", 2nd Edition, S Chand Publishing, New delhi, 2018
3. Thyagaran K, Ajoy Ghatak, "Lasers – Fundamantals and Applications", 2nd Edition, Laxmi Publications Pvt Limited, New delhi, 2019
4. https://nptel.ac.in/downloads/104104085/
5. https://nptel.ac.in/courses/122107035/8/

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EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I
(Theory)
(100 Marks)</th><th colspan="2">Assessment II
(Practical)
(100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21CY101	ENGINEERING CHEMISTRY (Common to all BE./B.Tech. courses)	Category: BSC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate the fundamentals of water technology and electrochemistry
- To gain basic knowledge of corrosion of metals and alloys
- To acquire knowledge about the properties of fuels and applications of polymers

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the principles of water technology in treatment of industrial and domestic water and estimate the various constituents of industrial water (Apply)

CO2: Describe the principles and applications of electrochemical cells, fuel cells and solar cells (Understand)

CO3: Outline the different types of corrosion processes and preventive methods adopted in industries (Understand)

CO4: Explain the analysis and calorific value of different types of fuels (Understand)

CO5: Classify the polymers and their engineering applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	2	-	1	-	-	1	1	-
CO2	3	1	-	-	-	-	2	-	1	-	-	1	1	-
CO3	3	1	-	-	-	-	2	-	1	-	-	1	1	-
CO4	3	1	-	-	-	-	2	-	1	-	-	1	1	-
CO5	3	1	-	-	-	-	2	-	1	-	-	1	2	-
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I CHARACTERISTICS OF WATER AND ITS TREATMENT 6

Characteristics of water – Hardness – Types, Dissolved oxygen, Total dissolved solids, Disadvantages due to hard water in industries – (Scale, Sludge, Priming, Foaming and Caustic embrittlement), Water softening methods – Lime-soda, Zeolite, Ion exchange processes and reverse Osmosis and their applications, Specifications of domestic water (ICMR and WHO) – Water treatment for municipal supply – Sedimentation with coagulant – Sand Filtration – Chlorination, Disinfection methods – UV treatment, Ozonolysis, Electro dialysis

UNIT II ELECTROCHEMISTRY AND ENERGY STORAGE SYSTEMS 6

Introduction, Electrodes – (Calomel electrode), Electrochemical series and its applications, Brief introduction to conventional primary and secondary batteries – (Pb acid, Lithium) – Fuel cells – Polymer

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membrane fuel cells, Solid-oxide fuel cells – Working principles, advantages, applications. Solar cells – Dye sensitized solar cells – Working principles, characteristics and applications

UNIT III CORROSION AND ITS CONTROL 6

Types – Dry – Chemical corrosion and Wet – Galvanic and differential aeration (Pitting, Crevice, pipeline) – Factors influencing rate of corrosion – Corrosion control methods – Sacrificial anode and impressed current method – Protective coating – Electroplating – Ni plating.

Alloys – Ferrous (stainless steel), Heat treatment – Non-ferrous alloys (Brass -Dutch metal, German Silver) – Composition, properties and uses

UNIT IV FUELS AND COMBUSTION 6

Fuels- Solid fuel: Coal - Analysis of coal (Proximate analysis only) – Liquid fuel – Manufacture of synthetic petrol (Bergius process) – Octane number, cetane number, Knocking in engines- Anti-knocking agents, Gasoline additives, Gaseous fuel: Compressed natural gas (CNG) – Liquefied petroleum gases (LPG) – Composition only.

Calorific value – Higher and lower calorific values – Flue gas analysis (ORSAT method). Measurement of calorific value using bomb calorimeter, Three-way catalytic converter – Selective catalytic reduction of NOx

UNIT V POLYMERS 6

Introduction – Monomer, dimers, functionality, degree of polymerisation, transition glass temperature Classification of polymers, Difference between thermoplastics and thermosetting plastics, Engineering application of plastics - ABS, PVC, PTFE and Bakelite.

Types of compounding of plastics – Moulding, Injection moulding, Extrusion moulding, Compression moulding Conducting polymers – Polypyrrole, Polyacetylene, Polyaniline – Structure and applications, Composites – FRP – Properties and applications

LIST OF EXPERIMENTS

1. Determination of total, permanent and temporary hardness of a given sample water by EDTA method
2. Estimation of ferrous ion by potentiometric titration
3. Estimation of Copper in Brass by EDTA method
4. Determination of percentage of moisture, volatile, ash and carbon content in a given sample of coal.
5. Determination of molecular weight and degree of polymerization of an oil sample by viscosity measurement (Ostwald's viscometer).
6. Determination of chloride content in the water sample
7. Determination of strength of HCl by pH metric method

Contact Periods:

Lecture:	30 Periods	Tutorial:	– Periods	Practical:	30 Periods	Project:	– Periods
						Total:	60 Periods

TEXT BOOKS:

1. Jain P C and Monika Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai Publishing Company, Pvt. Ltd., New Delhi, 2015
2. Vairam S, Kalyani P and Suba Ramesh, "Engineering Chemistry", 2nd Edition, Wiley India Pvt. Ltd, New Delhi, 2014

REFERENCES:

1. Friedrich Emich, "Engineering Chemistry", 2nd Edition, Scientific International Pvt. Ltd, New Delhi, 2014
2. Prasanta Rath, "Engineering Chemistry", 1st Edition, Cengage Learning India, Pvt. Ltd, Delhi, 2015
3. Shikha Agarwal, "Engineering Chemistry, Fundamentals and Applications", 1st Edition, Cambridge University Press, 2015
4. https://nptel.ac.in/courses/113/104/113104008/

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21CSG01	PROBLEM SOLVING AND C PROGRAMMING (Common to All Branches)	Category: ESC				
		L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide exposure to problem-solving through programming
- To develop computational thinking perspective of one's own discipline
- To write, compile and debug programs using C language

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Formulate the algorithmic solutions for a given computational problem (Understand)

CO2: Describe modularization, structures and pointers in C language (Understand)

CO3: Design and implement algorithms for a given problem using C control structures (Apply)

CO4: Apply the C programming constructs for searching and sorting techniques (Apply)

CO5: Solve real time problems using suitable non-primitive data structures in C (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	1	2	2	-	3	-	2
CO2	2	1	1	2	-	-	-	1	2	2	-	2	-	2
CO3	3	2	2	2	-	2	-	1	2	2	-	2	-	2
CO4	3	2	2	2	-	-	-	1	2	2	-	2	-	2
CO5	3	2	2	2	-	-	-	1	2	2	-	2	-	2
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I COMPUTATIONAL THINKING 6

Computational Thinking – Modern Computer – Information based Problem solving – Real world information and Computable Data – Data types and data encoding – Number Systems – Introduction to programming languages – Basics of C programming – variables– Data types – keywords – C program structure – Simple programs in C

UNIT II ALGORITHMIC APPROACH 6

Logic – Boolean Logic – Applications of Propositional logic – Problem Definition – Logical Reasoning and Algorithmic thinking – Pseudo code and Flow chart – Constituents of algorithms – Sequence, Selection and Repetition – Problem understanding and analysis – Control structures in C – Algorithm design and implementation using control structures

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UNIT III SEARCHING, SORTING, AND MODULARIZATION 6

Data Organization – Arrays – Introduction to Searching and Sorting – Linear Search, Binary Search – Basic sorting techniques – Two-dimensional arrays – Matrix manipulation – Modularization – Functions – Function prototype – Function definition – Function call – Built-in functions (string functions and math functions) – Recursion

UNIT IV STRUCTURES AND POINTERS 6

Pointers – Pointer operators – Pointer arithmetic – Arrays and pointers – Array of pointers – Example Program – Sorting of names – Parameter passing – Pass by value – Pass by reference – Structure – Nested structures – Pointer and Structures – Array of structures – Example Program using structures and pointers – Unions

UNIT V FILES 6

Files – Types of file processing – Sequential access – Random access – Sequential access file – Example Program – Finding average of numbers stored in sequential access file – Random access file – Example Program – Transaction processing using random access files – Command line arguments

LIST OF EXPERIMENTS

A. Lab Programs

1. Using IO Statements, get higher secondary marks of a student. Calculate and display the medical and engineering cut-off marks. [Assume the calculation formula]
2. Develop a C program to emulate the operations of an ATM using control structures. Authentication, Deposit, Withdrawal, and Balance check and pin change operations are to be supported.
3. Develop a calculator to perform the operations including addition, subtraction, multiplication, division and square of a number.
4. Given different prices of a vegetable which is varying through the day (from morning to evening), find out the best buy price and sell price for the maximum profit. Eg. For the prices [33, 35, 28, 36, 39, 25, 22, 31], best buy is at 28 and best sell is at 39.
5. Collect height and weight of 4 of your friends and calculate their body mass index. Use 2 dimensional array to store the values.
6. Weights of 10 students of your class who are standing in a line is given in a random order. Find out if there is a heavy person whose weight is the sum of previous two persons.
7. Convert the given decimal number into binary, octal and hexadecimal numbers using user defined functions.
8. From a given paragraph perform the following using built-in functions:
    a) Find the total number of words.
    b) Capitalize the first word of each sentence.
9. Solve Towers of Hanoi using recursion.
10. Develop an expense manager which reads date, product, price and product category. The program should display the total expense amount based on product category or date as per user's selection. Use structures.
11. Develop a banking application to store details of accounts in a file. Count the number of account holders based on a search condition such as - whose balance is less than the minimum balance.

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B. Mini Project (SAMPLE)

Create a Railway Reservation system with the following modules of Booking,

- Availability checking
- Cancellation
- Prepare chart

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project: – Periods
			Total: 60 Periods

TEXT BOOKS:

1. David D. Railey and Kenny A.Hunt , "Computational Thinking for Modern problem Solver", 1st Edition, CRC Press, 2014
2. Brian W. Kernighan and Dennis Ritchie, " The C Programming Language" , 2nd Edition, Pearson, 2015

REFERENCES:

1. Paolo Ferragina and Fabrizio Luccio, "Computational Thinking First Algorithms", Then Code" ,1st Edition, Springer International Publishing, 2018
2. Reema Thareja, "Programming in C", 2nd Edition, Oxford University Press, 2016
3. Paul Deitel and Harvey Deitel, "C How to Program", 7th Edition, Pearson Publication
4. Juneja, B. L and Anita Seth, "Programming in C",1st Edition, Cengage Learning India Pvt. Ltd., 2011
5. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", 1st Edition, Oxford University Press, 2009

EVALUATION PATTERN:

Continuous Internal Assessments				**End Semester Examinations**	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER I

U21MEG01	ENGINEERING GRAPHICS	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To expose the standards and conventions followed in preparation of engineering drawings
- To develop graphic skills for communication of concepts, ideas and engineering drawings
- To expose on 2D & 3D drawings and its projections

COURSE OUTCOME:

Upon completion of the course, the student will be able to

CO1: Sketch the curves and orthographic projections of points as per BIS conventions (Apply)

CO2: Illustrate the orthographic projections of straight lines and plane surfaces (Apply)

CO3: Sketch the orthographic projections of solids, lateral surfaces of frustums, truncated solids and its development (Apply)

CO4: Develop the lateral surfaces of simple solids (Apply)

CO5: Interpret the orthographic and isometric views of simple components (Apply)

CO PO Mapping:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	3	-	-	1	-	2	-	1	-	1
CO2	3	2	2	-	3	-	-	-	-	2	-	1	-	1
CO3	3	2	2	-	3	-	-	-	-	3	-	1	-	1
CO4	3	2	2	-	3	-	-	-	-	3	-	1	-	1
CO5	3	2	2	-	3	-	-	-	-	3	-	1	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

BASICS OF ENGINEERING DRAWING AND CAD (Not for examination)

Introduction – Drawing instruments and its uses – Sheet layout – BIS conventions – Lines – Lettering and dimensioning practices – Lines – Co – Ordinate points – Axes – Poly lines – Square – Rectangle – Polygons – Splines – Circles – Ellipse – Text – Move – Copy – Off – Set – Mirror – Rotate – Trim – Extend – Break – Chamfer – Fillet – Curves – Constraints viz. agency – Parallelism – Inclination and perpendicularity

UNIT I CONICS, SPECIAL CURVES AND PROJECTION OF POINTS **12**

Construction of parabola – Ellipse and hyperbola using eccentricity method – Construction of involutes for squares and circles – Construction of Tangent and normal to the above curves – Introduction – Method of projection – Planes of projection – Reference line and notations – Orthographic Projection of points – Points in all four quadrants

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UNIT II PROJECTION OF STRAIGHT LINES AND SURFACES 12

Projection of straight lines – Lines inclined to HP / VP plane – Inclined to both HP and VP planes (straight lines are assumed to be in first quadrant only) – Projection of planes – Projection of square – Rectangle – Pentagon – Hexagon and circular plane – Inclined to both the plane by change of position method

UNIT III PROJECTION OF SOLIDS 12

Introduction – Projection of solids – Prisms – Pyramids – Cylinders and cones with axis inclined to both the planes (Solids resting on HP only)

UNIT IV DEVELOPMENT OF LATERAL SURFACES OF SOLIDS 12

Introduction – Cutting plane – Sectional views of right regular solids resting with base on HP – Prisms – Pyramids – Cylinder and cone – True shapes of the sections – Development of lateral surfaces of right regular prisms – pyramids – Cylinders – Cones resting with base on HP only – Development of the frustums and truncations

UNIT V ORTHOGRAPHIC AND ISOMETRIC PROJECTIONS 12

Orthographic projection – Simple machine components using free hand sketching – Isometric projection – Simple Solid exercises and combination of solids

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project:	– Periods
			Total:	60 Periods

TEXT BOOKS:

1. ND Bhat & VM Panchal, "Engineering Drawing", Charotar Publishing House, Gujarat, 51st Edition, 2013
2. Venugopal K. and Prabhu Raja V, "Engineering Graphics", New Age International (P) Limited, 6th Edition, 2019

REFERENCE BOOKS:

1. Natrajan K.V., A text book of Engineering Graphics, Dhanalakshmi Publishers, Chennai, 21st Edition, 2017
2. Sam Tickoo, AutoCAD 2013 for Engineers and Designers, Dream tech Press, 1st Edition, 2013
3. M.H.Annaiah & Rajashekar Patil, Computer Aided Engineering Drawing, New Age International Publishers,4th Edition, 2012
4. Basant Aggarwal, Engineering Drawing, Tata Mc Graw Hill Education Private Limited, 1st Edition, 2010
5. D.M.Kulkarni, A.P.Rastogi, A.K.Sarkar, "Engineering Graphics with AutoCAD", PHI Learning Private Limited, New Delhi, Revised Edition., 2010

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	
100		100
60		40
100		

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`SEMESTER II

U21MA202	TRANSFORMS AND ITS APPLICATIONS (For BM)	Category: BSC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand Fourier analysis for periodic and aperiodic signals
- To understand the concepts of Laplace Transforms to find solutions of initial value problems for linear ordinary differential equations
- To understand the concept of Z-transform techniques in the field of engineering

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Use the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series (Understand)

CO2: Analyze the spectral characteristics of signals using Fourier transforms (Apply)

CO3: Apply the concepts of Laplace transform with their properties in circuit theory and control systems (Apply)

CO4: Apply the concepts of Inverse Laplace transform with their properties in core engineering applications (Apply)

CO5: Analyze the signal discretized in time and check for their stability, frequency response (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2	-	-	-	-	-	-	-	-	-	-	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I FOURIER SERIES 9

Dirichlet's conditions – general Fourier series – odd and even functions – half range sine series – Half range cosine series – Parseval's identity – harmonic analysis

UNIT II FOURIER TRANSFORM 9

Fourier transform pair – Fourier sine and cosine transforms – properties (without proof) – transforms of simple functions – convolution theorem – Parseval's identity

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UNIT III LAPLACE TRANSFORM 9

Transform of standard functions – transform of unit step function and unit impulse function —transforms of derivatives and integrals – transform of periodic functions

UNIT IV INVERSE LAPLACE TRANSFORM 9

Inverse Laplace transform – convolution theorem – ordinary differential equations with constant coefficients

UNIT V Z – TRANSFORM 9

Z–transforms – elementary properties – inverse Z–transform – initial and final value theorems (statement only) – convolution theorem – formation of difference equations – difference equations using Z – transform

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd, New Delhi, 2018
2. Wylie C. R. and Barrett L. C., "Advanced Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2016
3. Grewal B S, "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2017

REFERENCES:

1. Andrews, L.C and Shivamoggi, B, "Integral Transforms for Engineers", 1st Edition, SPIE Press, 2016
2. Bali N P and Dr Manish Goyal, "A text book of Engineering Mathematics", 12th Edition, Laxmi Publications, 2016
3. Peter V. O'Neil, "Advanced Engineering Mathematics", 1st Edition, Cengage, New Delhi, 2016
4. James, G., "Advanced Modern Engineering Mathematics", Pearson Education, 3rd Edition, 2013

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / MCQ	Written Test	*Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: BSC				
U21PH202	MEDICAL PHYSICS (For BM only)	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the basics of atomic physics and non-ionizing radiation
- To inculcate the principles behind senses and radioactive nuclides
- To gain the knowledge of interaction of radiation and its effects in human body

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the basics of atomic physics and non – ionizing radiation (Understand)

CO2: Classify the types of senses, vision and audition (Understand)

CO3: Utilize the basic concepts of radioactivity and radionuclides in various medical applications (Understand)

CO4: Examine the interaction of radiation with matter and its clinical significance (Understand)

CO5: Identify the radiation exposure, dosage effects and prevention measures (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	1	1	-
CO2	2	1	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
CO4	3	3	2	-	-	-	-	-	-	-	-	1	1	-
CO5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I ATOMIC PHYSICS AND NON-IONIZING RADIATION 9

Atomic Physics: Absorption and Emission of light – Spin–orbit coupling – Zeeman effect – Quantum mechanical explanation of Zeeman effect – Anomalous Zeeman effect – Stark effect – Non – ionizing radiation: Non – ionizing electromagnetic radiation: Non – ionizing radiation effects: Low frequency effects and High frequency effects

UNIT II PHYSICS OF THE SENSES 9

Introduction and objectives – Cutaneous sensation – The chemical senses – Audition – Doppler effect – Vision – Psychophysics (Introduction)

UNIT III PRINCIPLES OF RADIOACTIVE NUCLIDES 9

Radioactive Decay – Spontaneous Emission – Isomeric Transition – Gamma ray emission, alpha, beta, Positron decay – Sources of Radioisotopes: Natural and artificial radioactivity – Radionuclide – Cyclotron and reactor produced Radionuclide – Radionuclide used in Medicine

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UNIT IV INTERACTION OF RADIATION WITH MATTER 9

Interaction of charged particles with matter – Specific ionization – Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X – ray and gamma radiation with matter – Attenuation of gamma radiation, Interaction of neutron with matter and their clinical significance (Radiation Dosimetry)

UNIT V RADIATION QUANTITIES AND RADIATION EFFECTS 9

Radiation Quantities: Inverse square law – KERMA and absorbed dose – Stopping power – Relationship between the dosimetric quantities – Bragg 's curve – Concept of LD 50 – Radiation Effects and Prevention Measures: Stochastic and Non – Stochastic effects – Principles of radiation protection in diagnostic medical exposure – Individual prevention measures

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Brown B. H., Smallwood R. H., Barber D., Lawford P. V and Hose D. R., "Medical Physics and Biomedical Engineering", 1st edition, CRC Press, 2017
2. Gopal B. Saha., "Physics and Radiobiology of Nuclear Medicine", 4th edition, Springer, 2013

REFERENCES:

1. Meredith W. J. and Massey J. B., "Fundamental Physics of Radiology", 1st Edition, Varghese Publishing house, 1992
2. Muhammad Maqbool– "An Introduction to Medical Physics", Reprinted 1st edition, Springer, 2018
3. Woodcock J. P., "Ultrasonics Medical Physics Handbook – 1", 1st Edition, Adam Hilger Ltd, Bristol, 2002
4. Attix F H, "Introduction to Radiological Physics and Radiation dosimetry", 1st Edition, Viley – VCH, Verlog, 2004
5. https://nptel.ac.in/courses/115103101

EVALUATION PATTERN:

Continuous Internal Assessments				Total Internal Assessments	End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)			
*Individual Assignment / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: ESC				
U21BM201	LINEAR INTEGRATED CIRCUITS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21EEG01 - Basics of Electrical and Electronics Engineering

COURSE OBJECTIVES:

- To introduce the basic characteristics of operational amplifiers.
- To learn the linear and non-linear applications of operational amplifiers
- To learn the types of A-D and D-A Converters.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the characteristics of operational amplifiers (Understand)

CO2: Comprehend the various parameters of operational amplifier (Understand)

CO3: Design the different circuits designed with operational amplifiers (Apply)

CO4: Develop applications with 555 ICs (Apply)

CO5: Deploy the A-D and D-A converter in applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	3	-	-	-	2	-	-	-	-	-	2
CO2	3	2	2	-	2	-	-	2	-	-	-	-	-	-
CO3	2	2	2	2	2	-	-		-	-	-	-	1	-
CO4	2	2	2	2	2	-	-	2	-	-	-	-	-	2
CO5	3	2	-	-	-	-	-		-	-	-	-	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I OPERATIONAL AMPLIFIERS CHARACTERISTICS 9

Fabrication of linear ICs – Characteristics of an Ideal Operational Amplifier – Circuit schematic of IC 741 and MOSFET operational amplifier – Operational Amplifier Characteristics – Open loop gain – CMRR – Slew rate and transfer characteristics – Input bias and output offset voltages – Offset compensation techniques – Frequency response characteristics – Frequency compensation

UNIT II LINEAR APPLICATIONS OF OP- AMP 9

Inverting and Non-inverting amplifiers – Voltage follower – Summing and Differential amplifiers – Instrumentation amplifiers – Integrator and Differentiator – Voltage to current converter – Current to voltage converter

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UNIT III NON-LINEAR APPLICATIONS OF OP- AMP 9

Comparator – Zero crossing detector – Sample and hold circuit – Precision diode – Rectifiers – Clipper and Clamper – Sinusoidal oscillators – Active filters – Low pass – High pass – Band pass and band stop Butterworth filters

UNIT IV 555 FAMILY IC'S AND PHASE LOCKED LOOP 9

IC 555 Timer Functional block diagram and description – Mono-stable and Astable operation – Applications – IC 556 Voltage Controlled Oscillator – Function generator ICs – Functional Block Diagram – Principle of operation – Building block of PLL – Characteristics and mathematical expressions for Lock and Capture ranges – Applications – Frequency Synthesis and Translation

UNIT V A-D AND D-A CONVERTERS 9

Analog to digital converters – Continuous – Counter ramp – Successive approximation – Single and dual slope and parallel types – Digital to Analog converters – Binary weighed and R-2R Ladder types – DAC/ADC performance characteristics and comparison

TEXT BOOKS:

1. Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", 4th Edition, Pearson education, 2009
2. Roy Choudhury and Shail Jain, "Linear Integrated Circuits", 4th Edition, Wiley Eastern, New Delhi, 2012

REFERENCES:

1. Coughlin & Driscoll, "Operational-Amplifiers and Linear Integrated Circuits", Pearson education, 1st Edition, 2001
2. Sergio Franco, "Design with operational amplifier and analog integrated circuits", Tata McGraw Hill, 2nd Edition, 2002

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: HSMC				
U21EN201	PERSONALITY ENHANCEMENT (Common to AD, BM, CH, CE, CS, CS(AIML), EE, EC, ME, MI and IT)	L	T	P	J	C
		1	0	2	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop of personality traits that contributes in the professional environment
- To create a basic awareness about the significance of soft skills in professional and interpersonal communications
- To enhance the level of self-confidence that helps to excel in the leadership skills

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Nurture a deep understanding of personality development and interpersonal relationship for overall self-development (Understand)

CO2: Communicate proficiently in high-end interviews and in all social situations (Understand)

CO3: Synthesize complex concepts and present them in speech and writing (Analyze)

CO4: Negotiate and lead teams towards success (Understand)

CO5: Present ideas in an effective manner using web tools (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	2	3	-	1	-	-
CO2	-	-	-	-	-	-	-	1	2	3	-	1	-	-
CO3	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO4	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO5	-	-	-	-	-	-	-	1	-	3	-	-	-	-
Correlation levels:	1: Slight (Low)					2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I LEXICAL REASONING 9

Module:1 Establishing Associations

Activity: Verbal Analogy, Logical Reasoning

Module:2 Lateral Thinking

Activity: Reasoning and Assertions

Module:3 Sentence Completion

Activity: Cloze Test, Single Word Substitutes

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UNIT II SOCIAL CORRESPONDENCE 9

Module:4 Etiquettes

Activity: Brain storming & performing in actions

Module:5 Introspection

Activity: SWOT Analysis, Goal Setting

Module:6 Co-verbal Gesture

Activity: Body Language, Non verbal cues

UNIT III ART OF NETWORKING 9

Module:7 Addressing a Multitude

Activity: Welcome address, Vote of Thanks, Public Speaking

Module:8Persuasive Communication

Activity: Making Technical Presentation

Module:9 Career Oriented Communication

Activity: Face to face Conversation, Mock Interview

UNIT IV CRITICAL THINKING 9

Module:10 Organizing ideas

Activity: Mind Mapping

Module:11 Problem Solving Skills

Activity: Conflict management, Case Study

Module:12 Critical Review

Activity: Book/ Movie Review, Comparative Analysis

UNIT V CONTENT WRITING 9

Module:13 Reports

Activity: Writing Event Report, Project Report

Module:14 Writing for Digital platform

Activity: Writing Posts, Blogs

Module:15 Developing Content

Activity: Product Description, Writing Proposals

LIST OF EXERCISES

1.Listening to Inspirational Speech

2.Listening to Product Description

3.Book/Movie Review

4.Presentation

5.Mock Interview

6.Public Speaking

Contact Periods:

Lecture: 15 Periods	Tutorial – Periods	Practical: 30 Periods	Project:	– Periods
			Total:	45 Periods

TEXT BOOKS:

1. Meenakshi Raman & Sangeetha Sharma. "Professional English: for AKTU", 1st Edition, Oxford University Press, 2018
2. Barun. K.Mitra. "Personality Development and Soft Skills", OUP India. 2nd Edition, 2016

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REFERENCES:

1. Mathew Allen. "Smart Thinking: Skills for Critical Understanding and Writing", 2nd Edition, OUP India, 2016
2. Means, Thomas L, "English and Communication for Colleges", 4th Edition, Cengage 2017
3. Using English: "A Coursebook for Undergraduate Engineers and Technologists", 1st Edition, Orient Black Swan, 2017

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><td colspan="2">Assessment I
(Theory)
(100 Marks)</td><td colspan="2">Assessment II
(Practical)
(100 Marks)</td><td rowspan="3">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>*Individual Assignment / Seminar / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>50</td></tr>
<tr><td colspan="4">50</td><td>50</td></tr>
<tr><td colspan="5">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: ESC				
		L	T	P	J	C
U21CSG02	PYTHON PROGRAMMING (Common to All Branches)	2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand syntax and semantics of python programming
- To implement programs using python data structures
- To gain expertise in using python libraries for solving real time problems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the basic operations of tokens in python (Understand)

CO2: Demonstrate the programs using control statements (Apply)

CO3: Develop programs using python data structures (Apply)

CO4: Implement the exceptions in file-handling concepts (Apply)

CO5: Apply the python libraries in real-world problems (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	1	1	1	-	1	-	1
CO2	2	1	1	2	-	-	-	1	1	1	-	1	-	1
CO3	3	2	2	2	-	-	-	1	1	1	-	1	-	1
CO4	3	2	2	2	-	-	-	1	1	1	-	1	-	1
CO5	3	2	2	2	1	-	-	1	1	1	-	1	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I LANGUAGE BASICS 6

Python interpreter and interactive mode – Tokens – Data types – Numbers and math functions – Input and Output operations – Comments – Reserved words – Indentation – Operators and expressions – Precedence and associativity – Type conversion – Debugging – Common errors in Python

UNIT II CONTROL STATEMENTS, FUNCTIONS, AND MODULES 6

Selection – Conditional branching statements – if – if-else – Nested-if – if-elif-else statements – Iterative statements – while – for loop – break – continue and pass statements – Functions – Function Definition and Function call – Variable scope and Lifetime – Return statement – Lambda functions or Anonymous functions – Recursion – Modules and Packages

UNIT III PYTHON DATA STRUCTURES 6

Strings – Slicing – Immutability – Built-in string methods and functions – Concatenating – Appending

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and Multiplying strings – String modules – List – Creation – Accessing values – Slicing – List methods – In-built functions for Lists – Tuples – Creation – Operations on tuples – Traversing – Indexing and Slicing – Tuple assignment – In-built functions for tuples – Sets – Creation – Operations – Dictionaries – operations and methods

UNIT IV EXCEPTION AND FILE HANDLING 6

Exceptions – Errors and Exceptions – Handling exception – Built-in and User-defined exceptions – Files – Types – Operations – Open – Read – Write – Close

UNIT V NUMPY and PANDAS 6

Numpy – Introduction – Computations using NumPy functions – Computation on Arrays – Aggregation – Indexing and Sorting – Pandas – Introduction and Basic Pandas Concepts – Data frames – Data Handling

LIST OF EXPERIMENTS

1. Programs on selection and Iteration operations
2. Get an integer input from a user. If the number is odd, then find the factorial of a number and find the number of digits in the factorial of the number. If the number is even, then check the given number is palindrome or not
3. Strings and its operations
4. Given two strings, PRINT (YES or NO) whether the second string can be obtained from the first by deletion of none, one or more characters
5. List and its operations
6. Programs for positive and negative indexing
7. Program to check if the given list is in Ascending order or Not
8. Tuples and its operations
9. Python program to convert a tuple to a string
10. Python program to reverse a tuple
11. Sets and its operations
12. Python program to check if a set is a subset of another set
13. Dictionaries and its operations
14. Python program to iterate over dictionaries using for loops
15. Computations using NumPy functions
16. NumPy program to convert a list of numeric value into a one-dimensional NumPy array
17. NumPy program to convert a list and tuple into arrays
18. Data manipulations using Pandas
19. Program to convert a NumPy array and series to data frames
20. Program to add, subtract, multiple and divide two Pandas Series
21. Program to retrieve and manipulate data using dataframes

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Reema Thareja, "Python programming: Using problem solving approach", 1st Edition, Oxford Press, 2017
2. William McKinney, Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 2nd Edition, Shroff/O'Reilly Publication, 2017

REFERENCES:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd Edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016
2. Ashok Namdev Kamthane and Amit Ashok Kamthane, "Programming and Problem Solving with Python", 2nd Edition, McGrawHill Education, 2018

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3. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach",1st Edition, Pearson India Education Services Pvt. Ltd., 2016
4. https://python-iitk.vlabs.ac.in/List%20of%20experiments.html
5. http://greenteapress.com/wp/think-python/

EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		Assessment II (Practical) (100 Marks)		Theory Examinations (Examinations will be conducted for 100 Marks)	Practical Examinations (Examinations will be conducted for 100 Marks)
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER II

		Category: BSC				
		L	T	P	J	C
U21CY201	FUNDAMENTALS OF BIOCHEMISTRY	2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire knowledge on structural and functional properties of carbohydrates, proteins, lipids and nucleic acids
- To emphasize the role of biomolecules in metabolic processes in living systems
- To gain knowledge about drugs and their mode of action

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the knowledge of carbohydrates, its reactions and metabolic pathways (Apply)

CO2: Describe the nomenclature, metabolic pathways, degradation and disorders of lipid metabolism in living beings (Understand)

CO3: Elucidate the structure of nucleic acids, its types, DNA and RNA (Understand)

CO4: Outline the classification, structure and properties of amino acids and proteins (Understand)

CO5: Apply the concept of synthesis, mode of action of various drugs in human being (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	1	1	1	1	-	1	1	-
CO2	3	1	-	-	-	-	-	1	1	1	-	1	1	-
CO3	3	1	-	-	-	-	-	1	1	1	-	1	1	-
CO4	3	1	-	-	-	-	-	1	1	1	-	1	1	-
CO5	3	1	1	-	-	-	2	-	1	1	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I CARBOHYDRATES 6

Classification of carbohydrates, chemical properties, structure – Monosaccharides – Glucose, disaccharides – Sucrose and polysaccharides – Starch, Digestion and absorption of carbohydrates, metabolic pathways – Glycolysis, glycogenesis, glycogenolysis - TCA cycle

UNIT II LIPIDS 6

Classification of lipids –Simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat – (Hydrogenation, Acid, Iodine and Saponification values, Reichert- Meissl value), Metabolic pathways – Synthesis and degradation of fatty acid (beta oxidation), ketogenesis, Disorders of lipid metabolism

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UNIT III NUCLEIC ACIDS 6

Structure of purines and pyrimidines, nucleoside, nucleotide, DNA act as a genetic material, Chargoffs rule, Watson and crick model of DNA – Structure of RNA and its type, Disorder of purines and pyrimidines nucleotide.

UNIT IV AMINO ACIDS & PROTEINS 6

Amino acids – Classification – Physical properties, chemical properties of glycine – Proteins-classification, structural organization – Properties and testing.

UNIT V MEDICINAL CHEMISTRY 6

Synthetic drugs – Requirement of drug, classification based on chemical structure and therapeutic action. Definition, structure, mode of action and properties – Antibacterial (Sulfonamides, Ciprofloxacin), Anti-inflammatory (Salicylic acid, Indomethacin), Antimalarial (Chloroquinine), Analgesics (Aspirin, acetaminophen), Cardiovascular drugs (Barbiturates, Lidocaine), Anesthetics (Benzocaine, Promethazine)

LIST OF EXPERIMENTS

1. Qualitative tests for carbohydrates – Glucose, Fructose, Starch
2. Qualitative tests for proteins
3. Qualitative tests for lipids
4. Estimation of blood glucose
5. Estimation of uric acid
6. Estimation of cholesterol
7. Separation of amino acids by TLC

Contact Periods:

Lecture:	30 Periods	Tutorial:	– Periods	Practical:	30 Periods	Project:	– Periods
						Total:	60 Periods

TEXT BOOKS:

1. Rafi M. D. "Text book of biochemistry for Medical Student", 2nd edition, University Press, 2014
2. David L. Nelson and Michael M, Lehninger, "Principles of Biochemistry", 7th edition, W.H. Freeman & Co. Ltd, 2017

REFERENCES:

1. Keith Wilson and John Walker, "Principles and techniques of practical biochemistry", 5th edition, Oxford University Press, 2009
2. Pamela C. Champe and Richard. A. Harvey, "Lippincott Biochemistry - Lippincott's Illustrated Reviews", 2nd edition, Raven publishers,1994
3. Ashutoskar, "Medicinal Chemistry", 4th edition, New age international, 2010
4. https://nptel.ac.in/courses/102/106/102106087/

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	**60**	**75**	**25**		
25		**25**		**25**	**25**
50				**50**	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER II

U21BM202	LINEAR INTEGRATED CIRCUITS LABORATORY	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To design and test the linear integrated circuits using available ICs
- To analyse the circuits designed using 555 timer
- To analyse and simulate the applications of op-amp

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Design and test the applications of operational amplifiers (Apply)

CO2: Design filters using op-amp and perform experiment on frequency response (Apply)

CO3: Analyse the working of astable and monostable multivibrator using 555 timer and op-amp (Analyze)

CO4: Design and test the applications of oscillators (Apply)

CO5: Analyse and simulate op-amp based circuits (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	-	2	-	-	-	3	-	-	-	2	2
CO2	3	1	2	-	2	-	-	-	3	-	-	-	2	2
CO3	3	1	2	-	2	-	-	-	3	-	-	-	2	1
CO4	3	2	2	-	2	-	-	-	3	-	-	-	2	2
CO5	3	2	3	-	2	-	-	-	3	-	-	-	2	1
CO	3	2	3	-	2	-	-	-	3	-	-	-	2	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

1. Design and testing of inverting and non-inverting amplifier
2. Design and testing of summing amplifier
3. Design and testing of differentiator and integrator
4. Design and testing of instrumentation amplifier
5. Design and testing of Active filters (LPF, HPF and BPF)
6. Design and testing of Schmitt Trigger

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7. Design and simulate clipper circuit
8. Design and testing of monostable multivibrator using IC 555
9. Design and testing of astable multivibrator using IC 555
10. Design of RC Phase shift oscillators using op-amp
11. Design and simulate analog to digital converter
12. Design and simulate digital to analog converter

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Total: 30 Periods

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER II

U21MEG02	MANUFACTURING PRACTICES	Category: ESC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide exposure on workshop tools and additive manufacturing processes
- To provide hands on training experiences in sheet metal, carpentry welding and plumbing operations
- To provide hands on experience on soldering and simple electrical circuit wiring

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the various tools and measuring equipment used for assembly and dismantling practice (Apply)

CO2: Develop simple components using 3D printer (Apply)

CO3: Fabricate products using sheet metal and carpentry (Apply)

CO4: Perform operations such as welding and plumbing (Apply)

CO5: Connect and test the electrical and electronics components for the given circuit diagram (Apply)

CO PO Mapping:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	1	-	1	-	1	1	-	1	1	-
CO2	3	1	1	-	3	-	1	-	2	1	-	2	1	-
CO3	3	1	1	-	1	-	1	-	3	2	-	1	1	-
CO4	3	1	1	-	1	-	1	-	3	2	-	1	1	-
CO5	3	1	1	-	1	-	1	-	3	2	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I PRODUCT WORKSHOP **12**

Disassemble the product of sub assembly – Measure various dimensions using measuring instruments. Free hand rough sketch of the assembly and components – Name of the components and indicate the various materials used – Study the functioning of the assembly and parts – Study the assembly and components design for compactness – Processing – Ease of assembly and disassembly – Assemble the product or subassembly

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B.E. - BM - R2021 - CBCS

SEMESTER III

		Category: PCC				
		L	T	P	J	C
U21BM301	HUMAN ANATOMY AND PHYSIOLOGY	3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To identify all the organelles of a human cell and their function
- To comprehend the structure of various organs in human body systems
- To explore the functions and importance of anatomical features in human body systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Outline basic structure, functions and physiology of human cell organelles and blood cell (Understand)

CO2: Illustrate the structure and working of cardiovascular and nervous system (Understand)

CO3: Infer the skeletal and respiration system mechanism (Understand)

CO4: Summarize the working of digestive and the excretory system (Understand)

CO5: Identify the structure and physiology of endocrine system and different senses (Understand)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I THE CELL AND GENERAL PHYSIOLOGY 9

Structure and functions of human cell organelles – Cell reproduction – Genetic control of protein synthesis – Membrane potential – Action potential – Resting potential – Generation and conduction – Blood cells structure and function – Immunity – Blood groups – Blood clotting

UNIT II CARDIAC AND NERVOUS SYSTEM 9

Structure of heart and heart valves – Cardiac cycle – ECG wave pattern – Heart sounds – Blood pressure classification – Nerve tissues – Physiology of nervous system – Nervous control of heart – [illegible] – Feedback control of blood pressure

of respiration – Pulmonary ventilation – Principles of gas exchange – Regulations of respiration

UNIT IV DIGESTIVE AND EXCRETORY SYSTEM 9

Organs of alimentary tract – Propulsion and mixing of food – Secretory functions – Digestion and absorption in the gastrointestinal tract – Structure of kidney and nephron – Urine formation

UNIT V ENDOCRINE SYSTEM AND SPECIAL SENSES 9

Anatomical loci of Endocrine glands – Hormones and their functions – Structure of eye – Optics of vision – Structure of ear – Physiology of hearing – Taste and smell sensors – Structure of skin

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Arthur C Guyton, John E Hall, "Textbook of Medical Physiology", 2nd Edition, Saunders Elsevier, 2019
2. Jain A K, "Textbook of Physiology", 9th Edition, Avichal Publishing Company, 2019

REFERENCES:

1. Anil Baran Singha Mahapatra, "Essential of Medical Physiology", 2nd Edition, Current Book International, Kolkata, 2007
2. Ranganathan T S, "A Textbook of Human Anatomy", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012
3. Sujit K Chaudhuri, "Concise Medical Physiology", 2nd Edition, New Central Book Agency Pvt.Ltd, Kolkata, 2011
4. Sarada Subramanyam, K Madhavan Kutty, Singh H D, "Textbook of Human Physiology", 5th Edition, S. Chand and Company Ltd, New Delhi, 2014

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: PCC				
U21BM303	BIOMATERIALS AND ARTIFICIAL ORGANS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To interpret the classification and characteristics of biomaterials
- To understand the different biocompatible metals, ceramics and polymers
- To infer the importance of artificial organs and tissue replacements

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the different types of biomaterials and its properties (Understand)
CO2: Identify the different metals and ceramics used as biomaterials (Apply)
CO3: Describe the importance of polymeric biomaterials (Understand)
CO4: Examine the significance of various artificial organs (Analyze)
CO5: Analyze the various types of tissue replacements (Analyze)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I INTRODUCTION TO BIOMATERIALS 9

Definition and classification of biomaterials – Biocompatibility – Nature – Mechanical properties – Viscoelasticity – Biomaterial performance – Nano-scale phenomena

UNIT II METALLIC AND CERAMIC MATERIALS 9

Metallic implants – Stainless steels – Co-based alloys – Ti-based alloys – Shape memory alloy – Nanostructured metallic implants – Degradation and corrosion – Ceramic implant – Bioinert – Bioresorbable – Bioactive ceramics – Nanostructured bioceramics

UNIT III POLYMERIC BIOMATERIALS 9

Polymerization – Biopolymers – Collagen – Elastin – Cellulose – Chitin – Synthetic polymers – Polyolefins – Polyamides – Acrylic polymers – Hydrogels – Silicone rubber

UNIT IV INTRODUCTION TO ARTIFICIAL ORGANS 9

Artificial heart – Prosthetic cardiac valves – Artificial Pancreas – Artificial liver – Artificial muscle – Artificial skin – Artificial blood

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UNIT V TISSUE REPLACEMENT AND IMPLANTS 9

Soft tissue replacements – Sutures, surgical tapes, adhesives – Percutaneous and skin implants – Maxillofacial augmentation – Hard tissue replacement implants – Internal fracture fixation devices – Joint replacements – Dental implants – Body response to implants

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Sujata V. Bhatt, "Biomaterials", 3rd Edition, Alpha Science International Ltd, 2017
2. Kopff W.J, "Artificial Organs", 1st Edition, John Wiley and sons, New York, 1976

REFERENCES:

1. B. D. Ratner, F. J. Schoen, A. S. Hoffman, J. E. Lemons, "Biomaterials Science: AnIntroduction to Materials in Medicine", 3rd Edition, Academic Press, 2012
2. Andrew F. Von Racum, " Handbook of Biomaterials Evaluation: Scientific, Technical andClinical Testing of Implant Materials", 2nd Edition, CRC Press, 1998
3. Gray E. Wnek and Gray L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc., New York, 2004
4. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984
5. Joseph D. Bronzino, "Tissue Engineering and Artificial Organs", 3rd Edition, CRC press, 2006

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: ESC				
	DIGITAL ELECTRONICS	**L**	**T**	**P**	**J**	**C**
U21ECG01	(Common to EC, BM, CS, CSBS , AI & ML , IT and AD: For CS, CSBS , AI & ML , IT and AD, It is offered during II Semester and For EC and BM, It is offered during III Semester)	2	0	2	0	3

PRE–REQUISITES:

- NIL

COURSE OBJECTIVES:

- To understand the fundamentals of digital logic circuits
- To design the combinational logic circuits.
- To design the synchronous and asynchronous sequential circuits

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply various reduction methods to simplify logic expressions (Apply)

CO2: Implement the combinational logic circuits using gates (Apply)

CO3: Examine the performances of latches and flip-flops (Analyze)

CO4: Construct sequential logic circuits using flip-flops (Apply)

CO5: Design hazard free circuit for asynchronous sequential circuit (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	2	-	-	-	2	2	2	-	2	1	1
CO2	3	2	-	2	-	-	-	2	2	2	-	2	1	1
CO3	3	3	2	2	-	-	-	2	2	2	-	2	1	1
CO4	3	2	-	2	-	-	-	2	2	2	-	2	1	1
CO5	3	3	2	2	-	-	-	2	2	2	-	2	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I BOOLEAN THEOREMS AND LOGIC REDUCTION 6

Number system – Complements – Boolean theorems – Codes – Logic gates – NAND and NOR gates – Representation of boolean expression – SOP, POS, canonical form – Simplification of logic functions using K-map, Quine McCluskey method

UNIT II COMBINATIONAL LOGIC DESIGN 6

Adder-1 Bit adder/subtractor, parallel adder, 2's complement adder/subtractor – Implementation of combinational circuits – Multiplexers, decoders, encoders, demultiplexers – Code converters – Error detection and correction codes – Parity generator and checker

UNIT III LATCHES AND FLIPFLOPS 6

Latches – NOR, NAND – Digital pulses – Clocked flip-flops – Master/Slave flip-flop – Asynchronous inputs – Flip-flop timing considerations – Conversion of flip-flop

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UNIT IV SEQUENTIAL CIRCUITS 6

General model of sequential circuits – Mealy/Moore models, excitation table, state table, state diagram – Design of synchronous sequential circuits – Synchronous up/down counters, modulus counters – Asynchronous counter – Sequence detector

UNIT V REGISTERS AND HAZARDS 6

Shift registers – Ring counter, Johnson counter – Hazards and Essential Hazards in logic circuits – Design of Hazard free circuits

LIST OF EXPERIMENTS (INDICATIVE)

1. Characteristics of digital IC's
2. Implementation of combinational logic design using MUX IC's
3. Design and implementation of various data path elements (Adder/Subtractor)
4. Characteristics of flip-flop
5. Design and implementation of synchronous sequential circuit (Counters/ Shift registers)
6. Design and implementation of asynchronous mod counters

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. M.Morris Mano, Michael D Ciletti, "Digital Design", 6th Edition, Pearson, 2018
2. Charles H. Roth, Jr, Larry L. Kinney, " Fundamentals of logic design", 7th Edition, Kluwer Academic Publishers, 2014

REFERENCES:

1. Thomas L.Floyd, "Digital Fundamentals", 11th Edition, Prentice Hall, 2015
2. A.Anand Kumar, "Fundamentals of Digital Circuits", 2nd Edition, PHI Learning, 2013
3. Ronald J Tocci, Neal S Widmer, Gregory L Moss, "Digital Systems Principles and Applications", 10th Edition, Pearson, 2009
4. D. Donald Givone, "Digital Principles and Design", 4th Edition, Tata McGraw Hill, 2008

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Theory) (100 Marks)</th><th colspan="2">Assessment II (Practical) (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)</td><td>Test</td><td rowspan="2">Theory Examinations (Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations (Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

		Category: ESC				
U21CSG03	**DATA STRUCTURES** (Common to AM, BM, CB, EC, EE, IT)	**L**	**T**	**P**	**J**	**C**
		2	**0**	**2**	**0**	**3**

PRE–REQUISITE:

- U21CSG01 – Problem Solving and C Programming

COURSE OBJECTIVES:

- To understand the concepts of ADT and list operations
- To learn linear data structures – stacks and queues
- To apply Tree and Graph structures

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the concept of linear and non-linear data structures (Understand)

CO2: Demonstrate stack and queue with suitable applications (Apply)

CO3: Implement various searching, sorting, and hashing techniques (Apply)

CO4: Analyze non-linear data structures – trees (Apply)

CO5: Implement various problems in graph data structures (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	-	-	-	1	2	2	-	3	-	1
CO2	2	2	2	2	-	-	-	1	2	2	-	3	-	1
CO3	3	3	2	2	-	-	-	1	2	2	-	3	-	1
CO4	3	3	2	2	-	-	-	1	2	2	-	3	-	1
CO5	3	3	2	2	-	-	-	1	2	2	-	3	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I LINEAR DATA STRUCTURES – LIST 6

Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list-based implementation – Singly linked lists – Circularly linked lists – Doubly-linked lists – Applications of linked list

UNIT II LINEAR DATA STRUCTURES – STACKS, QUEUES 6

Stack ADT – Operations – Applications – Evaluating arithmetic expressions – Conversion of Infix to postfix expression – Queue ADT – Operations – Circular Queue – Priority Queue – DeQueue – Applications of queues

UNIT III SEARCHING, SORTING, AND HASHING TECHNIQUES 6

Introduction to Searching – Types of search – Linear Search – Binary Search – Sorting – Bubble sort

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– Selection sort – Insertion sort – Shell sort – Hashing – Hash Functions – Separate Chaining – Open Addressing – Rehashing

UNIT IV NON-LINEAR DATA STRUCTURES – TREES 6

Tree ADT – Tree traversals – Binary Tree ADT – Expression trees – Implementation of expression tree – Applications of trees – Binary search tree ADT – Operations in binary search tree – Introduction to Heap – Properties

UNIT V NON-LINEAR DATA STRUCTURES – GRAPHS 6

Introduction to Graph – Types of graph – Graph traversal – Breadth-first traversal – Depth-first traversal – Topological Sort – Minimum spanning tree algorithms – Shortest path algorithm – Dijkstra's algorithm

LIST OF EXPERIMENTS (INDICATIVE)

1. Write a function program to perform the following operations on a singly linked list
   i. Create a list cube
   ii. Insert an element to the list
   iii. Delete the maximum element from the list
   iv. Arrange the list in a sorted order
   v. Display the elements of the list
2. Write a main method to demonstrate the above functionalities
3. Creation of Array and linked list implementation of Stack and Queue ADTs
4. Implementation of quick, heap, and shell sort
5. Program to sort the elements in ascending order using selection sort and bubble sort
6. Implementation of hashing technique
7. Develop a program to perform a linear and binary search
8. Program to construct an expression tree for a given expression and perform various tree traversal methods.
9. Implement Prim's algorithm with the following functionalities
   i. Read a set of vertices minimum of six from the keyboard
   ii. Get the number of edges and form the graph
   iii. Find the value of each edge by using the distance formula for two points.
   iv. Develop a Minimum Spanning Tree for the graph
   v. Find the total length of all edges. Write a main method to execute the above functionalities
10. Choose an appropriate data structure and create a token system for banking service (withdrawal, deposit, and money transfer)
11. Create a food delivering system that allocates the path for the delivery of food using appropriate data structures
12. Create a book rack allocation system in a library, which allocates appropriate space for the books based on category using appropriate data structures

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project: – Periods
			Total 60 Periods

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TEXT BOOKS:

1. Reema Thareja, "Data structures using C", 1st Edition, Oxford University Press, 2018
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, "Fundamentals of Data Structures in C", 2nd Edition, University Press, 2017

REFERENCES:

1. R. Venkatesan, S. Lovelyn Rose, "Data Structures", 1st Edition, Wiley, 2019.
2. Seymour Lipschutz, "Data structures with C", 4th Edition, McGraw Hill Education, 2017

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I
(Theory)
(100 Marks)</th><th colspan="2">Assessment II
(Practical)
(100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

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SEMESTER III

		Category: PCC				
U21BM302	BIOMEDICAL SENSORS AND INSTRUMENTATION	L	T	P	J	C
		3	0	0	2	4

PRE–REQUISITES:

- U21EEG01 - Basics of Electrical and Electronics Engineering

COURSE OBJECTIVES:

- To acquaint with measurement, methods and associated errors
- To explore the various biopotential electrodes and biomedical sensors
- To get familiarized with different displays and patient safety

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the concept of measurement, methods and errors (Understand)

CO2: Select the suitable biosensor for designing the biomedical instrument (Understand)

CO3: Identify the biopotential electrode and interface circuit (Apply)

CO4: Measure blood flow, ECG, EEG, EMG and explain the patient monitoring system (Apply)

CO5: Illustrate different display systems and safety aspects of a biomedical circuit (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	1	-	-	-	2	2	1	-
CO2	3	3	3	-	-	-	1	-	-	-	2	1	2	-
CO3	3	3	3	-	-	-	1	-	-	-	2	1	2	-
CO4	3	3	2	-	-	-	1	-	-	-	2	2	3	-
CO5	3	3	3	-	-	-	2	-	-	-	2	2	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I MEASUREMENT SYSTEM 9

Generalized measurement system – Units and standards – Sensor classification – Static and dynamic characteristics – Errors in measurement

UNIT II SENSORS FOR BIOMEDICAL APPLICATIONS 9

Thermistor – Thermocouple – Resistance temperature detector – Strain gauge – Diaphragms – Bourdon tube – LVDT – Photodiode, phototransistor, photomultiplier tube – Piezoelectric transducers

UNIT III BIOPOTENTIAL ELECTRODES AND INTERFACES 9

Biopotential – Contact impedance – Electrode electrolyte interface – Electrode skin interface – Motion artifacts – Types of electrodes – Surface, needle and micro electrodes – pH, pO_2, pCO_2 – ISFET – Blood glucose measurement

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UNIT IV BIOMEDICAL PARAMETERS MEASUREMENT 9

Blood flow measurement – ECG, EEG, EMG measurement – Evoked potential – Signal averaging – Computer assisted patient monitoring and ICU

UNIT V DISPLAYS AND PATIENT SAFETY 9

Cathode ray oscilloscope – Digital storage oscilloscope – LED display – LCD – Graphic recorders – Physiological effects of electric current – Micro shock – Macro shock – Leakage current – Isolation circuits – Electromagnetic interference – Radiation hazards and safety – Shielding

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: 15 Periods

Total: 60 Periods

TEXT BOOKS:

1. Khandpur R S, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw Hill, New Delhi, 2014
2. Shawney A. K, "Electrical, Electronic Measurement and Instrumentation" 19th Edition, Dhanpat Rai & Co, New Delhi, 2014

REFERENCES:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", 2nd Edition, Prentice Hall of India, New Delhi, 2015
2. John G. Webster, "Medical Instrumentation: Application and Design", 3rd Edition, Tata McGraw Hill Pvt. Ltd, 2011
3. Joseph J Carr and John M Brown, "Introduction to Biomedical Equipment Technology" 4th Edition, Pearson Edition, 2002
4. Ernest O. Doebelin, "Measurement System, Application and Design", 6th Edition, McGraw Hill, 2006

EVALUATION PATTERN:

<table>
<tr><th colspan="5">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Theory) (100 Marks)</th><th colspan="3">Assessment II (Project) (100 Marks)</th><th rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</th></tr>
<tr><th>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</th><th>Written Test</th><th>Review I</th><th>Review II</th><th>Review III</th></tr>
<tr><td>40</td><td>60</td><td>15</td><td>25</td><td>60</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="3">25</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER III

U21BM304	BIOMEDICAL SENSORS AND INSTRUMENTATION LABORATORY	Category: PCC				
		L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study the functioning of sensors in various biomedical applications
- To explore the application of amplifiers in biosignal acquisition and analysis
- To identify the apt measurement setup for various parameters

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the best transducers to measure displacement (Apply)

CO2: Demonstrate the measurement of bio-signals (Understand)

CO3: Experiment with the various parameters of ECG signals (Apply)

CO4: Analyze the data from pulse rate and blood pressure measurement (Analyze)

CO5: Outline the simulation of amplifiers for biomedical applications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	2	-	-	-	3	-	-	-	2	-
CO2	-	-	2	-	2	3	-	-	3	-	-	-	2	-
CO3	-	-	2	2	2	-	-	-	3	-	-	-	2	-
CO4	-	-	1	3	2	3	-	-	3	-	-	-	2	-
CO5	-	-	3	-	2	-	-	-	3	-	-	-	-	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

LIST OF EXPERIMENTS

1. Study of Digital Storage Oscilloscope
2. Strain gauge measurement
3. Measurement of displacement using LVDT
4. Measurement of temperature using a thermocouple
5. Real time monitoring of EMG
6. ECG wave analysis using simulator
7. Detection of QRS component from ECG signals using analog circuits
8. Measurement of ECG using a right leg driven ECG amplifier

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9. Measurement of pulse-rate using photo transducer
10. Measurement of pH and conductivity
11. Measurement of blood pressure using sphygmomanometer
12. Design a PCB layout for any bio amplifier using suitable software tool

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

REFERENCES:

1. Webster, "The Measurement, Instrumentation and Sensors Handbook", 2nd Edition, CRC press, 2014
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw-Hill, New Delhi, 2014
3. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd Edition, Prentice Hall of India, New Delhi, 2015

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER III

		Category: PCC				
U21BM305	HUMAN ANATOMY AND PHYSIOLOGY LABORATORY	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To estimate type of blood cells
- To understand the essential parameters of haematology
- To get familiarized with essential first aid technique

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the type of blood cells (Understand)

CO2: Enumerate the haematological parameters (Understand)

CO3: Analyze the special sensory organs (Apply)

CO4: Identify the structure and function of different bones (Understand)

CO5: Practice essential first aid technique (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	2	-	-	-	3	-	-	-	1	-
CO2	-	-	2	-	2	-	-	-	3	-	-	-	1	-
CO3	-	-	2	-	2	-	-	-	3	-	-	-	1	-
CO4	-	-	2	-	2	-	-	-	3	-	-	-	1	-
CO5	-	-	3	-	2	-	-	-	3	-	-	-	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

1. Separation of blood cells, blood plasma and study of Neubauer chamber
2. Estimation of RBC count
3. Estimation of WBC count
4. Estimation of eosinophil count
5. Estimation of platelet count
6. Estimation of differential count
7. Estimation of haemoglobin
8. Identification of blood group

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9. Determination of bleeding time and clotting time
10. Testing of Visual Activity (Snellen's Chart) and Hearing Ability (Tuning fork)
11. Study of bones
12. Essential first aids – Wound Dressing and CPR Techniques

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

REFERENCES:

1. Arthur C Guyton, John E Hall, "Textbook of Medical Physiology", 2nd Edition, Saunders Elsevier, 2019
2. Jain A K, "Textbook of Physiology", 9th Edition, Avichal Publishing Company, 2019

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER IV

U21MA406	PROBABILITY AND STOHASTIC PROCESSES (For BM)	Category: BSC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the concepts of probability, random variable and distributions that are applicable in the field of engineering
- To understand the concepts of stochastic processes with real life examples
- To understand the concepts of testing of hypothesis for small and large samples which plays an important role in testing of fertilizers and chemical products

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply probability axioms and the moments of discrete and continuous random variables to core engineering problems (Apply)

CO2: Use discrete probability distributions including requirements, mean and variance for making decisions (Understand)

CO3: Compare correlation and linear regression with respect to two dimensional random variables (Understand)

CO4: Analyze the simple classes of discrete random processes to model random arrivals (Apply)

CO5: Analyze large and small sample tests and perform small sample tests based on Chi-square t and F distributions (Apply)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I PROBABILITY 9

Probability – Axioms of probability – Conditional probability – Baye's theorem – Discrete and continuous random variables – Moments – Moment generating functions

UNIT II DISTRIBUTION FUNCTIONS 9

Binomial distribution – Poisson distribution – Geometric distribution – Uniform distribution – Exponential distribution – Normal distribution

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UNIT III TWO DIMENSIONAL RANDOM VARIABLES 9

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression

UNIT IV STOCHASTIC PROCESSES 9

Classification – Stationary process – Markov chain – Bernoulli and Poisson process

UNIT V TESTING OF HYPOTHESIS 9

Large sample test for single mean and difference of means – Small sample test: t distribution – F distribution – Chi square distribution

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

3. Milton J S and Arnold J C, "Introduction to Probability and Statistics", 4th edition, Tata McGraw Hill, 2008
4. Oliver C.Ibe, "Fundamentals of Applied Probability and Random Processes", Elsevier Academic Press, 2nd edition, 2014

REFERENCES:

3. Johnson R A, "Miller and Freund's Probability and Statistics for Engineers", 8th edition, Pearson Education, Asia, 2015
4. Devore J L, "Probability and Statistics for Engineering and the Sciences", 8th edition, Cengage Learning, New Delhi, 2014
5. Ross S M, "Introduction to Probability and Statistics for Engineers and Scientists", 3rd edition, Elsevier, 2010
6. Stark H., and Woods J.W., "Probability and Random Processes with Applications to Signal Processing", 3rd edition, Pearson Education, Asia, 2002

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Seminar / MCQ	Written Test	*Individual Assignment / Seminar / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

U21BM401	MICROBIOLOGY AND PATHOLOGY	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21BM301 - Human Anatomy and Physiology

COURSE OBJECTIVES:

- To familiarize with the basics of cell culture, staining and smearing
- To identify the morphology of microorganisms
- To explore the different diseases and disorders

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Perform staining procedure and identify the growth of microorganism in a given culture (Understand)

CO2: Outline the structure and morphology of microorganisms (Apply)

CO3: Explain the cause and pathogenesis of disease (Understand)

CO4: Outline the pathophysiology of disorders and compare the relation among disorders (Understand)

CO5: Characterize the hormonal disease and explain the metabolic effect of cancer (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	3	1	-
CO2	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	2	-	-	-	-	-	-	-	-	-	-	2	1	-
CO4	2	-	-	-	-	-	-	-	-	-	-	2	1	-
CO5	2	-	-	-	-	-	-	-	-	-	-	2	-	-
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO MICROBIOLOGY 9

Microscopy – Light microscope – Phase contrast and Electron microscopes – Sterilization techniques – Culture methods – Isolation and maintenance – Culture media – Selective and enrichment media – Staining techniques – Acid-fast staining – Growth curve and generation time

UNIT II MORPHOLOGICAL STUDIES 9

Fr Morphology, structure and classification: bacteria and virus – Pathogenesis and pathology of viral infections – Routes of infection and spread – Endogenous and exogenous infections – Plaque assay – T4 Phages and lambda stages

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UNIT III IMMUNOPATHOLOGY 9

Normal human microflora – Host – Parasitic interaction – Exo and Endotoxins – Natural and artificial immunity – Auto-immune disorders – Antigen and antibody reactions – Immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, Monoclonal antibodies

UNIT IV DISORDERS OF KIDNEY AND PLASMA PROTEINS 9

Acute and chronic renal failure – Proteinuria and nephritic syndrome – Acute and chronic liver failure Hypoalbuminaemia – Hypogammaglobulinaemia – Hypergammaglobulinaemia

UNIT V DISORDERS OF HORMONES AND METABOLIC ASPECTS OF CANCER 9

Congenital adrenal hyperplasia – Hyperthyroidism – Hypothyroidism – Pathogenesis of cancer – Tumour markers – α-Fetoprotein (AFP) – Carcinoembryonic antigen (CEA) – Para proteins – Enzymes as tumour markers and Carbohydrate antigen (CA) markers

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th Edition, WB, Saunders Co. 2015
2. Ananthanarayanan and Panicker, "Textbook of Microbiology", 10th Edition, Orient blackswan, 2017

REFERENCES:

1. Prescott, Harley and Klein, "Microbiology", 10th Edition, McGraw Hill, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

		Category: ESC				
U21AMG04	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (For BM)	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To utilize the fundamentals of probability distribution for machine learning
- To formulate the mathematical foundation behind supervised and unsupervised learning
- To apply the supervised and unsupervised methods to develop decision systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Summarize the history and state of the art of AI (Understand)

CO2: Formulate the framework of machine learning models (Apply)

CO3: Deploy the linear regression methods on any dataset (Apply)

CO4: Apply the architecture of neural networks and SVM (Apply)

CO5: Choose the appropriate unsupervised techniques for any given data (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	2	2	2	-	-	-	-	-	-	-	-	-	-	1
CO3	2	2	2	-	-	-	-	-	-	-	-	-	-	1
CO4	2	2	1	-	-	-	-	-	-	-	1	-	-	1
CO5	2	2	2	-	1	-	-	-	-	-	1	-	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO AI 9

Artificial Intelligence (AI) – Foundations of AI – History – State of the art – Problem solving by searching – Problem solving agents – Problem formulation – Search – Breadth first – Uniform – Cost – Depth first – Depth-limited – Iterative depth – First search

UNIT II LEARNING TYPES AND METHODS 9

Components of learning – Simple learning model – Types of learning: Supervised, Unsupervised, and Reinforcement – Other views of learning – Error and noise – Error measures – Noisy targets

UNIT III REGRESSION 9

Introduction to Supervised learning – Linear regression – Algorithm – Univariate – Bivariate – Generalization issues – Bias – Variance – Learning curve – Overfitting – Regularization – Case study

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UNIT IV CLASSIFICATION 9

Linear classification – Non separable data – Logistic regression – Gradient descent – Artificial Neural Network (ANN) – Single-layer feed forward – Multi-layer feed forward – Back Propagation – Support vector Machines (SVM) – Case study

UNIT V CLUSTERING 9

General problem – K-means clustering – Choosing the k Mixture models – EM algorithm – Gaussian mixture model – Bayesian network – Case study

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Project – Periods

Total 45 Periods

TEXT BOOKS:

1. Stuart Jonathan Russell, Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach", 4th Edition, Pearson, 2020
2. Abu-Mostafa Y.S, Magdon-Ismali M, Lin H.T, "Learning from Data", 1st Edition, AML Book Publishers, 2012

REFERENCES:

1. Simon Rogers, Mark Girolamo, "A first Course in Machine Learning", 1st Edition, CRC Press, 2011
2. Alpaydin Ethem, "Introduction to Machine Learning, 2nd Edition, MIT Press, 2014
3. UCI Machine learning repository, https://archive.ics.uci.edu/

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

		Category: ESC				
U21CSG04	JAVA PROGRAMMING (Common to AM, BM, CB, CS, EC, EE, IT)	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITE:

U21CSG01 - Problem Solving and C Programming

COURSE OBJECTIVES:

- To describe object-oriented programming paradigm and its principles
- To implement programs with Core Java features and API
- To develop applications with Java Collections

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the object-oriented programming concepts to develop simple java programs (Understand)

CO2: Develop Java programs using Inheritance principle (Apply)

CO3: Apply exception handling techniques in Java programs (Apply)

CO4: Develop Java programs with Input Output classes and multithreading (Apply)

CO5: Implement Java programs with Collections (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	2	-	-	-	1	2	2	-	2	-	1
CO2	3	2	2	2	-	-	-	1	2	2	-	2	-	1
CO3	3	2	2	2	-	-	-	1	2	2	-	2	-	1
CO4	3	2	2	2	-	-	-	1	2	2	-	2	-	1
CO5	3	2	2	2	-	-	-	1	2	2	-	2	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I OBJECT ORIENTED DEVELOPMENT AND JAVA BASICS 6

Object Oriented Programming – Concepts – Abstraction – Encapsulation – Comparison with function oriented programming – Characteristics of Java – Java Environment – JVM and JDK – Classes – Constructors – Methods – Static members – Comments – Data Types – Variables – Operators – Control Flow

UNIT II PACKAGES AND INHERITANCE 6

Defining a Package – Importing Packages – Inheritance – Creating super classes and sub classes – Access modifiers – Constructors in sub classes – Polymorphism – Method overloading – Method overriding – Abstract classes and abstract methods – Interfaces – Defining an interface – Implementing interface – Extending interfaces – Object class

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UNIT III EXCEPTION HANDLING 6

Exceptions – Throwing and catching exceptions – Checked and unchecked exceptions – Exception hierarchy – Built in exceptions – Creating own exception – Chained exceptions – Stack Trace Elements

UNIT IV I/O STEAMS AND MULTITHREADING 6

Input / Output Basics – Scanner class – Streams – Byte streams and Character streams comparison – Reading from and Writing to Console and Files – Multithreaded Programming – The Java Thread Model – Creating multiple threads – Thread class – Runnable Interface

UNIT V COLLECTIONS 6

Collections Framework Overview – Basics of List – Set – Queue – Programs using Array list – HashMap and HashSet – Hashcode and equals methods

LIST OF EXPERIMENTS

1. Write a Java program to create a class Student with private data members and public methods to implement encapsulation and abstraction.
2. Develop a Java program to implement constructor overloading and method overloading.
3. Develop a Java program to implement run-time polymorphism with inheritance.
4. Develop a Java program to implement inheritance using Interfaces and Abstract classes. Use packages.
5. Develop a Java program to demonstrate exception handling
6. Develop a multithreaded java program using a Thread class and Runnable interface
7. Develop a Java program to implement basic console IO and File IO.
8. Develop a Java program to store multiple objects in an Array List and to implement search and sort operations.

Contact Periods:

Lecture:	30 Periods	Tutorial:	– Periods	Practical:	30 Periods	Project:	– Periods
						Total:	60 Periods

TEXT BOOKS:

1. Herbert Schildt, "Java: The Complete Reference", 11th Edition, McGraw Hill Education, 2018
2. Cay.S.Horstmann and Gary Cornell, "Core Java 2, Vol 1, Fundamentals", 11th Edition, Pearson Education, 2020

REFERENCES:

1. J.Nino and F.A. Hosch , "An Introduction to Programming and OO Design using Java", 1st Edition, John wiley & Sons,2018
2. Paul Deitel, Harvey Deitel, "Java SE 8 for programmers", 3rd Edition, Pearson, 2015
3. E Balagurusamy, "Programming with Java",6th Edition, McGraw Hill Education,2019

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

		Category: PCC				
U21BM402	BIOPHYSICAL SIGNAL AND SYSTEMS	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the basic properties of signals and systems
- To analyze discrete time signals and systems in the Laplace and Z transform domain
- To understand analysis of physiological signals

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the continuous and discrete time signals (Understand)

CO2: Enumerate the equations governing the continuous and discrete time systems (Apply)

CO3: Formulate the sampling and reconstruction techniques with Fourier transform (Apply)

CO4: Utilize the representation of systems using Laplace and Z transform (Analyze)

CO5: Integrate Physiological systems and analysis (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	1	2	-	-	-	2	-	-	2	-	2
CO2	3	2	-	1	2	-	-	-	2	-	-	2	-	2
CO3	3	2	-	1	2	-	-	-	2	-	-	2	-	2
CO4	3	2	-	1	2	-	-	-	2	-	-	2	-	2
CO5	3	2	-	1	2	-	-	-	2	-	-	2	-	2
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION 9

Introduction to Signals and systems – Mathematical operations on Continuous time signals – Introduction to Discrete time signals - Representation of DT signals - Mathematical operations on Discrete time signals – Classification of continuous signals – Problems

UNIT II CONTINUOUS TIME, DISCRETE TIME SIGNALS 9

Continuous time signals : Block diagram representation of CT systems in time domain – Convolution integral – Convolution Integral by graphical method – Discrete time signals – Convolution sum –Linear convolution by graphical, tabulation and matrix method – Problems

UNIT III SAMPLING AND ANALYSIS OF DISCRETE TIME SIGNALS 9

Sampling and aliasing – Fourier transform of DT signals – Properties of DT Fourier transform – Frequency spectrum and Aliasing due to sampling – Signal reconstruction – Problems on Fourier

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transform

UNIT IV ANALYSIS OF SIGNALS WITH TRANSFORMS 9

Laplace transform – Transform and region of convergence – Properties of Laplace and z-transform – Inverse Laplace and z-transform – Rational system functions – Inverse Laplace and z-transform of rational functions – Analysis of LTI system with rational system functions

UNIT V PHYSIOLOGICAL SIGNALS 9

Analysis of wave shape and waveform complexity – Case study 1 – Real Time ECG QRS Detection with Simulink – Block diagram - ECG signal pre-processing and filtering – Case study 2 – Analysis of respiration - Extraction of a respiratory signal as time series and estimation of Respiration rate from the respiratory signal

LIST OF EXPERIMENTS

1. Study of Scientific and Simulation Packages.
2. Generation of Basic Signals.
3. Basic operation on signals.
4. Computation of Step Response of the system.
5. Computation of Impulse response of the system.
6. Verification of Linearity property.
7. Verification of Time Variant property.
8. Solving difference Equations.
9. Computation of Linear Convolution.
10. Computation of Circular Convolution.
11. Signal visualization and measurement
12. Plotting respiratory rate

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 60 Periods

TEXT BOOKS:

1. Oppenheim A V, Wilsky A Sand Hamid Nawab S, "Signals and Systems", Prentice Hall of India, New Delhi, 2011
2. A. Nagoor Kani, "Signals and Systems: Simplified", Tata McGraw Hill, New Delhi, 2018
3. M. Rangaraj Rangayyan, "Biomedical Signal Analysis", Wiley Publishers, New Delhi, 2016

REFERENCES:

1. Roberts M J,"Signals, Systems - Analysis using Transform Methods and MATLAB", Tata McGraw Hill, New Delhi, 2004
2. Samir S Soliman, Srinath M D, "Continuous and Discrete Signals and Systems", Prentice Hall International, New Delhi, 2003
3. https://in.mathworks.com/help/dsp/ug/real-time-ecg-qrs-detection.html
4. Charlton P H, Villarroel M, Salguiero F, "Waveform Analysis to Estimate Respiratory Rate" 2016
5. https://www.ncbi.nlm.nih.gov/books/NBK543644/ doi: 10.1007/978-3-319-43742-2_26
6. https://in.mathworks.com/help/dsp/ug/signal-visualization-and-measurements-in-matlab.html
7. https://in.mathworks.com/matlabcentral/answers/427625-matlab-plotting-and-breathing-rate

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EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I
(Theory)
(100 Marks)</th><th colspan="2">Assessment II
(Practical)
(100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER IV

		Category: PCC				
U21BM403	MICROBIOLOGY AND PATHOLOGY LABORATORY	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To comprehend the factors that affect/effect growth of microorganism
- To use the instruments used for analyzing microorganisms
- To apply the fundamentals of laboratory precautions and preparations and the techniques of culturing bacteria

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze the factors influencing the growth of microorganism (Understand)

CO2: Develop the media for culturing bacteria (Apply)

CO3: Identify the different types of bacteria using staining techniques (Apply)

CO4: Inspect the oxygen content of culture media and bacterial mobility (Apply)

CO5: Identify the activity of microbes in a culture media (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	2	-	-	-	3	-	-	-	-	2
CO2	-	-	2	-	2	-	-	-	3	-	-	-	-	2
CO3	-	-	2	-	2	-	-	-	3	-	-	-	-	1
CO4	-	-	2	-	2	-	-	-	3	-	-	-	-	2
CO5	-	-	3	-	2	-	-	-	3	-	-	-	1	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

LIST OF EXPERIMENTS

1. Study of parts of compound microscope
2. Culture media preparation and Pure culture techniques (Pour plate method, Spread plate method, Streak plate)
3. Effect of temperature on the growth of micro-organism
4. Effect of salt concentration on the growth of microorganisms
5. Simple staining of bacteria
6. Gram staining of bacteria
7. Capsule (Positive and Negative) staining

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8. Spore staining
9. Bacteria motility test
10. Quality analysis of phytochemical components in herbal extracts
11. Antibacterial susceptibility of a bacterial isolate
12. Cryoprocessing of tissue and cryosectioning (Study)

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

REFERENCES:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, —Pathologic Basis of Diseases, 7th edition,WB, Saunders Co. 2015
2. Ananthanarayanan & Panicker, "Microbiology II", 10th edition, Orient blackswan, 2017
3. Dubey RC and Maheswari DK. —A Text Book of Microbiologyll Chand & Company Ltd, 2007

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
60		40
100		

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SEMESTER IV

		Category: HSMC				
U21SSG01	SOFT SKILLS – I (Common to all programmes)	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To inculcate potential skills and to work as a team effectively
- To develop confidence and enhance interpersonal skills

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Enhance decision making and negotiation skills (Analyze)
CO2: Maintain open, effective, and Professional Communication (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	-	3	-	2	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	1	-	-

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I VERBAL COMPETENCE **10**

Verbal Analogy – Spotting Errors – Ordering of Sentences – Cloze Test – Effective Listening – Reading Comprehension

UNIT II EFFECTIVE COMMUNICATION **10**

Overcoming Communication Barriers – Body Language and its Etiquettes – Contextual Communication – 7C's of Communication – Listening to Documentaries

UNIT III INTERPERSONAL SKILLS **10**

Group Decision Making – Paralanguage – Negotiation Skills – Preparation & Planning, Bargaining & Problem Solving –Self Grooming – SWOT Analysis

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical 30 Periods Project: – Periods
Total: 30 Periods

TEXT BOOKS:

1. Prashant Sharma, "Soft Skills: Personality Development for Life Success", 1st Edition, BPB Publications, 2022
2. Suresh Kumar E, Sreehari P and Savithri J, "Communication Skills and Soft Skills: An Integrated

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Approach", 1st Edition, Dorling Kindersley, 2011

REFERENCES:

1. Jeff Butterfield, "Problem Solving and Decision Making", 2nd Edition, Course Technology, 2010
2. Wushow Bill Chou, "Fast-Tracking your Career: Soft Skills for Engineering and IT Professionals", 1st Edition, IEEE Press, 2013

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	**100**

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SEMESTER V

		Category: PCC				
U21BM501	MICROCONTROLLER AND ITS APPLICATIONS	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21ECG01 – Digital Electronics

COURSE OBJECTIVES:

- To explain the architecture of RP2040 chip
- To outline the features of cortex M0+ chip
- To explore the peripherals in RP2040

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the architecture of RP2040 (Understand)

CO2: Illustrate the bus fabric and single cycle I/O of RP2040 (Apply)

CO3: Use appropriate configurations of cortex M0+ in system design (Apply)

CO4: Demonstrate the Programmable I/O in system design (Apply)

CO5: Categorize the peripherals for designing a system using RP2040 (Analyze)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	1	-	1	-	1	-	-	-	-	-	-	2	-
CO3	3	2	1	-	1	-	-	-	-	-	-	-	2	1
CO4	2	2	1	1	1	-	-	-	-	-	-	-	1	1
CO5	3	2	2	1	1	-	-	-	-	-	-	-	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I MICROCONTROLLER RP2040 9

Introduction – A system overview of the RP2040 chip – Pin Descriptions – GPIO Functions

UNIT II SYSTEM DESCRIPTION 9

Bus Fabric: AHB–Lite Crossbar – Atomic Register Access – APB Bridge – Narrow IO Register Writes – Processor subsystem: SIO – Interrupts – Event Signals –Debug

UNIT III CORTEX–M0+ AND DMA 9

Cortex–M0+ – Functional Description – NVIC – MPU – Debug – GPIO – DMA: Data requests, Interrupts and Memory

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UNIT IV THE PROGRAMMABLE INPUT/OUTPUT 9

State machines – PIO Programs – Control Flow – Registers – Stalling – Pin Mapping – IRQ Flags – Interactions Between State Machines – Instruction Set – Functional Details

UNIT V PERIPHERALS 9

USB – UART –I2C – SPI – PWM –Timer – Watchdog – The Real–time Clock (RTC) –ADC – SSI

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. RP2040 Datasheet, A microcontroller by Raspberry Pi, V1.8, Synopsys, Inc. 2022
2. Harry Fairhead, "Programming The Raspberry Pi Pico In C", 1st Edition, IO Press, 2021

REFERENCES:

1. Sai Yamanoor and Srihari Yamanoor, "Python Programming with Raspberry Pi", 1st Edition, Packt Publishing, 2017
2. Stephen Smith, "RP2040 Assembly Language Programming: ARM Cortex–M0+ on the Raspberry Pi Pico", Springer Science, 2022

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER V

		Category: PCC				
U21BM502	BIOSIGNAL PROCESSING	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- U21BM402 - Signals and Systems

COURSE OBJECTIVES:

- To interpret the design aspects of FIR and IIR filter
- To summarize different biosignals and its associated artifacts
- To explore the power spectrum estimation and shape analysis for classification of signals

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Design the different types of analog and digital IIR filters (Apply)

CO2: Design the FIR filters based on the given specifications (Apply)

CO3: Categorize the biosignals and methods for the artifact removal (Analyze)

CO4: Estimate the power spectrum and event detection (Understand)

CO5: Interpret the analysis and classification of events in biosignals (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	3	-	-	1	2	1	-	1	-	2
CO2	3	3	2	-	3	-	-	1	2	1	-	1	-	3
CO3	3	3	2	1	3	-	-	1	2	1	-	1	-	3
CO4	3	3	2	1	3	-	-	1	2	1	-	1	-	3
CO5	3	3	2	2	3	-	-	1	2	1	-	1	-	3
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I INFINITE IMPULSE RESPONSE FILTERS 9

Analog Filter design – Butterworth filter – Chebyshev filter – Design of IIR filters from analog filters – Impulse invariance – Bilinear transformation – IIR realizations – Direct form – Cascade form – Parallel form

UNIT II FINITE IMPULSE RESPONSE FILTERS 9

FIR Design – FIR design by windows – Rectangular window – Hamming window – Hanning window – FIR design by frequency sampling method – FIR realizations – Direct form – Cascade form

UNIT III BIOMEDICAL SIGNALS AND ARTIFACT REMOVAL 9

Nature of biomedical signals – Characteristics – Objectives of biomedical signal analysis – Physiological artifacts and interference – Time domain filtering – Synchronous averaging filters – Moving average filters – Frequency domain filtering – Optimal filtering – Adaptive filtering using LMS

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algorithm

UNIT IV POWER SPECTRUM ESTIMATION AND EVENT DETECTION 9

Introduction – The Periodogram – Non parametric methods – Bartlett method – Welch method – Blackman and Tukey method – Performance characteristics – Event detection – QRS detection – Correlation analysis of EEG rhythms – Homographic filtering

UNIT V PATTERN RECOGNITION AND DIAGNOSTIC DECISION 9

Pattern classification – Supervised pattern classification – Linear discriminant analysis – Distance functions – Unsupervised pattern classification – Cluster seeking methods – Neural networks – Detection of Ectopic beats in ECG – Detection of knee joint cartilage pathology

LIST OF EXPERIMENTS

1. Design of IIR Butterworth filter (LPF, HPF, BPF and BSF)
2. Design of IIR Chebyshev filter (LPF and HPF)
3. Design of FIR filter using Hamming window
4. Design of FIR filter using Hanning window
5. Artifact removal – powerline interference
6. Adaptive filtering
7. Estimation of power spectral density in an ECG signal
8. Detection of QRS complex in ECG signal
9. Analysis of EEG signal
10. Determination of heart rate from the ECG signal

Contact Periods:

Lecture: 30 Periods	Tutorial: – Periods	Practical: 30 Periods	Project: – Periods
			Total: 60 Periods

TEXT BOOKS:

1. John G Proakis and Dimitris G Manolakis, "Digital signal Processing: Principles, Algorithms and Applications", 4th Edition, Prentice Hall of India, New Delhi, 2007
2. Rangaraj M Rangayyan, "Biomedical Signal Analysis: A Case-Study Approach", 2nd Edition, Wiley India, New Delhi, 2015

REFERENCES:

1. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", 4th Edition, Tata Mc GrawHill Pvt. Ltd., 2011
2. Eugene N Bruce, "Biomedical Signal Processing and Signal Modelling", 1st Edition, Wiley India, New Delhi, 2007

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EVALUATION PATTERN:

Continuous Internal Assessments				End Semester Examinations	
Assessment I (Theory) (100 Marks)		**Assessment II (Practical) (100 Marks)**		**Theory Examinations (Examinations will be conducted for 100 Marks)**	**Practical Examinations (Examinations will be conducted for 100 Marks)**
*Individual Assignment / Case Study / Seminar / Mini Project / MCQ	Written Test	Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test		
40	60	75	25		
25		25		25	25
50				50	
Total: 100					

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER V

		Category: PCC				
U21BM503	BIOCONTROL SYSTEMS	L	T	P	J	C
		3	0	0	2	4

PRE–REQUISITES:

- U21MA202 - Transforms and its applications
- U21BM402 - Biophysical Signals and Systems

COURSE OBJECTIVES:

- To introduce the types of control systems and its mathematical representation
- To examine the performance of a control system
- To apply the knowledge of control system engineering in modeling physiological system

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the transfer function of a control system using various techniques (Apply)

CO2: Infer the time and stability responses of the given system using mathematical methods (Apply)

CO3: Implement mathematical methods to identify the frequency response of the given system (Apply)

CO4: Describe the concepts of physiological system modelling (Understand)

CO5: Summarize the properties of physiological control systems (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	1	-	-	-	-	-	-	-	-	1
CO2	3	2	-	2	1	-	-	-	-	-	-	-	-	1
CO3	3	2	-	2	1	-	-	-	-	-	-	-	-	1
CO4	3	-	-	-	1	-	-	-	-	-	-	-	-	1
CO5	3	-	-	-	1	-	-	-	-	-	-	-	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I INTRODUCTION TO CONTROL SYSTEMS 9

Control system – Open loop and closed loop systems – Mechanical and Electrical modeling of physical systems – Transfer function – Block diagram representation – Signal flow graphs – Feedback principles and characteristics of control system

UNIT II TIME RESPONSE AND STABILITY ANALYSIS 9

Step and Impulse responses of first order and second order systems - Time domain specifications – Error coefficients and constants – Stability - Routh Hurwitz criteria - Root locus technique - Dominant poles - Relative stability

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UNIT III FREQUENCY RESPONSE ANALYSIS 9

Frequency response analysis – Correlation between time and frequency response – Bode plot – Stability in frequency domain – Nyquist stability criteria - Nyquist plot

UNIT IV PHYSIOLOGICAL CONTROL SYSTEMS 9

Introduction to physiological control systems – Art of modeling physiological systems – Parametric and non-parametric models – Lumped and distributed parametric models - Positive and negative feedback physiological control systems

UNIT V PROPERTIES OF PHYSIOLOGICAL CONTROL SYSTEM 9

Generalized system properties - Adaptive and constrained systems - Models with combination of system elements – Linear model of respiratory mechanics - Linear model of lung mechanics

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: – Periods Project: 30 Periods
Total: 60 Periods

TEXT BOOKS:

1. Nagarath I J, Gopal M, "Control Systems Engineering", 6th edition, New Age International Pvt. Ltd., New Delhi, 2018
2. Khoo Michael C K, "Physiological Control Systems: Analysis, Simulation and Estimation", 2nd edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2018

REFERENCES:

1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt. Ltd., New Delhi, 2015

EVALUATION PATTERN:

<table>
<tr><th colspan="5">Continuous Internal Assessments</th><th>End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (Theory) (100 Marks)</th><th colspan="3">Assessment II (Project) (100 Marks)</th><td rowspan="2">Theory Examinations
(Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Review I</td><td>Review II</td><td>Review III</td></tr>
<tr><td>40</td><td>60</td><td>15</td><td>25</td><td>60</td><td></td></tr>
<tr><td colspan="2">25</td><td colspan="3">25</td><td>50</td></tr>
<tr><td colspan="5">50</td><td>50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Designer can choose any one / two components based on the nature of the course.

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SEMESTER V

		Category: HSMC				
U21SSG02	SOFT SKILLS - II	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the importance of communication and enhance self confidence
- To acquire employability skills

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Actively participate in Group Discussion (Apply)
CO2: Enhance interview skills and make effective Presentation (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	2	3	-	-	-	-
CO2	-	-	-	-	-	-	-	-	2	3	-	-	-	-
Correlation levels:	1: Slight (Low)					2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I PRESENTATION SKILLS **10**

Presentation Techniques – Time Management Techniques – Body language – Managerial Skills – Making Effective Presentation

UNIT II GROUP DISCUSSION AND PUBLIC SPEAKING **10**

Introduction to Group Discussion – Understanding Group Dynamics – Group Discussion Strategies– Activities to Improve GD Skills – Public Speaking Techniques – Public Speaking Activitiy

UNIT III INTERVIEW SKILLS **10**

Listening to Interviews – Preparation for the Interview – Interview Techniques and Etiquettes –Handling Stress Interview – Mock Interview – Online Interview Techniques

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Prashant Sharma, "Soft Skills: Personality Development for Life Success", BPB Publications, 1st Edition, 2022
2. Leader Interpersonal and Influence Skills: The Soft Skills of Leadership", Routledge Publications, 2014

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REFERENCES:

1. Ghosh B N, "Managing Soft Skills for Personality Development", 1st Edition, Tata McGraw-Hill, 2012
2. Nitin Bhatnagar and Mamta Bhatnagar, "Effective Communication and Soft Skills Strategies for Success", 1st Edition, Pearson Education, 2012

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	**100**

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SEMESTER V

		Category: PCC				
U21BM504	MICROCONTROLLER LABORATORY	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21EEG01 - Basics of Electrical and Electronics Engineering
- U21ECG01 - Digital Electronics

COURSE OBJECTIVES:

- To explore the registers in microcontroller
- To program microcontrollers to work with peripherals
- To provide an exposure on controlling the various peripherals of microcontroller

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Experiment the arithmetic operations using microcontroller (Apply)

CO2: Demonstrate the GPIO operations in microcontroller (Apply)

CO3: Modify the GPIO operations in the microcontroller (Analyze)

CO4: Create waveforms using microcontroller (Apply)

CO5: Program the peripherals of the microcontrollers (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	3	-	-	1	3	2	-	1	2	1
CO2	3	2	1	-	3	-	-	1	3	2	-	1	2	1
CO3	3	3	3	1	3	-	-	1	3	2	-	1	2	1
CO4	3	2	1	3	3	-	-	1	3	2	-	1	2	1
CO5	3	2	1	3	3	-	-	1	3	2	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

LIST OF EXPERIMENTS

1. Arithmetic Operations using microcontroller
2. Logical Operations using microcontroller
3. LED control using microcontroller
4. 7 Segment LED control using microcontroller
5. LCD controller using microcontroller
6. Stepper motor controller using microcontroller
7. Servo motor control using microcontroller
8. Waveform generation using microcontroller

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9. ADC using microcontroller
10. Timer using Microcontroller

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

REFERENCES:

1. Harry Fairhead, "Programming the Raspberry Pi Pico", 1st Edition, IO Press, 2021
2. Sai Yamanoor and Srihari Yamanoor, "Python Programming with Raspberry Pi", 1st Edition, Packt Publishing, 2017

EVALUATION PATTERN:

Continuous Internal Assessments		**End Semester Examinations**
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	25	
100		100
40		60
100		

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SEMESTER VI

U21BM601	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	Category: PCC				
		L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21BM302 - Biomedical Sensors and Instrumentation

COURSE OBJECTIVES:

- To infer the working of devices for diagnosis and treatment of cardiac and neuro emergency
- To explain the techniques used for the analysis and support of respiratory action and waste removal
- To interpret the various sensory measurements and imaging techniques that hold clinical importance

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the working of equipment used for cardio and neuro care (Understand)

CO2: Explore equipment used for analysis and support of muscular and neurological equipment (Understand)

CO3: Illustrate the methods to measure the parameters related to respiratory and urinary system failure (Apply)

CO4: Describe the measurement techniques of sensory responses (Understand)

CO5: Summarize the principle of ultrasonic, thermography and its applications in medicine (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	2	-	-	-	-	-	3	-
CO2	3	2	1	2	-	-	2	-	-	-	-	-	3	-
CO3	2	2	2	2	3	-	2	-	-	-	-	-	3	-
CO4	3	2	3	2	-	-	2	-	-	-	-	-	3	-
CO5	3	2	1	2	-	-	-	-	-	-	-	-	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I CARDIAC AND NEUROLOGICAL EQUIPMENT 9

Heart rate monitor – Holter monitor – Pacemaker – Defibrillator – Evoked Potential – Visual auditory and somatosensory – MEG (Magneto Encephalogram) – Brain stimulation treatment – Biotelemetry

UNIT II MUSCULAR AND BIOMECHANICAL EQUIPMENT 9

Recording and analysis of EMG waveforms – Fatigue characteristics – Muscle stimulators – Nerve stimulators – Nerve conduction velocity measurement – EMG bio feedback instrumentation- Diathermy – Electrosurgical equipment – Cryotherapy – Static measurement – Load Cell – Pedobarograph – Dynamic measurement – Velocity – Acceleration – Gait

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UNIT III RESPIRATORY AND UROLOGY EQUIPMENT 9

Spirometer – Pneumotachometer – Whole body Plethysmograph – Intra alveolar and thoracic pressure measurements – Apnoea Monitor – Ventilator modes and working – Heart lung machine – working – Haemodialysis – Peritoneal dialysis – Principle and equipment

UNIT IV SENSORY EQUIPMENT 9

Psychophysiological Measurements – Polygraph – Basal skin resistance (BSR) – Galvanic skin resistance (GSR) – Sensory responses – Audiometer – Pure tone – Speech – Eye Tonometer – Applanation Tonometer – Hearing aids

UNIT V ULTRASONIC AND THERMOGRAPHY TECHNIQUE 9

Tissue Reaction – Application of ultrasound as diagnostic tool – Cardiology – Obstetrics and Gynaecology – Ophthalmology – Thermography – Recording and clinical application

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. John G Webster, "Medical Instrumentation Application and Design", 4th Edition, Wiley India Pvt ltd, 2015
2. Joseph J Carr and John M Brown, "Introduction to Biomedical Equipment Technology", 2nd Edition, Pearson education, 2012

REFERENCES:

1. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design",2nd Edition, McGraw Hill, 2003
2. Khandpur R S, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw-Hill, 2014
3. Geddes LA and Baker LE, "Principles of Applied Biomedical Instrumentation", 3rd Edition, Tata McGraw Hill, 2008
4. Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer, "Biomedical Instrumentation and Measurement", 2nd Edition, Prentice Hall of India, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VI

		Category: HSMC				
U21BM602	HOSPITAL MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES: Nil

COURSE OBJECTIVES:

- To understand the opportunities for training and research in all aspects of hospital / health administration.
- To educate the students in the development of high quality of hospital care in the community to provide a satisfactory environment to the patient and clinical research.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understands the principles of Hospital administration (Understand)

CO2: Outline the problem encountered during outpatient and inpatient services (Understand)

CO3: Recognize the importance of ancillary services in healthcare based upon the patient's perceived need (Understand)

CO4: Explains the safety procedures followed for hospitals equipment and precautionary about disease transmission (Understand)

CO5: Identify the importance of Human resource management in organizing the hospital (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	-	-	-	2	-	-	-	-	-	-	1	-
CO2	1	2	1	1	-	3	-	-	-	-	-	-	-	-
CO3	2	2	2	2	-	2	-	-	-	-	-	-	-	-
CO4	2	2	1	1	-	3	-	-	-	-	-	-	1	-
CO5	1	2	1	1	-	2	-	-	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I STANDARD OF HOSPITAL 9

Concept of Hospital Management - Role of Administrator - Responsibilities of Administrator - Hospital Design, Outlines for establishing Departmental Zones - Hospital Engineering, hospital visit and interaction with the design and set up the hospital rules.

UNIT II HOSPITAL ORGANIZATION 9

Organization of Out-Patient Services - Problems encountered in functioning of O.P Department - Organization of In- Patient Services - Casualty & Emergency Services - Organization and management of Operation theatres

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UNIT III SERVICES IN HOSPITAL 9

Organization of Ancillary Services: Lab Services - Department of Physiotherapy & Occupational Therapy - Organization of Blood Transfusion Services - Department of Radio - diagnosis - Hospital Pharmacy

UNIT IV STERILIZATION AND HOSPITAL SAFETY 9

Disease transmission, Sterilization and disinfection methods, Hospital safety - Radiation Safety, hazardous safety, safety disposal of biological waste - Maintenance of Equipment & Instruments.

UNIT V SUPPORTIVE SERVICES IN HOSPITAL 9

Organization and management of Nursing services and Dietary Services in hospital - House-keeping and maintenance - Medical Records -Staffing the hospital - Human resources management in hospital - Management Assisted by Computers: Reservation, Admission, Registration & Discharge Module

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Webster J.C. and Albert M.Cook, "Clinical Engineering Principle and Practice", Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979
2. Rao L.L., Hospital Management, Annamalai University Press, 2007
3. Lele R.D., Computers in Medicine, Tata McGraw Hill, 2008
4. Mohan Bansal, Medical informatics, Tata McGraw Hill, 2005

REFERENCES:

1. Goyal R.C., "Handbook of hospital personal management", Prentice Hall of India, 1996.

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VI

		Category: PCC				
U21BM603	BIOMECHANICS	L	T	P	J	C
		2	0	2	0	3

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To summarize the fundamental concepts of biomechanics
- To infer the structure and properties of solid, fluid, hard and soft tissues
- To illustrate the functions of joint mechanics and sport mechanics

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the basic concepts of biomechanics (Apply)

CO2: Illustrate significant mechanical properties of biosolids and biofluids (Understand)

CO3: Classify the significant mechanical properties of hard and soft tissues (Understand)

CO4: Outline the function of mechanics of joints (Apply)

CO5: Examine the applications of biomechanical studies in sports (Analyze)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I INTRODUCTION TO BIOMECHANICS 6

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

UNIT II MECHANICS OF BIOSOLIDS AND BIOFLUIDS 6

Constitutive equation – Stress – Strain – Viscoelasticity – Flow properties of blood – Rheology of blood in micro vessels – Bio viscoelastic solids

UNIT III MECHANICS OF HARD AND SOFT TISSUES 6

Bones – Structure – Composition – Mechanical properties – Anisotropy – Fracture mechanisms – Pseudo elasticity – Structure – Function – Mechanical properties of Skin – Ligaments – Skeletal muscles and tendons

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UNIT IV MECHANICS OF JOINTS 6

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

UNIT V SPORTS BIOMECHANICS 6

Gait analysis – Qualitative biomechanical analysis to improve technique – Qualitative analysis of sports movements – Understand injury development – Geometry of motion – Force and pressure measurement

LIST OF EXPERIMENTS (INDICATIVE)

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 Skelcam.
5. Design and development of pedometers and activity tracker using accelerometers.
6. Gait analysis using motion capture system.

Contact Periods:

Lecture: 30 Periods Tutorial: – Periods Practical: 30 Periods Project: – Periods
Total: 60 Periods

TEXT BOOKS:

1. Susan J Hall, "Basic Biomechanics", 7th Edition, McGraw Hill, 2015
2. Peter M McGinnis, "Mechanics of sports and exercise", 1st Edition, Human kinetics, 2013

REFERENCES:

1. Roger Bartlett, "Introduction to sports biomechanics", 2nd Edition, Routledge, 2007
2. Michael W Whittle, "Gait analysis: An Introduction", Butterworth Heinemann, 3rd Edition, Elsevier, 2007

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th colspan="2" rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I
(Theory)
(100 Marks)</th><th colspan="2">Assessment II
(Practical)
(100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Mini Project / MCQ</td><td>Written Test</td><td>Evaluation of Laboratory Observation, Record
(Rubrics Based Assessments)</td><td>Test</td><td rowspan="2">Theory Examinations (Examinations will be conducted for 100 Marks)</td><td rowspan="2">Practical Examinations (Examinations will be conducted for 100 Marks)</td></tr>
<tr><td>40</td><td>60</td><td>75</td><td>25</td></tr>
<tr><td colspan="2">25</td><td colspan="2">25</td><td>25</td><td>25</td></tr>
<tr><td colspan="4">50</td><td colspan="2">50</td></tr>
<tr><td colspan="6">Total: 100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinater can choose any one / two components based on the nature of the course.

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SEMESTER VI

		Category: HSMC				
U21SSG03	SOFT SKILLS – III	L	T	P	J	C
		0	0	2	0	1

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To improve language adeptness and to enhance fluency in language.
- To Gain emotional intelligence and to manage stress.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Write reports and make reasoning and assertions (Apply)
CO2: Overcome stress and attain work-life balance (Analyse)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	1	3	-	-	-	-
CO2	-	-	-	-	-	-	-	1	-	3	-	2	-	-
Correlation levels:	1: Slight (Low)					2: Moderate (Medium)					3: Substantial (High)			

SYLLABUS:

UNIT I LANGUAGE ADEPTNESS **10**

Sentence Completion – Report Writing – Logical Reasoning – Cause and Effect – Assertion and Reasoning – Digital Profiling – Creative Resume

UNIT II STRESS MANAGEMENT **10**

Factors Causing Stress – Positive and Negative Stress – Effects of Stress – Stress Overcoming Techniques – Context Based Tasks

UNIT III EMOTIONAL INTELLIGENCE **10**

Leadership effectiveness – Self-awareness – Self-management – Self-motivation – Empathy and Social Skills

Contact Periods:

Lecture: - Periods Tutorial: -Periods Practical: 30 Periods Project: – Periods

Total: 30 Periods

TEXT BOOKS:

1. Daniel Goleman, "Emotional Intelligence: Why it Can Matter More Than IQ", 1st Edition, Bloomsbury, 2009
2. Alan Barker, "Improve Your Communication Skills : Present with Confidence; Write with Style; Learn Skills of Persuasion",1st Edition, Kogan Page, 2010

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REFERENCES:

1. Jeremy Stranks, "Stress at Work: Management and Prevention", 1st edition, Butterworth - Heinemann, 2005
2. Edward J Watson, "Emotional Intelligence: A Practical Guide on How to Control Your Emotions and Achieve Lifelong Social Success", 1st edition, Amazon Digital Services LLC, 2016.

EVALUATION PATTERN:

Continuous Internal Assessments	Marks
Test - I	50
Test - II	50
Total	**100**

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SEMESTER VI

		Category: PCC				
U21BM604	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- U21BM304 – Biomedical Sensors and Instrumentation Laboratory

COURSE OBJECTIVES:

- To demonstrate the recording and analysis of different bio potentials
- To examine different therapeutic modalities
- To have knowledge on the working principle of critical care equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Measure different bioelectrical and non-electrical signals using various methods (Apply)

CO2: Elucidate the concept of image formation using ultrasound scanners (Understand)

CO3: Illustrate various therapeutic equipment (Apply)

CO4: Interpret the working of life saving equipment (Apply)

CO5: Examine the electrical safety aspects of biomedical equipment (Understand)

CO-PO MAPPING:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3	-	-	-	-	-	-	-	3	-
CO2	3	3	3	2	2	-	-	-	-	-	-	-	3	-
CO3	3	3	2	2	3	-	-	-	-	-	-	-	3	-
CO4	3	3	3	2	3	-	-	-	-	-	-	-	3	-
CO5	3	3	2	2	2	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

LIST OF EXPERIMENTS

1. Measure the electrical signal recorded over the occipital cortex in response to light stimulus
2. Study of Pacemaker and Defibrillator as a lifesaving unit.
3. Study of electrical safety of equipment
4. Analyze the working of electro surgical unit in cutting and coagulation
5. Observe the use of high frequency electromagnetic current for the physical therapy and surge (ultrasound and shortwave)
6. Record the ventilation capacity of lungs
7. Analyze the method and instrument used to produce mechanical ventilation
8. Spot the cleaning of blood using artificial kidney in case of renal failure
9. Spot the working of heart lung machine

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10. Measure the hearing ability of an individual using an audiogram
11. Explore the working transducers and image formation in ultrasound scanners for any 2 applicatior
12. Study of Transcutaneous electrical nerve stimulation using medical simulator

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

REFERENCES:

1. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", 2nd Edition, McGraw Hill, 2003
2. Khandpur R S, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw-Hill, 2014
3. Geddes LA and Baker LE, "Principles of Applied Biomedical Instrumentation", 3rd Edition, Tata McGraw Hill, 2008
4. Leslie Cromwell, Fred J Weibell, Erich A Pfeiffer, "Biomedical Instrumentation and Measurement", 2nd Edition, Prentice Hall of India, 2015

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	
100		100
60		40
100		

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SEMESTER VII

		Category: PCC				
U21BM701	RADIOLOGICAL EQUIPMENT	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21PH202 - Medical Physics
- U21BM301 - Human Anatomy and Physiology

COURSE OBJECTIVES:

- To understand the concept of x-ray imaging
- To explore the concept of using magnetic and radiofrequency fields in imaging
- To identify the potential of radioisotopes in imaging application
- To know the working of ultrasound waves in capturing the state of the organ and function

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Outline the effective production of x rays and their application in different ways (Understand)

CO2: Make use of various cases examined under CT and understand the influence of technical parameters in getting quality CT image (Apply)

CO3: Interpret the types of MRI images and study the current state of the organ (Apply)

CO4: Identify the potential of radioisotopes in imaging and the working of Gamma Camera (Apply)

CO5: Inspect the semiology of ultrasound images (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	-	-	-	-	-	-	-	-	-	1	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	1	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	1	-
CO4	3	-	1	-	-	-	-	-	-	-	-	-	1	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-	1	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

SYLLABUS:

UNIT I MEDICAL X-RAY EQUIPMENT **9**

Nature of X-rays – Production of X-rays – X- ray machine – Anode cooling chart and tube rating chart – visualization of X-ray images – X-ray detectors and parameters – image intensifier system – Digital fluoroscopy – Digital subtraction angiography – Mammography

UNIT II COMPUTER TOMOGRAPHY **9**

Tomography principle – CT hardware – Physics of data acquisition – reconstruction from fan beam projections – spiral tomography – Single slice, multi slice and cone beam tomography – Scanner geometry – Technical parameters of CT devices

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UNIT III MRI 9

Basic principles of image acquisition – Static coils, Gradient coils and shim coils – Radio frequency pulse – Pulse sequence – T1, T2 and T2* images – TR, TE and tissue contrast – Slice selection and spatial encoding – Data space – Field of view – k-Space – scan parameters – Types of MRI imaging – fMRI, MRA, MRV

UNIT IV NUCLEAR IMAGING SYSTEMS 9

Radioisotopes – Gamma Camera – Performance parameters for gamma camera – SPECT – Detectors, performance of SPECT camera – PET – Detectors, Coincidence timing window, dual and triple head gamma camera, data acquisition methods – Design considerations and quality control tests for nuclear imaging systems – Computers in nuclear imaging systems

UNIT V DIAGNOSTIC ULTRASOUND IMAGING 9

Physics of ultrasound imaging – Instrumentation – Image display modes and storage – Transducers – Special imaging modes – Image quality and pitfalls – Doppler Sonography – Instrumentation and display – Source of artifacts – Interpretation of doppler spectrum and color doppler

Contact Periods:

Lecture: 45 Periods	Tutorial: – Periods	Practical: – Periods	Project:	– Periods
			Total:	45 Periods

TEXT BOOKS:

1. Khandpur. Raghbir Singh., "Handbook of biomedical instrumentation", 3rd Revised Edition, McGraw-Hill Education, 2014

REFERENCES:

1. Saha, Gopal B. "Physics and radiobiology of nuclear medicine", Springer Science & Business Media, 2012
2. Rumack, Carol M., and Deborah Levine, "Diagnostic Ultrasound" 5th Edition, Elsevier Health Sciences, 2017
3. Dale, Brian M., Mark A. Brown, and Richard C. Semelka, "MRI: basic principles and applications", John Wiley & Sons, 5th Edition, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VII

		Category: PCC				
U21BM702	MEDICAL IMAGE PROCESSING	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21BM502 - Biosignal Processing

COURSE OBJECTIVES:

- To interpret the fundamentals of image formation and operations.
- To apply the image enhancement and segmentation techniques in medical images.
- To use various algorithms for feature extraction and recognition.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the image formation, basic operations and transforms deployed on digital images (Understand)

CO2: Make use of different techniques employed for the enhancement of images (Apply)

CO3: Inspect segmentation methods and morphological operations on images (Apply).

CO4: Examine the image compression and reconstruction techniques (Analyze)

CO5: Analyze feature extraction algorithms and image classification methods (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	-	-	-	-	-	-	1	-	2
CO2	3	2	2	2	2	-	-	-	-	-	-	1	-	2
CO3	3	2	2	2	2	-	-	-	-	-	-	1	-	2
CO4	3	2	2	2	2	-	-	-	-	-	-	1	-	2
CO5	3	2	2	2	2	-	-	-	-	-	-	1	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I FUNDAMENTALS OF DIGITAL IMAGES AND TRANSFORMS 9

Digital image processing – Origin, fundamentals, representation – Elements of visual perception – Image Sampling and Quantization – Neighborhood pixel relationships – Basic image operations – Image transform – 2D DFT, DCT, Haar and Hadamard transforms

UNIT II IMAGE ENHANCEMENT AND RESTORATION 9

Basic gray level transformation – Histogram processing – Spatial domain filtering – Smoothening and sharpening – Frequency domain filtering – Color models – Image degradation – Noise models – Image restoration – Wiener filtering – Order statistics filter – Adaptive filters

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UNIT III IMAGE SEGMENTATION AND MORPHOLOGICAL OPERATIONS 9

Detection of discontinuities – Detection of points, line and edges – Edge linking and boundary detection – Thresholding – Region-based segmentation – Morphological operations – Erosion and dilation – Opening and closing – Morphology based segmentation

UNIT IV IMAGE COMPRESSION AND RECONSTRUCTION 9

Fundamentals – Compression standards – Image compression models – Error free compression – Run length coding – Loss less predictive coding – Lossy predictive coding – Projections and Radon transform – Inverse Radon transform – Filter back projection algorithm – Fourier reconstruction of MRI images

UNIT V FEATURE EXTRACTION AND CLASSIFICATION 9

Boundary descriptors – Regional descriptors – Principal Component Analysis – Classification based on supervised and unsupervised learning methods

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Anil K.Jain, "Fundamentals of Digital Image Processing", 3rd Edition, Prentice Hall of India, 2015
2. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 4th Edition, Pearson Education Asia, 2017

REFERENCES:

1. Sinha G. R, Patel, B. C., Medical Image Processing: Concepts and Applications, Prentice Hall, 1st edition, 2014

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VII

		Category: PCC				
U21BM703	REHABILITATION ENGINEERING	L	T	P	J	C
		3	0	0	0	3

PRE–REQUISITES:

- U21BM301 – Human Anatomy and Physiology
- U21BM603 – Biomechanics

COURSE OBJECTIVES:

- To identify the engineering concepts that can be applied in rehabilitation medicine and the role of engineers in various rehabilitation disciplines
- To illustrate the different types of therapeutic exercise technique
- To interpret the various orthotic devices and prosthetic devices to overcome orthopedic problems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Summarize the principles of rehabilitation system (Understand)

CO2: Identify various exercises involved in rehabilitation process (Apply)

CO3: Analyze rehabilitation management in communication (Analyze)

CO4: Apply restoration techniques in rehabilitation (Apply)

CO5: Contrast the effectiveness of rehabilitation (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	1	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	1	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	1	-
CO5	3	2	2	1	1	-	-	1	-	-	-	-	1	1
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I PRINCIPLE OF REHABILITATION ENGINEERING 9

Introduction to 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 and secondary disabilities – Clinical practice of rehabilitation engineering – Universal design – Design based on human ability – Standards for assistive technology

UNIT II THERAPEUTIC EXERCISE TECHNIQUE 6

Co-ordination exercises – Frenkels exercises – Gait analysis – Pathological gaits – Gait training – Relaxation exercises – Methods for training relaxation – Strengthening exercises – Strength training – Types of contraction – Mobilization exercises – Endurance exercises

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UNIT III MANAGEMENT OF COMMUNICATION 9

Impairment – Introduction to communication – Aphasia – Types of aphasia – Treatment of aphasic patient – Augmentative communication – General form of communication – Types of visual aids – Hearing aids

UNIT IV ORTHOTIC, PROSTHETIC DEVICES AND RESTORATION TECHNIQUES 9

General orthotics – Classification of orthotics – Functional and regional General principles of orthosis – Calipers – 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

UNIT V CASE STUDY 9

Geriatric Rehabilitation – Visual and auditory challenges faced by geriatrics and methods to overcome those challenges– Pediatric rehabilitation – Visual and auditory challenges faced by cerebral palsy – Muscular dystrophy and autism children – Methods to overcome those challenges – Glaucoma screening device – Medical image acquisition user interface – Glaucoma screening device

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total: 45 Periods

TEXT BOOKS:

1. S Sunder, "Textbook of Rehabilitation", 4th Edition, Jaypee Brothers Medical Publishers private limited, NewDelhi, 2019
2. Joseph D. Bronzino, "The Biomedical Engineering Handbook", 3rd Edition, Taylor and Francis, 3 volume set, 2006

REFERENCES:

1. Rory A. Cooper, Hisaichi Ohnabe and Douglas A.Hodson, "An Introduction to Rehabilitation Engineering" , 1st Edition, CRC Press, 2014
2. Marion A. Hersh and Michael A. Johnson, "Assistive Technology for Visually impaired and blind people", 1st E dition, Springer Verlag, 2014

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

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SEMESTER VII

		Category: PCC				
U21BM704	MEDICAL IMAGE PROCESSING LABORATORY	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To apply the image enhancement and segmentation techniques in medical images.
- To use the image descriptors and representation in medical images.
- To utilize the image compression models and reconstruction techniques.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the basic operations that can be deployed on images (Apply)

CO2: Make use of image enhancement and segmentation techniques in the processing of medical images (Apply)

CO3: Compare lossless and lossy image compression techniques (Analyze)

CO4: Inspect the features of an image using various image descriptors and morphological operations (Analyze)

CO5: Examine performance metrics in biomedical images (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	-	1	2	1	-	1	-	2
CO2	3	2	2	1	2	-	-	1	2	1	-	1	-	2
CO3	3	2	2	1	2	-	-	1	2	1	-	1	-	2
CO4	3	2	2	2	2	-	-	1	2	1	-	1	-	2
CO5	3	2	2	1	2	-	-	1	2	1	-	1	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

LIST OF EXPERIMENTS

1. Basic operations and gray level transformations on images
2. Sampling and quantization
3. Image enhancement using spatial and frequency domain filtering
4. Denoising of medical images
5. Image segmentation using edge and region-based methods
6. Lossless and lossy compression on images
7. Image representation using descriptors
8. Texture and morphological analysis of medical images

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9. Image reconstruction using Radon transform and its performance metrics
10. Mini Project

Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

REFERENCES:

1. Chris Soloman, Toby Breckon, Fundamentals of Digital Image Processing: A Practical Approach with examples in Matlab, Wiley-Blackwell, 2010
2. Rafael C. Gonzalez, Richard Eugene Woods, Steven L. Eddins, Digital Image Processing using Matlab, Pearson Education India, 2004
3. Sinha G. R, Patel, B. C., Medical Image Processing: Concepts and Applications, Prentice Hall, 2014

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record (Rubrics Based Assessments)	Test	
75	25	
100		100
60		40
100		

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SEMESTER VII

		Category: PCC				
U21BM705	REHABILITATION LABORATORY	L	T	P	J	C
		0	0	4	0	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To study restoring functionality.
- To assess the effectiveness of an individual's performance.
- Evaluate therapeutic exercise techniques in rehabilitation for optimal patient outcomes.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the intervention of upper and lower extremities (Apply)

CO2: Demonstrate various exercises involved in rehabilitation process (Apply)

CO3: Evaluate the components comprising balance control (Analyze)

CO4: Compare qualitative and quantitative techniques (Analyze)

CO5: Examine performance metrics in sports biomechanics (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	2	-	-	1	2	1	-	1	1	2
CO2	3	2	2	1	2	-	-	1	2	1	-	1	-	2
CO3	3	2	2	1	2	-	-	1	2	1	-	1	-	2
CO4	3	2	2	1	2	-	-	1	2	1	-	1	-	2
CO5	3	2	2	1	2	-	-	1	2	1	-	1	1	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

LIST OF EXPERIMENTS

1. Study of lower extremities.
2. Analyze lateral trunk control using rehametrics.
3. Observe the cognitive analysis on dynamic and static balance.
4. Real time monitoring of shoulder range of motion.
5. Record the anteroposterior centre of mass displacement in shoulder activity.
6. Design, development and interfacing of EMG controlled prosthetics / bionic arm.
7. Study of hip flexion and adduction.
8. Measure the reaction time using flash reflex training system.
9. Analyze monopedal endurance and observe the inference.
10. Record the alternating coordination.
11. Measure mediolateral centre of mass displacement.
12. Real time monitoring of trunk rotation on different acceleration.

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Contact Periods:

Lecture: – Periods Tutorial: – Periods Practical: 60 Periods Project: – Periods

Total: 60 Periods

REFERENCES:

1. Susan J Hall, "Basic Biomechanics", 7th edition, McGraw Hill, 2015
2. Roger Bartlett & Melanie Bussey, "Sports Biomechanics: Reducing Injury Risk and Improving Sports Performance", Routledge, 2012
3. Joseph D. Bronzino, "The Biomedical Engineering Handbook", 3rd Edition, Taylor and Francis, 3 volume set, 2006

EVALUATION PATTERN:

Continuous Internal Assessments		End Semester Examinations
Evaluation of Laboratory Observation, Record **(Rubrics Based Assessments)**	Test	
75	**25**	
100		**100**
60		**40**
100		

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SEMESTER VII

		Category: EEC				
U21BM706	PROJECT WORK PHASE - I	L	T	P	J	C
		0	0	0	4	2

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop the ability to identify and solve a specific problem in the field of Biomedical Engineering
- To train the students in preparing project reports and to face reviews and viva voce examination

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify and define complex problems related to Biomedical Engineering (Apply)

CO2: Examine the technical aspects of the chosen project with comprehensive and systematic approach (Apply)

CO3: Apply appropriate methodologies to address identified problems and experimental procedures of developed technical project in a team (Apply)

CO4: Analyze and interpret the data with appropriate statistical and qualitative analysis techniques in Biomedical Engineering (Apply)

CO5: Communicate and report the solution for the problem identified in Biomedical Engineering (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO2	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO3	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO4	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO5	3	2	2	3	2	2	2	2	3	3	2	3	3	3
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

STRATEGY

To identify a topic of interest in consultation with Faculty/Supervisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design / fabrication or develop computer code. Demonstrate the novelty of the project through the results and outputs

Contact Periods:

Lecture: - Periods Tutorial: – Periods Practical: – Periods Project: 60 Periods

Total: 60 Periods

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EVALUATION PATTERN:

Continuous Internal Assessments (100 Marks)			
Review I	**Review II**	**Review III**	**Total Assessment**
30	30	40	100

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SEMESTER VIII

		Category: EEC				
U21BM801	PROJECT WORK PHASE - II	L	T	P	J	C
		0	0	0	20	10

PRE–REQUISITES:

- Nil

COURSE OBJECTIVES:

- To develop the ability to identify and solve a specific problem in the field of Biomedical Engineering
- To train the students in preparing project reports and to face reviews and viva voce examination

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the leading problems related to Biomedical Engineering (Apply)

CO2: Compare the technical aspects of the chosen project with comprehensive and systematic approach (Analyze)

CO3: Apply appropriate research methodologies to investigate and address research problems in the chosen field of study (Apply)

CO4: Inspect and apply interdisciplinary knowledge and skills to address the defined complex problem (Analyze)

CO5: Communicate and report the project findings and future prospectus effectively (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO2	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO3	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO4	3	2	2	3	2	2	2	2	3	3	2	3	3	3
CO5	3	2	2	3	2	2	2	2	3	3	2	3	3	3
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

STRATEGY

To identify a topic of interest in consultation with Faculty/Supervisor. Review the literature and gather information pertaining to the chosen topic. State the objectives and develop a methodology to achieve the objectives. Carryout the design / fabrication or develop computer code. Demonstrate the novelty of the project through the results and outputs

Contact Periods:

Lecture: - Periods Tutorial: – Periods Practical: – Periods Project: 300 Periods

Total: 300 Periods

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EVALUATION PATTERN:

Continuous Internal Assessments (40 Marks)			End Semester Examinations (60 Marks)	
Review I	Review II	Review III	Project Report	Viva-Voice
10	15	15	10	50
Total: 100 Marks				

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VERTICAL I - BIO ENGINEERING

		Category: PEC				
U21BMP01	NANOTECHNOLOGY IN MEDICINE	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire the knowledge on general principles and properties of nanomaterials
- To understand essential concepts used in nanomaterial synthesis
- To obtain an understanding of the applications of nanotechnology in various fields of engineering and the medical domain

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the basic principles and properties of nanomaterials (Understand)

CO2: Illustrate the different classes of nanomaterials (Understand)

CO3: Describe the preparation of nanomaterials (Understand)

CO4: Explain the characterization techniques in nanotechnology (Understand)

CO5: Identify the applications of nanotechnology in healthcare (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	-	-	-	-	-	1	-	-	-	-	-	1	-
CO4	3	-	-	-	-	1	1	-	-	-	-	-	1	-
CO5	3	1	1	-	-	1	1	-	-	-	-	-	1	-
Correlation Level(s)	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I INTRODUCTION TO NANOTECHNOLOGY 9

Definition of nanosystem – Size dependent phenomena – Surface to volume ratio – Fraction of surface atoms and surface energy – Properties (optical, mechanical, electronic and magnetic) – Quantum dots – Quantum wells – Quantum wires

UNIT II DIFFERENT CLASSES OF NANOMATERIALS 9

Carbon nanotubes – Nanocomposites – Nanoceramics – Biological nanomaterials – Nanomaterials for equipment design: smart textiles and wearable devices

UNIT III PREPARATION OF NANOMATERIALS 9

Top down and Bottom up approach of building nanomaterials – Electro deposition – Plasma arc discharge – Pulsed laser deposition – Sol-gel method – Ball milling – Molecular beam epitaxy (MBE)

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UNIT IV EXPERIMENTAL TECHNIQUES IN NANOTECHNOLOGY 9

Characterization – X- ray diffraction (XRD) – Atomic force microscopy – Scanning Tunneling microscopy (STM) – Scanning probe microscopy (SPM) – Optical and Raman spectroscopy

UNIT V APPLICATIONS OF NANOTECHNOLOGY IN HEALTHCARE 9

Properties of nanocarriers – Drug delivery systems used in nanomedicine – Enhanced Permeability and Retention effect – Blood-brain barrier – Active and passive targeting of diseased cells – Nanotechnology in defense – Environmental application – Health and environmental impacts of nanotechnology

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: - Periods

Total: 45 Periods

TEXT BOOKS:

1. Wai-Yeung Wong, Qingchen Dong, "Functional Nanomaterials: Synthesis, Properties, and Applications", Wiley VCH, 1st edition, 2022
2. T.Pradeep, "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 1st edition, 2012
3. Sabu Thomas, Nandakumar Kalarikal, A Manuel Stephan, B. Raneesh and A.K. Haghi,, "Advanced Nanomaterials – Synthesis, Properties and Applications", CRC Press, Taylor & Francis group, 1st edition, 2014

REFERENCES:

1. Hanson, G.W, "Fundamentals of Nanoelectronics", Pearson Education, 1st edition, 2012
2. A.K.Bandyopathyay, "Nanomaterials", New Age International Publishers, 1st edition, 2010
3. Mick Wilson, Kannangara Geoff Smith, Michelle Simmons, Burkhard Raguse, "Nanotechnology - Basic Science and Emerging Technologies", Overseas Press Private Limited, 1st edition 2010

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	20	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL I - BIO ENGINEERING

U21BMP02	ADVANCES IN DRUG DELIVERY	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To summarize the different drug delivery routes
- To interpret the drug delivery vehicles and transporters
- To explore the concept of targeted drug delivery

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the phenomenon related to oral drug delivery (Understand)

CO2: Compare the pulmonary and transdermal drug delivery methods (Understand)

CO3: Identify the role of drug delivery vehicles (Apply)

CO4: Make use of transporters in drug delivery (Apply)

CO5: Explain the methods of targeted drug delivery and cancer theragnostics (Understand)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I ORAL DRUG DELIVERY 9

Drug delivery – Target bioavailability – Barriers to drug delivery – Physiological barriers – Chemical barriers – Biochemical barriers – Drug modifications – Physicochemical properties – Formulations – PK-PD modeling – Source of variability of drug response

UNIT II PULMONARY AND TRANSDERMAL DRUG DELIVERY 9

Aerosol technology – Disease therapy – Formulation variables – Regulatory considerations – Transdermal patch delivery system – Patchless transdermal drug delivery system – Recent advances

UNIT III DRUG DELIVERY VEHICLES 9

Drug delivery vehicle properties – Targeting – Size and surface – Liposomes – Polymer based nanocarriers – Dendrimers – Metal nanoparticles – Silica

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UNIT IV TRANSPORTERS IN DRUG DELIVERY 9

Drug transport in absorption and excretion – Intestinal transport – Hepatic transport – Renal transport – BBB transport – ABC transporter family – SLC transporter family.

UNIT V TARGETED DELIVERY OF DRUGS AND CANCER THERNOSTICS 9

Introduction – Microbially triggered release – pH dependent release – Osmotic release – Pressure controlled delivery – Nanoparticle approaches – Image guided drug delivery and therapy – Optical imaging – MRI – Nuclear imaging – Ultrasound

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: Periods

Total: 45 Periods

TEXT BOOKS:

1. Binghe Wang, Longqin Hu, Teruna J. Siahaan, "Drug Delivery: Principles and Applications", John Wiley & Sons, 2nd edition, 2016
2. Yie W. Chien, "Novel Drug Delivery Systems", CRC Press, 2nd edition, 2019

REFERENCES:

1. Anya M. Hillery, Kinam Park, "Drug Delivery: Fundamentals & Applications", CRC Press, 2nd edition, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	20	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL I - BIO ENGINEERING

U21BMP03	IMMUNOENGINEERING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM401 – Microbiology and Pathology

COURSE OBJECTIVES:

- To discuss the structure, functions and integration of immune system
- To explain the antigen-antibody interactions and protecting the body from foreign pathogens
- To understand genetics of transplantation and tumour development

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the various types of cells and organs involved in immune system (Understand)

CO2: Illustrate the pathways involved in cell mediated and humoral immune responses (Understand)

CO3: Apply the concepts of immunology in vaccine development and treatment of infectious diseases (Apply)

CO4: Describe the basic concepts in transplantation and tumour immunology (Understand)

CO5: Identify the reason behind the allergy hypersensitivity and autoimmune disorders and its treatment (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	-	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	1	1	-	-	-	-	-	-	-	-	1	1	-
CO4	3	-	-	-	-	-	-	-	-	-	-	1	1	-
CO5	3	1	1	-	-	-	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

SYLLABUS:

UNIT I IMMUNE SYSTEM AND ANTIGENS 9

Cells of immune system – Innate immunity and acquired immunity – Antigens: chemical and molecular nature – Types of immune responses – Monoclonal antibodies

UNIT II ANTIBODIES AND CELLULAR RESPONSES 9

T-cells and B-cells – Development, Maturation, Activation and Differentiation – Antibodies: structure and functions – Antigen-antibody reactions – Regulation of T-cell and B-cell responses

UNIT III INFECTIONS AND IMMUNITY 9

Injury – Inflammation and types – Immune responses to infections – Immunity to viruses, bacteria, fungi and cytokines – AIDS and Immunodeficiencies – Resistance

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UNIT IV TRANSPLANTATION AND TUMOR IMMUNOLOGY 9

Transplantation – Genetics of transplantation – Laws of transplantation – Tumor immunology – Tumor antigens – Tumor immune response – Tumor diagnosis – Tumor immunotherapy

UNIT V ALLERGY, HYPERSENSITIVITY AND AUTOIMMUNITY 9

Allergy – Hypersensitivity – Types of hypersensitivity – Autoimmunity – Auto immune disorders and diagnosis

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Peter J. Delves., Seamus J. Martin., Dennis R. Burton., Ivan M. Roitt., "Essential Immunology", Wiley-Blackwell; 13th edition, 2017
2. Abbas, K.A., Litchman, A.H., Pober, J.S., "Cellular and Molecular Immunology", Elsevier., 9th edition, 2017
3. William E.P., "Fundamental Immunology", Lippinkott Williams and Wilkins a Wolters Kluwer business, 7th edition, 2012

REFERENCES:

1. Ashim K.C., "Immunology and Immunotechnology", Oxford University Press, 1st edition, 2006
2. Kuby J., "Immunology", WH Freeman & Co., 8th edition, 2018
3. Christine D., "Clinical Immunology and Serology: A laboratory Perspective"; F.A. Davis Co. Philadelphia, 3rd edition, 2009

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL I - BIO ENGINEERING

		Category: PEC				
U21BMP04	BIOSENSORS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM302 – Biomedical Sensors and Instrumentation

COURSE OBJECTIVES:

- To illustrate the basic principle of operation of biosensors
- To explore the basics of biosensor fabrication using different techniques
- To interpret the medical applications of various types of biosensors

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the basic principles and working of biosensors (Understand)

CO2: Classify the various types of transducers and their corresponding applications (Understand)

CO3: Illustrate the types of bio-molecules for immobilization (Understand)

CO4: Interpret the working principles of several of types of chemical biosensors (Understand)

CO5: Identify the applications of biosensors with respect to its types (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	-	1	-	-	-	-	-	-	1	2	-
CO2	3	1	1	-	1	-	-	-	-	-	-	1	2	-
CO3	3	-	1	-	1	-	-	-	-	-	-	1	2	-
CO4	3	-	1	-	1	-	-	-	-	-	-	1	2	-
CO5	3	1	1	-	1	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I INTRODUCTION TO BIOSENSORS 9

Biosensors – Advantages and limitations – Various components of biosensors – Biocatalysis-based biosensors – Bio affinity-based biosensors – Microorganisms-based biosensors – Biologically active material and analyte – Types of membranes used in biosensor constructions

UNIT II BIORECEPTORS AND BIOSENSOR SYSTEMS 9

Enzyme – Nucleic acid – Cell based systems – Biomimetic receptors – Immobilization of biomolecules – Biosensors for various applications – Medical diagnosis – Food analysis – Drug development – Environmental monitoring

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UNIT III OPTICAL BIOSENSORS 9

Principles of Optical biosensing – Immobilization of bio-recognition elements – Types of optical biosensor – Surface plasmon resonance – Advantages and disadvantages – Applications

UNIT IV CHEMICAL BIOSENSORS 9

Blood gas and pH sensors – Bio-analytical sensor – Enzymatic biosensors – pO2 and pCO2 sensor – Manufacturing techniques of biosensors

UNIT V APPLICATION AND USES OF BIOSENSORS 9

Biosensors in clinical chemistry – Medicine and health care – Biosensors for environmental monitoring – Application of enzymes in analysis – Design of enzyme electrodes and their application as biosensors in industry – Healthcare – Food and environment

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Ozkan, S.A., Uslu, B., & Sezgintürk, M.K, "Biosensors: Fundamentals, Emerging Technologies, and Applications", CRC Pres, 1st edition, 2022
2. S Sunder, "Textbook of Rehabilitation", Jaypee Brothers Medical Publishers Pvt. ltd., New Delhi, 4th edition, 2019

REFERENCES:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw – Hill, 3rd edition, 2014
2. Joseph D. Bronzino, "The Biomedical Engineering Handbook", Taylor and Francis, 3 Volume set, 3rd edition, 2006

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL I - BIO ENGINEERING

U21BMP05	TISSUE ENGINEERING	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM301 - Human Anatomy and Physiology

COURSE OBJECTIVES:

- To understand the fundamentals of tissue engineering and its objectives
- To infer different types of stem cells in regenerative medicine
- To explore various biological material properties in tissue engineering

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the components of tissue engineering (Understand)

CO2: Illustrate stem cell potential in regenerative medicine (Understand)

CO3: Understand the imaging technique used in tissue engineering (Understand)

CO4: Make use of concepts of biological materials in tissue engineering (Apply)

CO5: Apply tissue engineering in different biomedical applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	1	-	-	-	-	2	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	1	2	-	-	-	1	-	-	-	-	-	2	-
CO5	3	1	2	-	-	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

SYLLABUS:

UNIT I INTRODUCTION TO TISSUE ENGINEERING 9

Tissue exchange and tissue development – Objectives of tissue engineering – Cell cycle and differentiation – Cell adhesion – Cell migration – Cell aggregation and tissue equivalent

UNIT II STEM CELLS 9

Definition of stem cells – Types of stem cells – Differentiation – Dedifferentiation – Maturation, Proliferation – Pluripotency and Immortalization – Sources of stem cells – Hematopoietic – Fetal-cord blood – Placenta – Bone marrow – Primordial germ cells

UNIT III COMPONENTS OF TISSUE ENGINEERING 9

Cell and drug delivery systems – Transplantation – Implantation – Synthetic components – Nanotechnology in tissue engineering – Imaging methods: Fluorescent microscopy – Confocal microscopy

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UNIT IV BIOMATERIALS IN TISSUE ENGINEERING 9

Degradable and Non-degradable biomaterials – Extracellular matrix – Decellularization Polymers: synthetic and natural – Cell interaction with polymers – applications of polymers

UNIT V APPLICATION OF TISSUE ENGINEERING 9

Replacement Engineering – Artificial organs – Cartilage, Tendons – Ligaments – Regenerative engineering: Nerve regeneration – Cardiac tissue regeneration – Muscle regeneration

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Ulrich Meyer, Thomas Meyer, Jörg Handschel, Hans Peter Wiesmann, "Fundamentals of Tissue Engineering and Regenerative Medicine", Springer, 1st edition, 2009
2. W.Mark Saltzman, "Tissue Engineering – Engineering principles for design of replacement - organs and tissue" Oxford University Press Inc New York, 1st edition, 2000
3. CS Potten, "Stemcells", Elsevier publications, 1st edition, 1997

REFERENCES:

1. Gray E.Wnek, Gray L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc New York, 1st edition, 2004
2. R.Lanza,J. Gearhartet al (Eds),"Essential of Stem Cell Biology", Elsevier Academic press, 1st edition, 2006

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td>200</td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL I - BIO ENGINEERING

		Category: PEC				
U21BMP06	BIOPRINTING	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM303 – Biomaterials and Artificial Organs

COURSE OBJECTIVES:

- To infer the basic mechanisms of bioprinting
- To select the suitable bioink and biomaterials for bioprinting in medical applications
- To explain the various techniques used for bioprinting
- To utilize the concept of bioprinting in organ construction

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the insight of bioprinting and cell culture process (Understand)

CO2: Describe the properties and types of bioink system (Understand)

CO3: Illustrate the various 3D bioprinting techniques (Understand)

CO4: Summarize 4D bioprinting approach and apply regulatory policies (Understand)

CO5: Apply the bioprinting concept in organ constructing applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	1	-	-	-	-	-	-	-	-	-	3	-
CO2	2	-	1	-	-	-	-	-	-	-	-	-	3	-
CO3	2	-	1	-	1	-	-	-	-	-	-	-	3	-
CO4	2	1	1	1	1	1	1	1	-	-	-	-	3	-
CO5	2	1	2	-	1	-	-	1	-	-	-	-	3	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO BIOPRINTING 9

Bioprinting – Types of Bioprinting – Process parameters in designing – Biomaterials for bioprinting – Therapies for tissue substitute – Cell source – Processing of cells for bioprinting – Cell culture models

UNIT II BIOINKS 9

Bioinks – Ideal material properties for bioink – Printability and cellular response– Hydrogels – Crosslinking of hydrogels for bioink– Bioink system – Single-material– Multimaterial

UNIT III BIOPRINTING TECHNIQUES 9

Stereolithography – Fused deposition modeling – Inkjet printing – Process parameter – Extrusion Bioprinting – Types– Characteristics and advantages – Laser Assisted bioprinting –Types and its Characteristics

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UNIT IV 4D BIOPRINTING AND REGULATORY ISSUES 9

4D Bioprinting – Features and approaches – Deformation of materials – Cellular self-assembly – Computational modeling – Clinical safety and efficacy – Regulatory challenges in Bioprinting

UNIT V MEDICAL APPLICATIONS OF BIOPRINTING 9

Bioprinting of heart – Bioprinting of kidney – Bioprinting of liver – Bioprinting of lung

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Chee Kai Chua, "Bioprinting Principles and its applications", World Scientific Publishing, 1st edition, 2015
2. Zhang et al., "3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine", Academic Press, 1st edition, 2015

REFERENCES:

1. Atala et al., "Essentials of 3D Biofabrication and Translation", Academic Press, 1st edition, 2015
2. Yang Wu, Jerry fuh, Ibrahim Tarik Ozbolat, "3D Bioprinting in Tissue and Organ Regeneration", Academic Press, 1st edition, 2022
3. Yong He, Qing Gao and Yifei Jin, "Cell Assembly with 3D Bioprinting", John Wiley & Sons, 1st edition, 2022

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td></td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL I - BIO ENGINEERING

		Category: PEC				
U21BMP07	BIOPHOTONICS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21PH202 - Medical Physics

COURSE OBJECTIVES:

- To interpret the different optical signatures found in biological systems
- To evaluate modern biophotonic instrumentation
- To analyze the applications in the field of biophotonics

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Examine the biophotonics tools and light tissue interaction processes (Understand)

CO2: Evaluate the characteristics and concepts of light waves, polarization, quantization, photon energy interference and coherence (Apply)

CO3: Update the techniques of biopolymers, optical biopsy and molecule detection Understand)

CO4: Interpret various detectors for detecting the presence of ionizing radiation (Understand)

CO5: Identify the applications of biophotonics with biosensors (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	1	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	-	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

SYLLABUS:

UNIT I OVERVIEW OF BIOPHOTONICS 9

Nature of light – Biophotonics spectral windows – Light absorption – Macromolecules – Biological cells – Diverse applications

UNIT II PROPERTIES OF LIGHT AND BIOPHOTONICS LASER 9

Light wave characteristics – Polarization – Quantized photon energy and momentum – Reflection and refraction – Snell's law – Diffuse reflection – Laser action – Laser diode – Solid state laser – Gas laser – Optical fiber laser

UNIT III PHOTOBIOLOGY 9

Photo processes in biopolymers – Human eye and vision – Photosynthesis – In vivo photo excitation and spectroscopy – Optical biopsy – Single molecule detection

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UNIT IV LIGHT ACTIVATED THERAPY 9

Photodynamic therapy (PDT) – Basic principles – Photo sensitizers for PDT – Mechanism of photodynamic action – Light irradiation of PDT – Two-photon PDT – Applications

UNIT V BIOSENSORS AND TECHNOLOGY APPLICATIONS OF BIOPHOTONICS 9

Optical Sensor – Optical fiber movements – Microbending fiber sensor – Interferometric sensor – Mach Zehnder – Michelson – Sagnac interferometers – Optical manipulation – Miniaturized analyses tools – Microscope in a needle – Neurophotonics – Single nanoparticle detection

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Paras N. Prasad, "Introduction to Biophotonics", 1st edition, A John Willey & Sons p ublications, 1st edition, 2003
2. Gerd Keiser," Biophotonics - concepts to applications", 2nd edition, Springer Publication, 1st edition, 2016

REFERENCES:

1. Vasa.P, Mathur.D, "Ultrafast Biophotonics", Springer International Publishing, 1st edition, 2016
2. Tuan Vo-Dinh, "Biomedical Photonics – Handbook", 1st edition, CRC Press, 1st edition, 2014
3. Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 1st edition, 2007
4. David Baxter.G, "Therapeutic Lasers – Theory and Practice", Churchill Livingstone, Publications, 1st edition , 2001

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL I - BIO ENGINEERING

U21BMP08	ETHICAL ISSUES & INTELLECTUAL PROPERTY RIGHTS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the ethical issues involved in doing research using animals and human
- To explore the ethical conduct in credit sharing, social and environmental responsibility
- To interpret the patenting systems in India and abroad

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the fundamentals of Engineering Ethics (Understand)

CO2: Identify the ethical issues in research with animals and human (Understand)

CO3: Summarize the features of credit sharing and issues related to society and environment (Understand)

CO4: Exemplify the importance of Intellectual Property Rights (Understand)

CO5: Explain the process of patenting in India and aboard (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	1	-	1	-	-	-	1	1	-
CO2	1	-	-	-	-	1	-	1	-	-	-	1	1	-
CO3	1	-	-	-	-	1	1	1	-	-	-	1	1	-
CO4	1	-	-	-	-	1	-	1	-	-	-	1	1	-
CO5	1	-	-	-	-	1	-	1	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I ENGINEERING ETHICS 9

Definition – Societies for engineers – Code of Ethics – Ethical Issues involved in cross border research – Ethical and Unethical practices – Case studies – Situational decision making

UNIT II ETHICAL ISSUES IN RESEARCH WITH ANIMALS AND HUMAN 9

Ethical considerations – Conducting research with animal subjects – Guidelines for the use of animal subjects – Guidelines for the collection and use of blood, tissue and other samples from human – Obtaining consent for collection – Transparency in handling the samples – Use of human subjects in research – Clinical trials – Voluntariness – Competence

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UNIT III CREDIT SHARING, SOCIETY AND ENVIRONMENT 9

Responsibilities and sharing of authorship in publishing – Patenting research – Integrity and quality of the data – Ethical conduct in the labs – Ethical issues related to the society and environment

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9

Objectives of the patent system – Patentable inventions in India and abroad – Geographical indications and sui generis systems – Implications of TRIP – GATT agreements

UNIT V PATENTING 9

Salient features of patent law in India – The process of patenting in India and abroad – Process of challenging and protecting patents – Opportunities challenges for biogenetics – Patent infringement

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Charles B. Fleddermann, "Engineering Ethics", 4th edition, Prentice Hall, 2012
2. Emanuel E J, et al, "Ethical and Regulatory Aspects of Clinical Research", 1st edition, Johns Hopkins University Press, 2003

REFERENCES:

1. Nikolaus Thumm, "Intellectual Property Rights", 1st edition, Springer – Verlag, 2000

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL II – MEDICAL DEVICE DEVELOPMENT AND MANAGEMENT

		Category: PEC				
U21BMP09	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To acquire knowledge on global trend, development methodologies of products and services
- To conceptualize innovative ideas, customer requirement and establishing target specifications
- To understand Return on Investment, Minimum Viable Product and Project Management

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain product development, planning and management (Understand)

CO2: Interpret development process, product design architecture (Understand)

CO3: Demonstrate the concept of proto typing and product specification (Understand)

CO4: Illustrate Minimum viable product and market fit (Apply)

CO5: Use the Design Process and Ideas to Action Project (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	1	1	1
CO2	2	-	-	-	-	-	-	-	-	-	-	1	1	1
CO3	2	-	-	-	-	-	-	-	-	-	-	1	1	1
CO4	2	1	1	-	-	-	-	-	-	-	-	1	1	1
CO5	2	1	1	-	-	-	-	-	-	-	-	1	1	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)							

SYLLABUS:

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Global trends analysis and product decision – Social, technical, economic and 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

UNIT II DEVELOPING INNOVATIVE IDEAS FOR PRODUCT LEADERS 9

Introduction to creative design, prototyping and testing – Development processes and organizations – Concept selection and product specification – Product design and architecture – Industrial design needs and considerations – Design of manufacturing process

UNIT III PRODUCT MANAGEMENT ESSENTIALS 9

The customer needs process – Aids for product development and prototypes – Concept generation: the five step method – Establishing target specifications – Setting the final specifications – Design for the environment and manufacturing process

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UNIT IV ESTABLISHING PRODUCT-MARKET FIT 9

Establishing product – Market fit – Specifying feature set – Understanding return on investment – Deciding on Minimum Viable Product (MVP) – Creating prototype – Marketing versus product tests – Quantitative tests versus qualitative tests – Fidelity for prototypes – Testing MVP with customers – Improving product-market fit

UNIT V CREATIVE DESIGN, PROTOTYPING, AND TESTING 9

Specialization in product ideation, design and management – Wire framing and proto type modeling – Product architecture – Choosing wire framing and prototyping tools – Open source – Robust design – Robust design process – Ideas to action project – Project management – Project planning and execution

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Book specially prepared by NASSCOM as per the MOU.
2. https://www.coursera.org/specializations/product-ideation-design-and-management
3. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, 5th edition, 2011
4. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, 11th edition, 2005

REFERENCES:

1. Hiriyappa B, "Corporate Strategy – Managing the Business", Author House, 1st edition, 2013
2. Peter F Drucker, "People and Performance", Butterworth – Heinemann [Elsevier], Oxford, 1st edition, 2004
3. Vinod Kumar Garg and Venkita Krishnan N K, "Enterprise Resource Planning -Concepts", 2nd edition, Prentice Hall, 2003
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, 7th edition, 2013

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="3">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>*Individual Assignment / Case Study / Seminar / Project / MCQ</th><th>Written Test</th><th>*Individual Assignment / Case Study / Seminar / Project / MCQ</th><th>Written Test</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL II – MEDICAL DEVICE DEVELOPMENT AND MANAGEMENT

		Category: PEC				
U21BMP10	MEDICAL DEVICE DESIGN	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To illustrate the basic steps of designing a medical device
- To explore the different techniques in design process
- To interpret the challenges in post market surveillance

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Infer the basic procedure of medical device design (Understand)

CO2: Classify the various stages of design process (Understand)

CO3: Illustrate ideas and concepts in device designing (Understand)

CO4: Interpret the process for validation and verification of medical devices (Understand)

CO5: Identify the challenges after post market survey of the product (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	2	2	-	-	-	-	1	-	2	-	-	-	-
CO3	3	2	2	-	-	-	-	1	2	2	-	-	-	-
CO4	3	1	2	-	-	-	-	-	2	2	-	-	-	-
CO5	2	1	2	-	-	-	-	-	-	2	1	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO MEDICAL DEVICES 9

Medical Devices - Design Life Cycle – Medial design classification – Rules and Models – EU Classification – USA Classification – case study on classification

UNIT II DESIGN PROCESS 9

Design Process versus Design Control – Design Models – Pahl and Beitz, and Pugh model – Divergent – Convergent Model – Audit /Review Procedure – Design Process – Product Design Specification – Finding, Extracting, and Analyzing the Content

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UNIT III IDEAS AND CONCEPTS 9

Creative Space – Generating Concepts/Ideas – Selecting Concepts and Ideas – Quality in design – Design of Experiments/2k Factorial Experiments – Failure Mode and Effect Analysis – Computer–Aided Design – D4X – Design for Usability

UNIT IV EVALUATION AND SUPPLY CHAIN 9

Evaluation – Risk Analysis – Criteria-Based Evaluation – Computer–Based Evaluation – Clinical Studies and Clinical Trials – Identifying Potential Suppliers – Packaging – Procurement – Labelling and Marking

UNIT V POST MARKET SURVEILLANCE 9

PMS and Its Role in Design – Protecting Your IP – Types – Regulatory Approval to Market – Class I Devices – FDA Process – EC process – Unique Selling Points – Key Opinion Leaders – Insurance

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods
Total: 45 Periods

TEXT BOOKS:

1. Peter J. Ogrodnik, "Medical Device Design", Academic press, Elsevier, 2 nd edition, 2020.
2. DeMarco, Carl T., "Medical Device Design and Regulation", American Society for Quality ASQ), 1st edition, 2011.

REFERENCES:

1. J. Paulo Davim, "The design and manufacture of medical devices", Woodhead Publishing, 1st edition, 2012
2. Richard C.Fries,"Handbook of Medical Device Design" , CRC Press,1st edition, 2000
3. Vikki Hazelwood, "Foundations and Strategies for Medical Device Design", McGrawhill, 1st edition, 2021

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

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VERTICAL II – MEDICAL DEVICE DEVELOPMENT AND MANAGEMENT

		Category: PEC				
U21BMP11	QUALITY MANAGEMENT AND ACCREDITATION IN HEALTHCARE	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the importance of quality and safety in healthcare sector
- To interpret the data collection, processing and analysis
- To explore the accreditation bodies and their roles

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the evolution of quality management (Understand)

CO2: Describe the fundamentals of healthcare quality management (Understand)

CO3: Explore the various medical device regulatory bodies and certifications (Understand)

CO4: Demonstrate the different certifications proposed for purposes of medical device testing (Understand)

CO5: Discuss appropriate assessment method to maintain quality healthcare (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	-	-	1	1	-	-	-	-	-	-	-
CO2	2	-	-	-	-	1	1	-	-	-	-	-	-	-
CO3	2	-	-	-	-	1	1	-	-	-	-	-	-	-
CO4	2	-	-	1	-	1	1	1	-	-	-	-	-	-
CO5	2	2	-	1	-	1	1	-	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I EVOLUTION OF QUALITY MOVEMENT 9

Quality assurance – total quality management – continuous quality improvement – Theories and principle of Quality Assurance: Principles – Juran – Triology – Kaizen – Philip Crosby's principle – Need and Benefits for quality management in healthcare – Quality Management Programme – ISO clauses – quality manual – quality of clinical services – Critical Pathways

UNIT II HEALTHCARE QUALITY MANAGEMENT 9

Quality – Healthcare Quality – Quality Management Activities – Quality Management in Industry and Healthcare – External Forces Impacting Healthcare Quality Management – Measuring Performance – Measurement in Quality Management – Characteristics – Categories – Selecting Performance Measures – Constructing Measures – Measures of Clinical Decision Making – Evaluating Performance – Display and Trend formats

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UNIT III BENCH MARKING OF QUALITY STANDARD 9

FDA regulations – Accreditation for hospitals – JCI – NABH and NABL – BIS – ACHS – Security & Safety of Hospital – Property – Staff & Patients – Radiation safety – Safety precautions – hazardous effects of radiation – allowed levels of radiation – ICRP regulations for radiation safety – Disposal of Biological waste

UNIT IV MEDICAL DEVICE EVALUATIONS 9

Functional Safety in Medical Industry – Ultrasound Testing – Electromagnetic Compatibility Testing – Sterilization Practices Control and Validation for Medical Devices – Biological – Physical and Chemical Testing for Medical Devices – Environmental Testing – Cyber security Testing and Assessment Services

UNIT V ASSESSING QUALITY HEALTHCARE 9

Patient Safety Organization-Governmental & Independent – Measuring Quality care – Evaluation of hospital services – Six sigma way – Quality Assurance in Hospitals SOP's – Patient Orientation for Total Patient Satisfaction – 5S techniques

Contact Periods:

Lecture: 45 Periods	Tutorial: – Periods	Practical: – Periods	Project:	– Periods
			Total:	45 Periods

TEXT BOOKS:

1. Karen Parsley, Karen Parsley and Philomena Corrigan, Quality improvement in Healthcare, Nelson Thrones Pub, 2nd edition, 2002
2. Patric Espath, Introduction to Healthcare Quality Management, AUPHA Press, 1st edition, 2000

REFERENCES:

1. B.M.Sakharkar, Principles of Hospital administration and Planning, Jaypee Brothers, Medical Publishers (P) Ltd, 2nd edition, 2009
2. Joseph F Dyro , "Clinical Engineering Handbook", Elsevier Publishers, 1st edition, 2004
3. Cesar A. Cacere and Albert Zana, "The Practice of Clinical Engineering", Academic press, New York, 1st edition, 1977
4. Webster J.G and Albert M. Cook, Clinical Engineering, Principles & Practices, Prentic Hall Inc., Englewood Cliffs, New Jersy, 1st edition, 1979

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)			
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	Total Internal Assessments	End Semester Examinations
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL II – MEDICAL DEVICE DEVELOPMENT AND MANAGEMENT

		Category: PEC				
U21BMP12	PATIENT SAFETY, STANDARDS AND ETHICS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To familiarize with the patient safety cultures, standards for laboratories and radiation areas
- To understand the purpose of quality assurance in healthcare
- To identify the patient and provider rights and legal issues in biomedical care

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the patient safety as an organizational function (Understand)

CO2: Apply the various standards related with electrical and clinical laboratories (Apply)

CO3: Identify the importance of patient safety against radiation hazards (Apply)

CO4: Explain the quality control and assurance activities to be followed in hospitals (Understand)

CO5: Outline the ethical issues related to hospital administration and realize the responsibilities and rights of both patient and provider (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	1	-	1	-	-	-	-	1	-
CO2	2	-	-	-	-	1	-	1	-	-	-	-	1	-
CO3	2	-	-	-	-	1	1	1	-	-	-	-	1	-
CO4	1	-	-	-	-	1	1	1	-	-	-	-	-	-
CO5	1	-	-	-	-	1	-	1	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I PATIENT SAFETY: AN ORGANIZATIONAL FUNCTION 9

Aspects of patient safety – Safety Cultures – Patient Roles in Patient Safety – Healthcare associated Infections – Risk factors for Adverse drug events – Rapid Response Systems – Patient Restraints

UNIT II ELECTRICAL HAZARDS AND LABORATORY SAFETY 9

Review of Electrical concepts – Electrical Hazards – Electrical related Standards – Standards for Clinical Laboratories – Standard Operating Procedures – Hazardous Waste Disposal – Biological Safety Cabinets – Safety Personnel Responsibilities

UNIT III RADIATION AREA SAFETY 9

OSHA Ionizing Radiation Standards – Surveys and Monitoring – Caution Signs – Storage and Handling Procedures – Radiation Safety Committee – Radioactive Waste Management – Wireless Medical Telemetry – Safety Recommendations for nonionizing radiation in Healthcare Facilities

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UNIT IV QUALITY ASSURANCE THROUGH CLINICAL AUDIT 9

Purpose of Quality Assurance – Clinical audit – Establishing Criteria for Diagnosis, Investigations and Treatment – Quality Assurance Committee (QAC) – Comprehensive Quality Assurances System (CQAS) – Total Quality Management (TQM) in Health Care

UNIT V ETHICAL AND LEGAL ASPECTS OF HOSPITAL ADMINISTRATION 9

General Acts/Legislations – Medical/Professional Acts – Law of Torts – Consumer Protection Act (CPA) – Hospital's Responsibilities – Professional Negligence – Medical Indemnity Insurance against Malpractice suits

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Sakharkar BM, "Principles of Hospital administration and Planning", JAYPEE Brothers, Medical Publishers (P) Ltd., 2nd edition, 2009
2. James T. Tweedy, "Healthcare Hazard Control and Safety Management", CRC Press, 3rd edition, 2014

REFERENCES:

1. Sharon Myers "Patient Safety & Hospital Accreditation - A Model for Ensuring Success", Springer Publishers, 1st edition, 2012
2. Donaldson, Liam, Walter Ricciardi, Susan Sheridan, and Riccardo Tartaglia. "Textbook of patient safety and clinical risk management", Springer Nature, 1st edition, 2021
3. Vincent, Charles, "Patient safety", John Wiley & Sons, 1st edition, 2011
4. Ramakrishna, Seeram, Lingling Tian, Charlene Wang, Susan Liao, and Wee Eong Teo. "Medical devices: regulations, standards and practices", Woodhead Publishing, 1st edition, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**			
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	**Total Internal Assessments**	**End Semester Examinations**
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL II – MEDICAL DEVICE DEVELOPMENT AND MANAGEMENT

		Category: PEC				
U21BMP13	MEDICAL DEVICE REGULATIONS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the regulations for medical devices
- To explore the assessment methods adopted for the quality sustenance in hospitals
- To identify the various regulatory standards and certifications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the international regulatory framework of medical device (Understand)

CO2: Describe the quality management system and risk management (Understand)

CO3: Discuss the technical documentations involved in regulatory process (Understand)

CO4: Explore premarket phase of medical device regulatory process (Understand)

CO5: Outline the post market phase and various regulatory standards and certifications (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO4	2	1	-	-	-	1	1	-	-	-	-	-	1	-
CO5	2	1	-	-	-	1	1	-	-	-	-	-	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I OVERVIEW OF THE INTERNATIONAL REGULATORY FRAMEWORK FOR MEDICAL DEVICES 9

Established and emerging markets – Credibility and authority of approvals – Medical device life cycle – Definitions of medical devices – Active implantables and in vitro diagnostics – Borderline products – Combination products – EU – US – Australian – Canadian – Japanese regulations for combination products – Risk-based Classification – Classification philosophies

UNIT II QUALITY MANAGEMENT SYSTEM AND RISK MANAGEMENT 9

General principles and the use of standards – Standards organizations – Standards applicable to medical devices – Software and firmware – Software regulations – RF wireless devices –

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Cybersecurity – Hazardous substances contained in electronic devices – Medicines and biologics – Tissues of animal origin susceptible to TSE – Phthalates – Allergens

UNIT III TECHNICAL DOCUMENTATION 9

Documentation mandated by EU – US – Australian – Canadian – Japanese – GHTF summary technical documentation – Example of STED-Aligned DHF – Manufacturing information – Verification and validation – Clinical evaluation – Regulated product submission – Regulatory submissions repository – Case study: The Scattered DHF

UNIT IV PRE-MARKET PHASE 9

Design controls – Information management during the Pre-Market phase – D and D planning stage – D and D process stage – Product identification and traceability – Case study – Regulatory submissions – Approvals and registrations

UNIT V POST-MARKET PHASE 9

Product launch – Continued regulatory compliance – Change management – Post-Market surveillance – Regulatory systems and processes – Case study: Square peg in a round hole note on ISO 13485 – ISO 15378 - ISO 14971 – ISO 10993 – IEC 60601

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Almir Badnjević, "Inspection of Medical Devices: For Regulatory Purposes", Springer, 1st edition, 2018
2. Val Theiz, "Medical Device regulatory practices: An international Perspective", Pan Stanford, 1st edition, 2015

REFERENCES:

1. Jack Wong, "Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products" Jenny Stanford Publishing; 3rd edition, 2022
2. Jack Wong, Handbook of Medical Device Regulatory Affairs in Asia: Second edition, Jenny Stanford Publishing; 2nd edition, 2018

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="3">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
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VERTICAL II – MEDICAL DEVICE DEVELOPMENT AND MANAGEMENT

		Category: PEC				
		L	T	P	J	C
U21BMP14	HEALTHCARE DATA ANALYTICS	3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To familiarize with the basics of data mining techniques
- To understand predictive and time series models
- To explore technologies and tools in healthcare application

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Understand the basic functionalities of Data Mining Techniques (Understand)

CO2: Understand data mining in predictive modelling (Understand)

CO3: Discuss big data analytics and time series analytics (Understand)

CO4: Explore the technologies and tools for data analytics (Understand)

CO5: Apply the concepts of data mining in healthcare applications (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	1	-	-	-	-	-	-	-	-	1
CO2	2	-	-	-	1	-	-	-	-	-	-	-	-	1
CO3	2	-	-	-	1	-	-	-	-	-	-	-	-	1
CO4	2	-	-	-	1	-	-	-	-	-	-	-	-	1
CO5	2	-	1	-	1	-	-	-	-	-	-	-	-	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I DATA MINING 9

Relation To statistics – databases – data Mining functionalities – steps in data mining process – architecture of typical data mining systems – classification of data mining systems – overview of data mining techniques

UNIT II PREDICTIVE MODELING 9

Mining association rules in large databases – classification and prediction: Issues regarding classification and prediction – classification by decision tree induction – Bayesian classification – other classification methods – prediction – clusters analysis: types of data In cluster analysis – categorization of major clustering methods

UNIT III OVERVIEW OF BIG DATA ANALYTICS 9

Introduction to big data – big data analytics applications – Time series analysis – Introduction to map Reduce / hadoop

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UNIT IV TECHNOLOGIES AND TOOLS FOR DATA ANALYTICS 9

Data visualization techniques using R Tool: Histograms – Box plots – Scatter plots – Time series – spatial Data – spark – Introduction to exploratory data mining – association Rule mining – clustering and classification techniques using WEKA Tool

UNIT V DATA ANALYTICS APPLICATIONS IN HEALTHCARE 9

Clinical prediction models – Temporal pattern mining methods – Visual analytics – Data analytics to pervasive healthcare – Fraud detection – Drug discovery along with systems for medical imaging and decision support

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Jiawei Han, Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, 1st edition, 2011
2. Chandan K. Reddy, Charu C. Aggarwal, "Healthcare Data Analytics", Chapman and Hall/CRC Data Mining and Knowledge Discovery Series 1st edition, 2020
3. Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk from the Frontline", O'Reilly, 1st edition, 2014

REFERENCES:

1. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 1st edition, 2011
2. Tom White, "Hadoop: The Definitive Guide", OReilly Media, 4th edition, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL II – MEDICAL DEVICE DEVELOPMENT AND MANAGEMENT

		Category: PEC				
U21BMP15	MEDICAL WASTE MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the hazardous materials used in hospital and its impact on health
- To familiarize with various waste disposal procedures and management
- To interpret the regulations and safety norms to be followed in medical waste management

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify different types of wastes generated from hospitals (Understand)

CO2: Understand the basic steps to be followed while segregating wastes (Understand)

CO3: Summarize various treatment techniques for medical wastes (Understand)

CO4: Illustrate and manage different types of hazardous medical wastes methods (Understand)

CO5: Outline various regulations and safety norms (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	1	1	1	-	-	-	1	1	-
CO2	2	-	-	-	-	1	1	1	-	-	-	1	1	-
CO3	2	-	-	-	-	1	1	1	-	-	-	1	1	-
CO4	2	-	-	-	-	1	1	1	-	-	-	1	1	-
CO5	1	-	-	-	-	1	1	1	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I INTRODUCTION TO MEDICAL WASTE 9

General and Hazardous health care waste, Infectious waste, Genotoxic waste, Waste sharps – Colour coding – Sources of health care wastes – bio hazard symbols

UNIT II HANDLING MEDICAL WASTE MANAGEMENT 9

Basic steps in segregation – Sharp decontaminating – Disinfections container for autoclaving – Sharp waste containers for storage and transportation – Shredding – Incrimination – Hydropulbing – Plasma tonch

UNIT III CONVENTIONAL TREATMENT TECHNOLOGIES 9

Wet thermal technology – Incineration – Microwave technology – Rotaclave system – Hydro clave system – Electro Thermal Reactivation (ETP) Treatment Process – Electron beam technology – Plasma pyrolysis

UNIT IV HAZARDOUS WASTES TREATMENT 9

Hazardous substance safety – OSHA hazard communication standard – DOT hazardous material

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regulations – Medical gas systems – Respiratory protection

UNIT V LEGISLATION AND POLICIES ON MEDICAL WASTE MANAGEMENT 9

Biomedical waste management and handling rules, 1998 and its amendment – Safe disposal of radioactive waste rules, 1995 guideline of BARC – CPCB guidelines

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Tweedy, James T., "Healthcare hazard control and safety management", CRC Press Taylor and Francis, 1st edition, 2014
2. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd, 1st edition, 2012

REFERENCES:

1. Safe disposal of Radioactive waste Rules, 1995 guideline of BARC
2. R.C.Goyal, "Hospital Administration and Human Resource Management II", PHI publications, 4th edition, 2006

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
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<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
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VERTICAL II – MEDICAL DEVICE DEVELOPMENT AND MANAGEMENT

		Category: PEC				
		L	T	P	J	C
U21BMP16	TESTING AND CALIBRATION	3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To provide an understanding of the regulatory requirements and ethical considerations in conducting usability testing for medical devices
- To obtain knowledge and skills necessary to plan, conduct, analyze, and report the results of usability tests for medical devices
- To understand the principles and practices of calibration of medical devices

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Design a usability testing plan for a medical device that meets regulatory requirements and ethical considerations (Understand)

CO2: Demonstrate a usability test for a medical device, collect and analyze data, and report the results effectively (Apply)

CO3: Make use of the results of a usability test to improve the design of a medical device and contribute to the overall safety and efficacy of medical devices (Apply)

CO4: Outline the regulatory requirements and guidelines for calibration of medical devices (Understand)

CO5: Apply advanced calibration techniques for specific medical devices (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	1	-	-	-	-	-	1	1	-
CO2	3	2	-	1	-	1	-	1	-	-	-	1	1	-
CO3	3	2	-	1	-	1	-	1	-	-	-	1	1	-
CO4	3	2	-	-	-	1	-	1	-	-	-	1	1	-
CO5	3	2	-	-	-	1	-	1	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

SYLLABUS:

UNIT I INTRODUCTION TO USABILITY TESTING OF MEDICAL DEVICES 9

Introduction – Testing – Regulatory requirements – Types – User groups – Ethical considerations– Planning – Setting up a usability test environment – Recruiting participants – Conducting a successful usability test for medical devices

UNIT II CONDUCTING USABILITY TESTING OF MEDICAL DEVICES 9

Preparing usability test materials for medical devices – Conducting usability tests – Collecting and analyzing data – Quantitative and qualitative methods for analyzing usability data – Reporting usability test results – Techniques to improve medical device design – Iterative usability testing – Usability testing in post-market surveillance

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UNIT III ADVANCED TOPICS IN USABILITY TESTING OF MEDICAL DEVICES 9

Human factors engineering – Risk management – Usability testing for combination products and connected health – Medical software and mobile medical applications – Home use medical devices – labelling – Global considerations – Future trends in medical device usability testing

UNIT IV INTRODUCTION TO CALIBRATION OF MEDICAL DEVICES 9

Calibration and its importance – Regulatory requirements and guidelines – Types of medical devices and their calibration requirements – Calibration methods and procedures – Traceability and uncertainty in calibration – Calibration documentation and record keeping – selection and qualification of calibration service providers – Evaluation and validation of calibration results – Common calibration errors and their prevention

UNIT V CALIBRATION OF CRITICAL DEVICES 9

Calibration of diagnostic imaging equipment – Electromedical equipment laboratory equipment – Surgical instruments – Patient monitoring devices – Rehabilitation and physiotherapy equipment – Infusion pumps and syringe drivers – Blood glucose meters and hematology analyzers – Point-of-care testing devices

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Period

Total: 45 Period

TEXT BOOKS:

1. Michael E. Wiklund, Jonathan Kendler, and Allison Y. Strochlic, "Usability Testing of Medical Devices" , 1st edition, CRC Press, 2010
2. "Specific Criteria for Calibration of Medical Devices", NABL 126, NABL, 01/06/2021

REFERENCES:

1. Wiklund, Michael E., and Andrea Dwyer. "Medical Device Use Error: Root Cause Analysis." 1st edition, CRC Press, 1st edition, 2014
2. McLeod, CC, and M Schneider. "Human Factors Methods for Improving Performance in the Process Industries", 1st edition, Wiley, 2007
3. Richard Aston, "Principles of Biomedical Instrumentation and Measurement" , 1st edition, Pearson Education, 1st edition, 2012

EVALUATION PATTERN:

<table>
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<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
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VERTICAL III - MECHANICS

U21BMP17	SPORTS BIOMECHANICS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM603 - Biomechanics

COURSE OBJECTIVES:

- To illustrate the applications of biomechanical studies in sports mechanics
- To summarize the fundamental concepts of sports biomechanics
- To analyze qualitative and quantitative analysis of human movements

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Apply the basic concepts of sports biomechanics (Apply)

CO2: Illustrate significant qualitative analysis of human movements (Understand)

CO3: Delineate the significant quantitative analysis of human movements (Understand)

CO4: Outline the characteristics of sports performance (Understand)

CO5: Examine the applications of biomechanical studies in sports (Analyze)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	1	-	-	-	-	-	-	-	-	-	1	2	-
CO3	3	1	-	-	-	-	-	-	-	-	-	1	2	-
CO4	3	2	1	-	1	-	-	-	-	-	-	1	2	1
CO5	3	2	2	1	1	-	-	1	-	-	-	1	2	1
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I INTRODUCTION 9

Essence of sports biomechanics – Kinetics and kinematics of human movements – Movement patterns – Comparison of qualitative and quantitative movement – Muscle and ligament property – Factors affecting properties of biological tissue

UNIT II QUALITATIVE ANALYSIS OF MOVEMENTS 9

Fundamentals of movement – Linear motion and the centre of mass – Linear motion and the center of mass – Coordination of joint rotations – Qualitative analysis preparation stage – Observation stage – Evaluation and diagnosis stage – Intervention stage

UNIT III QUANTITATIVE ANALYSIS OF MOVEMENT 9

Introduction – Movement recording using videography – Experimental procedures – Data processing – Projectile motion – Rotation in three-dimensional space - Understand injury development – Geometry of motion

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UNIT IV IMPROVEMENT OF SPORTS PERFORMANCE 9

Principles of coordinated movement – Structural analysis of movement – Biomechanical principles of coordinated movement – Temporal and phase analysis – Kinesiological analysis of sports movements – limitations of kinesiological analysis

UNIT V APPLICATIONS 9

Qualitative analysis – Batting – Catching – Kicking – Throwing technique – Dribbling technique – Squat – Drop jump – Injury risk

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Roger Bartlett, "Introduction to sports biomechanics", 3rd edition, Routledge, 2021
2. Duane Knudson, "Fundamentals of Biomechanics", 2nd edition, Springer, 2007

REFERENCES:

1. Roger Bartlett & Melanie Bussey, "Sports Biomechanics: Reducing Injury Risk and Improving Sports Performance", Routledge, 2012
2. Susan J Hall, "Basic Biomechanics", 7th edition, McGraw Hill, 2015

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL III - MECHANICS

		Category: PEC				
U21BMP18	BIOFLUIDS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the basics of fluid mechanics
- To analyze cellular, ocular, cardiovascular and respiratory fluid mechanics
- To learn mathematical modelling of fluid biological systems

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Identify the properties and behavior of biological fluids (Understand)

CO2: Explain the mechanics and mechanical interactions of cellular structures (Understand)

CO3: Understand the rheology of blood components (Understand)

CO4: Summarize the influence of biofluids in the cardio respiratory mechanism (Understand)

CO5: Interpret the numerical methods to solve fluid flow problems (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	1	2	-
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CO3	3	-	-	-	-	-	-	-	-	-	-	1	2	-
CO4	3	-	-	-	-	-	-	-	-	-	-	1	2	-
CO5	3	-	-	-	1	-	-	-	-	-	-	1	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I BIOFLUID MECHANICS 9

Intrinsic fluid properties – Pressure-flow relationship for Non-Newtonian Fluids – Fluid mechanics in straight tube – Structure of blood vessels – Material properties and modelling of Blood vessels

UNIT II CELLULAR MECHANICS 9

Cellular Biomechanics – Eukaryotic cell architecture, Cytoskeleton, Cell-matrix interactions — Mechanical property measurement – Optical Trapping – Magnetic bead microrheometry – Micropipette aspiration

UNIT III BLOOD RHEOLOGY AND BLOOD VESSEL MECHANICS 9

Rheological characteristics of blood – Viscosity of blood – Biomechanics of red cell membrane – Apparent and relative viscosity – Blood viscosity variation – Rheology of Blood In Micro vessels – Fahraeus-Lindquist effect and its inversion – Arterial wall as membrane – Uniaxial and Biaxial loading

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UNIT IV CARDIO RESPIRATORY MECHANICS 9

Heart – Cardiac muscle characterization – Native heart valves – Prosthetic heart valve fluid dynamics – Cardiac cycle – Pressure volume diagrams – Changes in contractility – Ventricular performance – Congestive heart failure

UNIT V COMPUTATIONAL FLUID DYNAMICS 9

Computational fluid dynamics (CFD) Code – Problem solving with CFD – Conservation Laws of Fluid Motion and boundary conditions – Turbulence and its model – Finite volume method for diffusion problems – Convection-Diffusion problems

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Krishnan B. Chandran, Ajit P. Yoganathan, Stanley E. Rittgers, "Biofluid Mechanics - The human circulation ll", CRC Taylor and Francis, 1st edition, 2007
2. Y.C Fung, "Biomechanics - Mechanical properties of living tissues ll", Springer Verlag, 2nd edition, 1993

REFERENCES:

1. Jung HeeSeo, Vijay Vedula, Theodore Abraham and Rajat Mittal, "Multiphysics computational models for cardiac flow and virtual cardiography ll", Int. J. Numer. Meth. Biomed. Engng,. Published online in Wiley Online Library, 2013
2. Lee Waite, Jerry Fine, "Applied Biofluid Mechanics ll", McGraw Hill, 1st edition, 2007
3. John K-J Li, "Dynamics of Vascular System ll", World Scientific, 1st edition, 2004

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL III - MECHANICS

		Category: PEC				
U21BMP19	PHYSIOLOGICAL MODELLING	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM503 - Biocontrol Systems

COURSE OBJECTIVES:

- To gain knowledge on system modeling in physiology
- To explore the different models of physiological systems
- To explain the application of Physiological models

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Infer the basics for the modeling of physiological systems (Understand)

CO2: Construct the linear physiological models (Apply)

CO3: Identify the various distributed modeling systems (Apply)

CO4: Develop the nonlinear models of physiological systems (Apply)

CO5: Model the time-varying and stochastic physiological systems (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO4	3	2	-	-	-	-	-	-	-	-	-	1	-	1
CO5	3	2	-	-	-	-	-	-	-	-	-	1	-	1
Correlation levels:		1: Slight (Low)		2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I INTRODUCTION 9

Purpose of system modeling – Modeling process: Model formulation, Model identification, Model validation, Model simulation – Control in physiological systems: Enzymes, Hormones

UNIT II LINEAR MODELING 9

Windkessel circulatory model – Model for elimination of a drug from the bloodstream – Gas exchange model – Model of swinging limb – Glucose regulatory system

UNIT III DISTRIBUTED MODELING 9

Blood tissue exchange: The single-capillary model, capillary interstitial fluid model – Model for estimation of hepatic transport – Renal medulla: Formulation for the tubular structures – Interstitial compartment

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UNIT IV NONLINEAR MODELING 9

Action potential model – Enzyme dynamics – Baroreceptors – Insulin receptor regulation – Thyroid hormone regulation – Modeling the chemical control of breathing

UNIT V TIME-VARYING AND STOCHASTIC MODELING 9

Cardiac modeling – Cellular modeling: conceptual model, mathematical model – Insulin secretion – Metabolic Endocrine System – Markov model

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Cobelli, Claudio, and Ewart Carson, "Introduction to modeling in physiology and medicine", Academic Press, 2019
2. Michael C.K. Khoo, "Physiological control systems: analysis, simulation, and estimation", 2nd edition John Wiley & Sons, 2018

REFERENCES:

1. Michael Chappell, Stephen Payne, "Physiology for Engineers: Applying Engineering Methods to Physiological Systems", Springer, 2016
2. Marmarelis, "Nonlinear Dynamic Modelling of Physiological Systems", Wiley-IEEE Press, 2004
3. Suresh R. Devasahayam, "Signals and Systems in Biomedical Engineering: Physiological Systems Modeling and Signal Processing", 3rd edition Springer, 2019
4. John Enderle, Susan Blanchard, Joseph Bronzino, "Introduction to Biomedical Engineering", 2nd edition, Academic Press, 2005

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
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				100	

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VERTICAL III - MECHANICS

		Category: PEC				
U21BMP20	ASSISTIVE TECHNOLOGY	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM302 - Biomedical Sensors and Instrumentation

COURSE OBJECTIVES:

- To make the students aware of the available assistive technology to improve the quality of life of disabled persons
- To know the challenges in design and implementation of these assistive products
- To engage the students in creating simple applications using the available technology

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Analyze the use of CAT models in different applications and comprehend the need of the model in design of assist devices (Understand)

CO2: Depict the design of available speech, text and Braille conversion applications (Apply)

CO3: Examine various cases and understand the pros and cons of implementing OCR and DAISY technology (Apply)

CO4: Develop a simple module for implementing assist technology for daily living with their expertise (Apply)

CO5: Identify the role of assistive technologies in education, employment and recreation (Understand)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I INTRODUCTION TO ASSISTIVE TECHNOLOGY SYSTEMS 9

Social context of disability – Quality of life on using assistive technology – Modeling assistive technology systems – Comprehensive Assistive Technology (CAT) models – Usage of CAT models in real time

UNIT II SPEECH, TEXT AND BRAILLE CONVERSION TECHNOLOGY 9

Prerequisite for speech, text and conversion technology – Pattern and speech recognition systems – Principles of speech synthesis – Text to Braille and Braille to Text conversion systems –Commercial equipment and its application – Haptic Technology

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UNIT III ASSISTIVE TECHNOLOGY FOR ACCESSING BOOKS AND DOCUMENTS 9

Challenges in accessing printed pages – Optical Character Recognition (OCR) technology – Reading systems – DAISY technology – Accessing textbooks and newspapers – Accessible music software for print impaired people

UNIT IV ASSISTIVE TECHNOLOGY FOR DAILY LIVING 9

Personal Care – Timekeeping, Alarms and Alerting – Assistive Technology for food preparation and consumption – Environmental control – Mobility Aids – Money, Finance and shopping – Communication and access to public information

UNIT V ASSISTIVE TECHNOLOGY FOR EDUCATION, EMPLOYMENT AND RECREATION 9

Accessing Educational processes and approaches – Educational Technologies, devices and tools technologies for professional, person-centered employment – Games, Puzzles, Toys – Access to sports and outdoor games – Assistive technology in tourists places – Wayfinding systems

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Bryant, Diane P., and Brian R. Bryant "Assistive technology for people with disabilities", Pearson Higher Ed, 2011
2. Hersh, Marion A Ed., and Michael A. Johnson, "Assistive technology for visually impaired and blind people", Springer, 2008

REFERENCES:

1. Suraj Singh Senjam, "Introduction to Assistive Technology", Nova Science Publishers, 2021
2. Emily C. Bouck, "Assistive Technology", SAGE Publications, Inc, 2016

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

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VERTICAL III - MECHANICS

		Category: PEC				
U21BMP21	ERGONOMICS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To illustrate the principles of ergonomics
- To comprehend the mechanics of muscle physiology
- To discover design aspects of biomedical devices

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the process of visual and auditory ergonomics (Understand)

CO2: Elucidate the concept of muscle physiology (Understand)

CO3: Explain the techniques used in controls and displays based on ergonomics (Understand)

CO4: Illustrate the functions of anthropometry (Understand)

CO5: Interpret the concepts of ergonomics in various field of application (Understand)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I VISUAL AND AUDITORY ERGONOMICS 9

Process of seeing – Visual capabilities – Factors affecting visual acuity and contrast sensitivity – Human factor aspects of hard copy text and computer screen text – Factors in selecting graphic representations symbols – Qualitative visual display – Process of hearing – Principles of auditory display

UNIT II MUSCLE PHYSIOLOGY 9

Muscle physiology – Muscle metabolism – Respiratory response – Joint motion study – Measure of physiological in-efficiency and energy consumption – Work rest cycles – Aspects of manual and posture study – Material handling (MMH) bio-mechanical recommended limits of MMH

UNIT III CONTROLS AND DISPLAYS 9

Spatial compatibility physical arrangement of displays and controls – Movement capability – Rotary

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controls and rotar displays movement of displays orientation of the operator and movement relationships control orders and control responses – Human limitations in tracking task

UNIT IV ANTHROPOMETRY 9

Anthropometry – Anthropometric design principles – Work space envelope – Factors in design of work space surfaces – Principles of seat design – Principles of control panel – Organization classification of human errors theories of accident causation – Reducing accidents by altering behavior

UNIT V APPLICATIONS OF ERGONOMICS 9

Computer design – Control panel design of an electronic instrument – Computer key board – Hand drill – Biomedical applications – Design optimization of medical equipment

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Pascale Carayon, "Handbook of Human Factors and Engineering", 2nd edition, CRC Press, 2011
2. Martin Helander, "Guide to Human Factors and Ergonomics", 2nd edition, CRC Press, 2005

REFERENCES:

1. Stephen Pheasant, Christine M. Haslegrave, "Bodyspace: Anthropometry, Ergonomics and the Design of Work", 3rd edition, CRC Press, 2016
2. Robert. N. Bailey, "Human Performance Engineering", 3rd edition, Prentice Hall, 1996
3. Shrawan Kumar, "Biomechanics in Ergonomics", 2nd edition, CRC Press, 2007

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="3">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><th>*Individual Assignment / Case Study / Seminar / Project / MCQ</th><th>Written Test</th><th>*Individual Assignment / Case Study / Seminar / Project / MCQ</th><th>Written Test</th></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
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</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL III - MECHANICS

		Category: PEC				
U21BMP22	HAPTICS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To explore the basics of haptics
- To familiarize with the perceptions of haptics
- To study the haptic interfaces and its applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the fundamentals of haptics (Understand)

CO2: Illustrate the static perception of the haptics (Apply)

CO3: Illustrate the dynamic perception of the haptics (Apply)

CO4: Discuss the interfaces in a haptic system (Understand)

CO5: Demonstrate the applications of haptics (Understand)

CO–PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	2	2	1	-	-	-	-	-	-	-	-	-	-
CO3	3	2	2	1	-	-	-	-	-	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	3	3	1	-	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I FUNDAMENTALS OF HAPTICS 9

Tactile System – Sense of Touch – Tactile Receptors – Kinesthesia – Thermal Sensing –Motor System – Sensorimotor Control of the Hand

UNIT II STATIC PERCEPTION 9

Perception of force magnitude and postural arm dynamics: Introduction – Methods – Procedure – Position disturbance signal design – Data analysis – Statistics

UNIT III DYNAMIC PERCEPTION 9

Discrimination of distance: Reference Distance – Movement axis – Movement mode – Materials and methods – Procedure – Data Analysis

UNIT IV HAPTIC INTERFACES 9

Haptic interaction, mechanical variables and haptic signals – The physics of haptic interaction – The importance of haptics in perception research – Haptic interface characteristics – The events

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happening when touching real and virtual objects: similarities and differences

UNIT V APPLICATIONS 9

Taste of vision for blind – Haptic Walker – Haptic sensing of virtual textiles – Haptic design of handles – Vestibular sensory substitution using tongue electro tactile display

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Jones, Lynette "Haptics, Ist edition", The MIT press, 1st edition 2018
2. Van Beek, Femke Elise, "Making Sense of Haptics: Fundamentals of Perception and Implications for Device Design", Springer, 1st edition, 2018
3. Grunwald, Martin, "Human haptic perception: Basics and applications", Springer Science and Business Media, 1st edition, 2008

REFERENCES:

1. McDaniel, Troy, and Sethuraman Panchanathan, "Haptic Interfaces for Accessibility, Health, and Enhanced Quality of Life", Springer, 1st edition, 2020
2. https://online.stanford.edu/courses/soe–yhapatics–introduction–haptics
3. https://www.learnhaptics.org/

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
Individual Assignment / Case Study / Presentation / Project / MCQ	Written Test	Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

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VERTICAL III - MECHANICS

		Category: PEC				
U21BMP23	IMPLANT SELECTION AND DEVELOPMENT	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM301 - Human Anatomy and Physiology

COURSE OBJECTIVES:

- To familiarize with the basics of implants and their design principles
- To identify the design parameters of implants
- To explore the different implantable blood interfacing devices and organs

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the significance of implants (Understand)

CO2: Illustrate the implant design principles, parameters and solutions (Understand)

CO3: Identify suitable material for blood interfacing implants (Apply)

CO4: Explain different types of soft tissue replacement and hard tissue replacement (Understand)

CO5: Assess compatibility and functioning of artificial organs inside the living system (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	1	1	-	-	-	-	-	-	-	-	1	1	-
CO3	3	1	1	-	-	-	-	-	-	-	-	1	1	-
CO4	3	1	1	-	-	-	-	-	-	-	-	1	1	-
CO5	3	1	1	-	1	-	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO IMPLANTS 9

Introduction - Outlook for organ replacements - Design consideration - Evaluation process - Immunological considerations - Blood transfusions

UNIT II PRINCIPLES OF IMPLANT DESIGN 9

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

UNIT III DESIGN PARAMETERS 9

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

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UNIT IV BLOOD INTERFACING IMPLANTS 9

Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood

UNIT V IMPLANTABLE MEDICAL DEVICES AND ORGANS 9

Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Yannas, I. V, "Tissue and Organ Regeneration in Adults", New York, NY: Springer, 2001
2. Kopff W.J, Artificial Organs, John Wiley and sons, New York, 1st edition, 1976

REFERENCES:

3. J D Bronzino, Biomedical Engineering handbook Volume II, (CRC Press / IEEE Press), 2000
4. R S Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, 2003
5. John Enderle, Joseph D.Bronzino, Susan M.Blanchard, ""Introduction to Biomedical Engineering", Elsevier, 2005

EVALUATION PATTERN:

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<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>40</td><td>60</td></tr>
<tr><td colspan="4">Total</td><td colspan="2">100</td></tr>
</table>

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VERTICAL III - MECHANICS

		Category: PEC				
U21BMP24	BONE REMODELING	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the bone mechanics
- To interpret the bone remodeling biology and diseases
- To explore the mathematical methods of bone remodeling

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the mechanics of human bone (Understand)

CO2: Compare the bone cells and bone remodeling cycle (Understand)

CO3: Classify the different bone diseases (Understand)

CO4: Apply the mathematical models in bone remodeling (Apply)

CO5: Interpret the application of finite element analysis in bone remodeling (Understand)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I BONE MECHANICS 9

Hierarchical organization of bone – Cortical bone macromechanical properties – Preparation of bone samples for mechanical testing – Cortical bone characteristics – Cortical bone ailments – Genetic disorders – Triggered bone ailments – Fractures – Bone as composite structure

UNIT II BONE REMODELING BIOLOGY 9

Bone cells – Osteoblasts – Osteoclasts – Osteocytes – Bone remodeling cycle – Bone cell interactions – Effect of osteoblasts on osteoclasts – Effect of osteoclasts on osteoblasts – Factors influencing bone

UNIT III BONE DISEASES 9

Osteoporosis – Rickets – Osteomalacia – Paget disease – Osteogenesis imperfecta – Multiple myeloma – Bone cancer

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UNIT IV MATHEMATICAL MODELING IN BONE REMODELING 9

Bone remodeling in vitro – Mechanical models – Isotropic models – Anisotropic models – Biological models – Biomechanical models – Mechanobiological models

UNIT V FINITE ELEMENT MODELING AND ANALYSIS 9

Finite element modeling of healthy bone – Finite element modeling of pathologic bone – Mathematical models treating bone diseases – Bone disease treatment modeling

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Rabeb Ben Kahla, Abdelwahed Barkaoui, "Bone Remodeling Process: Mechanics, Biology and Numerical Modeling", 1st edition, Academic Press, 2021
2. Julius Wolff, "The Law of Bone Remodeling", 1st edition, Springer Berlin, Heidelberg, 2012

REFERENCES:

1. Qing-Hua Qin, "Mechanics of Cellular Bone Remodeling", 1st edition, CRC Press, 2017
2. Gregory R Mundy, "Bone Remodelling and its Disorders", CRC Press, 2nd edition, 2021

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td>Total Internal Assessments</td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

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VERTICAL IV – MEDICAL DATA PROCESSING

		Category: PEC				
U21BMP25	INTERNET OF MEDICAL THINGS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To familiarize with Internet of Things (IoT) and its applications in healthcare
- To explore wearables in healthcare
- To study cloud of things and security of IoT

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the fundamentals of IoT (Understand)

CO2: Demonstrate IoMT, the concepts of IoT in healthcare (Apply)

CO3: Examine the technologies in wearables for healthcare measurement (Analyze)

CO4: Discuss the prevalence of cloud in IoT (Understand)

CO5: Examine current security and privacy concerns related to the connected devices (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	3	2	2	1	-	1	-	-	-	-	-	1	2	-
CO3	3	2	2	1	-	-	-	1	1	2	-	1	1	-
CO4	2	1	-	-	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	1	1	1	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I FUNDAMENTALS OF IoT 9

Introduction – IoT Characteristics – Architectures for IoT – Sensors, Actuators, and Data Storage – Communication Protocols – User Interface Properties – IoT in Healthcare (IoMT): Benefits, Developments, and Challenges

UNIT II INTERNET OF MEDICAL THINGS 9

Robotics in medicine – Data–driven medicine – Image management and video surveillance applied in medicine – Cybersecurity: The need for security in medical IT systems – Three Scenarios in Data Protection

UNIT III WEARABLES IN HEALTHCARE 9

Wearable Devices in the Medical Field – Antennas in diagnosis and treatment – wearable sensors for measuring fatigue – Experimental studies; Aerobic and anaerobic

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UNIT IV THE CLOUD OF THINGS 9

Cloud Computing: Cloud Middleware – The Cloud of Things – Mobile Cloud Computing – MAI versus XaaS – The Cloud of Things Architecture

UNIT V CYBERSECURITY AND THE INTERNET OF THINGS 9

Cybersecurity – New security and privacy challenges – Healthcare: Interoperability and Security Issues – Risks in the connected home – First Steps Toward Managing Discrimination, Privacy, Security, and Consent

Contact Periods:

Lecture: 45 Periods	Tutorial: – Periods	Practical: – Periods	Project:	– Periods
			Total:	45 Periods

TEXT BOOKS:

1. Cardona M, Solanki VK, Cena CE, "Internet of Medical Things: Paradigm of Wearable Devices", 1st edition, CRC Press; 2021 Feb 25
2. Zhou, H.," The internet of things in the cloud. Boca Raton", 1st edition, CRC press, 2012

REFERENCES:

1. Hillar, G.C., "Hands-On MQTT Programming with Python: Work with the lightweight IoT protocol in Python", 1st edition, Packt Publishing Ltd, 2018
2. Norris, Donald "The internet of things: Do-it-yourself at home projects for arduino, raspberry pi, and beaglebone black", 1st edition, McGraw-Hill Education, 2015
3. Spanulescu, Sever "Esp32 Programming for the Internet of Things", 1st edition, Lulu Press Inc, 2018
4. Pfister, Cuno, "Getting started with the Internet of things: connecting sensors and microcontrollers to the cloud", 1st edition, O'Reilly Media, Inc., 2011
5. https://www.coursera.org/learn/iot-cyber-security/home/

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
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				100	

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VERTICAL IV – MEDICAL DATA PROCESSING

		Category: PEC				
U21BMP26	AI FOR MEDICAL DIAGNOSIS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To be able to articulate a machine learning problem
- To conceptualize diagnostic models and evaluation metrics
- To understand prognosis - forecasting of the probable course of a disease

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain machine learning models (Understand)

CO2: Interpret classification of models in medical diagnosis (Understand)

CO3: Demonstrate evaluation metrics for AI models (Understand)

CO4: Illustrate the concept of analyzing MRI images (Apply)

CO5: Use AI for medical prognosis (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	3	1	1	-	1	-	-	-	-	-	-	-	-	2
CO4	3	1	1	-	1	-	-	-	-	-	-	-	-	2
CO5	3	1	1	-	1	-	-	-	-	-	-	-	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)						

SYLLABUS:

UNIT I INTRODUCTION TO APPLIED MACHINE LEARNING 9

Introduction to Machine Learning Process – Classification, Regression and Learning - Machine Learning in the Real World - Features and transformations of raw data – Learning data - Sources of Training Data - Ethical Issues - Image Classification Example – Machine Learning Process Life cycle – Example

UNIT II DISEASE DETECTION WITH COMPUTER VISION 9

Medical Image Diagnosis – Eye Disease and Cancer Diagnosis - Building and Training a Model for Medical Diagnosis – Training, Prediction, and Loss – Image Classification and Class Imbalance – CNN Architectures – Working with a Small Training Set – Generating More Samples – Model Testing – Exercise – Disease Detection with Computer Vision

UNIT III EVALUATING MODELS FOR MACHINE LEARNING 9

Sensitivity, Specificity and Evaluation Metrics – Accuracy in Terms of Conditional Probability Sensitivity, Specificity and Prevalence – PPV, NPV – Confusion Matrix – ROC Curve and Threshold

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– Varying the Threshold – Sampling from the Total Population – Confidence Intervals and 95% Confidence Interval

UNIT IV DIAGNOSING MRI IMAGES 9

Medical Image Segmentation – MRI Data and Image Registration Segmentation – Two and three Dimensional – U Net – Data Augmentation for Segmentation – Loss Function for Image segmentation – Different Populations and Diagnostic Technology – External Validation – Measuring Patient Outcomes

UNIT V MEDICAL PROGNOSIS 9

Medical Prognosis – Examples of Prognostic Tasks – Atrial Fibrillation – Liver Disease Mortality Risk of Heart Disease – Risk Score Computation – Evaluating Prognostic Models – Concordant Pairs, Risk Ties, Permissible Pairs – C-Index

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Arjun Panesar, "Machine Learning and AI for Healthcare", Springer Nature, Feb 2019
2. De Gruyter, "Artificial Intelligence for Data-Driven Medical Diagnosis", Feb 2021

REFERENCES:

1. https://in.coursera.org/learn/machine-learning-applied
2. https://in.coursera.org/learn/ai-for-medical-diagnosis
3. https://www.coursera.org/learn/ai-for-medical-prognosis

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL IV – MEDICAL DATA PROCESSING

		Category: PEC				
U21BMP27	VIRTUAL REALITY IN HEALTHCARE	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To explore the technology through demonstrations, case studies and applications
- To analyze the concepts of virtual reality to build a biomedical real time application
- To apply the augmented reality concepts to build a biomedical engineering application

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Outline input and output devices in VR systems (Understand)

CO2: Differentiate various modelling techniques in developing process (Apply)

CO3: Explain the safety considerations involved in VR (Understand)

CO4: Identify the VR technology enabled assistive devices (Apply)

CO5: Summarize the applications of VR in healthcare (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO2	2	1	1	-	-	-	-	-	-	-	-	-	-	2
CO3	2	1	1	-	-	1	-	-	-	-	-	-	-	2
CO4	2	1	1	-	-	-	-	-	-	-	-	-	-	2
CO5	2	1	1	-	-	-	-	-	-	-	-	-	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS

UNIT I INTRODUCTION 9

The three 1's of virtual reality - Commercial VR technology and the five classic components of a VR system – Input devices – Trackers – Navigation and gesture interfaces – Three dimensional position trackers – Navigation and manipulation Interfaces – Gesture interfaces – Output devices – Graphic displays – Sound displays and haptic feedback

UNIT II DEVELOPMENT PROCESS 9

Geometric modeling – Kinematics modeling – Physical modeling – Behavior modeling – Model Management – Advantages and disadvantages

UNIT III HEALTH AND SAFETY CONSIDERATIONS 9

Methodology and terminology – User performance studies – VR health and safety issues – Usability of virtual reality system – Cyber sickness – Side effects of exposures to virtual reality environment

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UNIT IV WEB AND MOBILE 9

JS – Pros and cons – Building blocks – WebVR – WebGL – Three.js – Device orientation events – Frameworks – A frame – React VR – Google VR for android – Scripts – Mobile device configuration – Building to android – Cameras and interaction – Teleporting – Spatial audio – Assessing human parameters – Device development and drivers – Design Haptics

UNIT V APPLICATIONS 9

Medical applications – Military applications – Robotics applications – Advanced real-time tracking – Other applications – Games – Movies and simulations

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Period
Total: 45 Period

TEXT BOOKS:

1. Burdea and Philippe Coiffet C, "Virtual Reality Technology", John Wiley and Sons, 2nd edition, 2008
2. Jason Jerald, "The VR Book: Human-centered design for virtual reality", Association for Computing Machinery and Morgan and Claypool, 1st edition, 2015

REFERENCES:

1. Dieter Schmaltz stag and Tobias Hollered, "Augmented Reality: Principles and Practice (Usability)", Pearson Education (US), 2nd edition, 2016
2. Steve Aukstakal Nix, "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability)", Addison-Wesley Professional, 1st edition, 2016
3. Robert Scoble and Shel Israel, "The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything", Patrick Brewster Press, 1st edition, 2016
4. Tony Parisi, "Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages", O'Reilly Media, 1st edition, 2014

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course coordinator can choose any one / two components based on the nature of the course.

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VERTICAL IV – MEDICAL DATA PROCESSING

		Category: PEC				
U21BMP28	DATA MINING AND PATTERN RECOGNITION	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21MA406 - Probability and Stochastic Processes

COURSE OBJECTIVES:

- To interpret the knowledge representation in data mining
- To apply the techniques of data mining and clustering in data
- To illustrate the pattern recognition methods in healthcare applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the fundamentals of data mining and data analysis (Understand)

CO2: Make use of different techniques deployed in data analysis and dimensionality reduction (Apply)

CO3: Examine various data clustering techniques (Analyze)

CO4: Inspect pattern recognition techniques for decision making (Analyze)

CO5: Apply data analysis techniques in medical images (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3	1	1	-	1	-	-	-	-	-	-	-	-	2
CO3	3	1	1	1	1	-	-	-	-	-	-	-	-	2
CO4	3	1	1	1	1	-	-	-	-	-	-	-	-	2
CO5	3	1	1	-	1	-	-	-	-	-	-	-	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I CONCEPT OF DATA MINING 9

Data Mining – Exploratory data analysis – Pattern mining – Clustering and classification – Numerical attributes – Univariate – Bivariate and Multivariate analysis – Categorical attributes – Univariate – Bivariate and Multivariate analysis

UNIT II TECHNIQUES OF DATA MINING 9

Graph models – Kernel methods – Kernel matrix and vector kernels – Basic kernel operations – Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Itemset mining algorithm – Sequence mining

UNIT III CLUSTERING 9

Representative-based clustering – K-Means algorithm – Expectation maximization – Hierarchical clustering – Density based clustering – DBSCAN – Kernel density estimation

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UNIT IV PATTERN RECOGNITION 9

Machine Perception – Pattern Recognition system – Design Cycle – Learning and Adaptation – Bayesian Decision Theory – Nearest neighbor – Support Vector Machine – Decision Trees

UNIT V PICTORIAL PATTERN RECOGNITION 9

Image edge sharpening – Morphological operation – Boundary detection and contour tracing – Image analysis via medial axis transformation – Shape descriptors – Exemplary applications – Computer aided diagnosis system for medical images

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Mohammed J. Zaki, Wagner Meira Jr, "Data Mining and Analysis: Fundamental Concepts and Algorithms", 1st edition, Cambridge University Press, 2014
2. Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", John Wiley and sons, New Jersey, 1st edition, 2012

REFERENCES:

1. Jain Pei, Jiawei Han and Micheline Kamber, "Data Mining: Concepts and Techniques", 3rd edition, Elsevier, 2011
2. Sing-Tze Bow, "Pattern Recognition and Image Processing", 2nd edition, Marcel Dekker Inc., 2002
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="2">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
<tr><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td>*Individual Assignment / Case Study / Seminar / Project / MCQ</td><td>Written Test</td><td></td></tr>
<tr><td>40</td><td>60</td><td>40</td><td>60</td><td>200</td><td>100</td></tr>
<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
<tr><td colspan="2">100</td></tr>
</table>

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL IV – MEDICAL DATA PROCESSING

		Category: PEC				
U21BMP29	BRAIN COMPUTER INTERFACE AND APPLICATIONS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM302 - Biomedical Sensors and Instrumentation

COURSE OBJECTIVES:

- To outline the fundamentals of Brain Computer Interfacing (BCI)
- To familiarize with the hardware and software involved in a BCI system
- To illustrate BCI with p300 and BCILAB

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Describe the fundamentals of BCI (Understand)

CO2: Restructure a BCI system based on the hardware sequence (Apply)

CO3: Illustrate the software requirement for a BCI system (Apply)

CO4: Demonstrate the relevance and processing of P300 (Apply)

CO5: Experiment BCI using BCILAB (Analyze)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I BRAIN–COMPUTER INTERFACE 9

The basic design and operation of a Brain – Computer Interface (BCI) system – Six important themes – Choosing signal types and brain areas – Recognizing and avoiding artifacts – Goal selection or process control

UNIT II BCI HARDWARE 9

Sensors – Amplifiers – Analog-to-Digital Conversion – Hardware interfaces – Client hardware

UNIT III BCI SOFTWARE 9

Components of BCI implementation – Design principles for R&D BCI software – Overview of general purpose BCI research software – evaluating BCI hardware and software – Latency overview

UNIT IV P300 EVENT-RELATED POTENTIALS 9

The P300 ERP and P300 – Based BCIs – The Oddball paradigm – P300 origin and function – P300-

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based BCIs – P300 Based BCI Study: The aims and limitations – Alternative electrode montages – Alternative signal processing methods

UNIT V BCILAB 9

Prerequisites – Defining an Approach – Steps – Scripting Online Analyses in BCILAB – Scripting Offline Analyses in BCILAB

Contact Periods:

Lecture: 45 Periods Tutorial – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Jonathan R. Wolpaw & Elizabeth Winter Wolpaw. "Brain–computer interfaces.", 1st edition, Oxford University Press, 2012
2. Rajesh P. N. Rao "Brain-computer interfacing: an introduction", 1st edition, Cambridge University Press, 2013

REFERENCES:

1. Aboul Ella Hassanien, and Ahmad Taher Azar, "Brain-computer interfaces - Current Trends and Applications", 1st edition, Springer International Publishing Switzerland, 2015
2. https://sccn.ucsd.edu/wiki/Introduction_To_Modern_Brain-Computer_Interface_Design

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL IV – MEDICAL DATA PROCESSING

		Category: PEC				
U21BMP30	WEARABLE DEVICES	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM302 - Biomedical Sensors and Instrumentation

COURSE OBJECTIVES:

- To learn the importance of wearable device
- To know the technologies influencing the concept of wearable devices
- To explore the application of wearable devices in enhancing the quality of life

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the requirements needed for the design of wearable devices (Understand)

CO2: Study cases related to contact and non-contact wearables (Apply)

CO3: Identify the influence of wearables in enhancing the quality of day-to- day activities (Analyze)

CO4: Describe wearable device for emergency support of elderly (Understand)

CO5: Review the existing wearable textiles and their field of application (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-	2	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION 9

Basic wearable computing requirements – Types of wearable applications – Ergonomics in wearable – Simple user interface design for wearable computing – Materials and components for constructin simple devices – Software and power requirements

UNIT II SKIN CONTACT AND NON-CONTACT WEARABLES 9

ECG lead construction methodologies – PPG based non-invasive methods for vital signal monitoring Movement analysis of human limb (EMG electrode based) – Brain computer interface (EEG electrod based) – Non contact wearable for sleep monitoring

UNIT III WEARABLES FOR PERSONALIZED HEALTH CARE MONITORING 9

Blood glucose meters – Blood Pressure – Pulse oximeters – Weight and body analysis – Pedometer Data Gloves – Wearables for blind

UNIT IV WEARABLES FOR EMERGENCY RESPONSE SYSTEM 9

Data description – Feature extraction techniques for implementation – Feature classification method – IoT and machine learning algorithms – Design of IoT based fall detection system for elderly

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UNIT V WEARABLE TEXTILE SYSTEMS 9

Textile wearable integration system – Textile requirements for integrated sensors – Fiber based sensors – Fiber sensor prototypes – Production of fibers for wearables – Spatial sensing using fiber-based sensors – Fiber based sensing modalities

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Tong, Raymond, ed, "Wearable technology in medicine and health care" Academic Press, 2018
2. Gargiulo, Gaetano D., and Ganesh R. Naik, "Wearable/Personal Monitoring Devices Present to Future" Springer Singapore Pte. Limited, 2021

REFERENCES:

1. Samraj, Andrews, "Skin-Close Computing and Wearable Technology", CRC Press, 2021

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**		**Total Internal Assessments**	**End Semester Examinations**
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL IV – MEDICAL DATA PROCESSING

		Category: PEC				
U21BMP31	VIRTUAL INSTRUMENTATION AND DAQ SYSTEMS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21EEG01 - Basics of Electrical and Electronics Engineering

COURSE OBJECTIVES:

- To learn computer-based interface system
- To practice LabVIEW programming environment
- To develop applications using virtual instrumentation technique

COURSE OUTCOMES:

On completion of the course the students will be able to

CO1: Illustrate the fundamentals of Virtual Instrumentation (Understand)

CO2: Develop LabVIEW programming (Apply)

CO3: Apply the LabVIEW programming for report generation (Apply)

CO4: Interface data acquisition system with real-time application (Apply)

CO5: Elucidate the applications of virtual instrument system (Apply)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I INTRODUCTION TO VIRTUAL INSTRUMENTATION 9

Historical perspective – Advantages of virtual instrument – Physical quantities and analog interfaces – User Interfaces and architecture – Comparison of conventional instruments with virtual instruments

UNIT II LabVIEW PROGRAMMING 9

Front panel – Block diagram, Tools, Control and Function palette – Modular programming – VI and sub VI – Structures – FOR loops – WHILE loops – Case – Sequence Structures – event structures – Formula nodes – Local and global variables

UNIT III ARRAYS, CLUSTERS AND REPORT GENERATION 9

Arrays, Clusters, String functions – File I/O – Time and Dialog control – Waveform – Graph – Chart operations – String functions – Report generation

UNIT IV Data Acquisition System 9

Review of Transducer and Signal conditioning – DAQ hardware – AI – AO-DI/O-DAQ assistant and configurations – Instrument control – GPIB – VISA – Instrument drivers – Serial port communication

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UNIT V Applications of Virtual Instrumentation 9

Networking basics for biomedical applications – Simulation of system using VI – Image acquisition and processing – Sound I/O – Motion control

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Sanjay Gupta, Joseph, "Virtual Instrumentation using LabVIEW", Second edition, Tata McGraw Hill, 2017
2. Gary W. Johnson and Richard Jennings, "LabVIEW – Graphical Programming", Fourth Edition, Tata McGraw Hill, 2016

REFERNCES:

1. Bruce mihure, Austin and Texas, "LabVIEW for data acquisition", Prentice Hall of India, New Delhi, 2001
2. LabVIEW Basics I and II Manual, National Instruments, India, 2020
3. Barry E. Paton, "Sensor, Transducers and LabVIEW", Prentice Hall of India, New Delhi, 2000

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**			
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	**Total Internal Assessments**	**End Semester Examinations**
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL IV – MEDICAL DATA PROCESSING

U21BMP32	BIOINFORMATICS	Category: PEC			
		L	T	P	C
		3	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To adapt basic knowledge on the biological information and databases
- To understand the sequence data in different databases
- To explain the practical use of tools for specific bioinformatics areas

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Interpret the basics of bioinformatics and biological data (Understand)

CO2: Comprehend the databases, tools, repositories and be able to use each one to extract specific information (Understand)

CO3: Examine the scoring matrices (Understand)

CO4: Analyze the sequences using dynamic programming method (Analyze)

CO5: Infer the concept of genome annotation and phylogenetic analysis (Understand)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	1
CO4	3	2	-	-	1	-	-	-	-	-	-	-	-	2
CO5	3	2	-	-	1	-	-	-	-	-	-	-	-	2
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS

UNIT I BIOLOGICAL INFORMATION 9

Definition and goals of bioinformatics – Structure of DNA – RNA – Protein – Peptide bond – Prediction of Physicochemical properties – Secondary structure prediction – Prediction of domains and motifs

UNIT II GENOMIC DATA AND DATABASES 9

Genomic data – Sequence data formats – Classification of databases – Primary databases – Secondary databases – Specialized databases – Sequence submission – Data search – Data Retrieval

UNIT III SEQUENCE ALIGNMENT AND SIMILARITY SEARCH 9

Sequence alignment – Sequence identity – Sequence similarity – Sequence homology – Global Alignment – Local Alignment – Pairwise Alignment – Multiple Alignment – Scoring matrix

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UNIT IV DYNAMIC PROGRAMMING 9

Dynamic Programming – Needleman – Wunsch Algorithm – Smith – Waterman Algorithm – BLAST – PSI BLAST – FASTA

UNIT V GENOME ANNOTATION AND PHYLOGENETIC ANALYSIS 9

Genome sequence – Sequence Assembly – Genome Annotation – Gene prediction – ORF – Phylogenetic analysis – Phylogenetic tree – Construction – Monophyly – Polyphyly – Paraphyly

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Supratim Choudhuri, "Bioinformatics of Beginners", 1st edition, Academic Press, 2014
2. David W. Mount, David Mount, "Bioinformatics: Sequence and Genome Analysis", 2nd edition, CSHL Press, 2004

REFERENCES:

1. Hooman H. Rashidi, Lukas K. Buehler, "Bioinformatics Basics: Applications in Biological Science and Medicine", 2nd edition, CRC Press, 2005
2. Per Jambeck, Cynthia Gibas, "Developing Bioinformatics Computer Skills", 1st edition, O'REILLY, 2001
3. Stephen Misener, Stephen A Krawetz, "Bioinformatics Methods and Protocols", 1st edition, Humana Press, 2010

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		**Assessment II (100 Marks)**			
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	**Total Internal Assessments**	**End Semester Examinations**
40	**60**	**40**	**60**	**200**	**100**
Total				**40**	**60**
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

HoD - BIOMEDICAL ENGINEERING
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VERTICAL V – ADVANCED HEALTHCARE SYSTEMS

		Category: PEC				
U21BMP33	BIOMEMS	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To explore the fundamentals micro fabrication technology
- To infer the engineering mechanics concepts relevant to micro systems
- To analyze the concepts of micro sensors and micro actuators in biomedical applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Illustrate the micro fabrication technologies (Understand)

CO2: Describe the engineering mechanics concepts involved in different structures (Apply)

CO3: Identify the suitable biosensors and micro actuators for BioMEMS applications (Understand)

CO4: Comprehend the fluid dynamics concepts for micro actuations (Understand)

CO5: Apply the knowledge in specific applications (Apply)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS

UNIT I FABRICATION TECHNOLOGIES 9

MEMS and microsystems – Silicon and its compounds – Photolithography – Ion implantation – Diffusion – Oxidation – CVD – PVD – Etching – Surface micromachining – Bulk micromachining – LIGA

UNIT II ENGINEERING MECHANICS FOR MICROSYSTEMS DESIGN 9

Mechanics for MEMS design – Static bending of thin plates – Mechanical vibration analysis – Thermo mechanical analysis – Fractures mechanics analysis – Thin film mechanics – Overview of finite element analysis

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UNIT III MICRO SENSORS AND MICRO ACTUATORS 9

Biosensors – Chemical sensors – Optical sensors – Thermal sensors – Thermocouples – Thermal resistors – Piezoelectric sensors – Micro actuators – Thermal forces – Shape memory alloys – Electrostatic forces – Piezoelectric actuation – Microaccelerometer

UNIT IV MICROFLUIDIC DEVICES AND COMPONENTS FOR BIO- MEMS 9

Microfluidics – Continuity equation – Momentum equation – Laminar flow in circular conduits – Micropump – Microvalves – Micromotors – Micromixers – Applications in Bio-MEMS

UNIT V SENSING TECHNOLOGIES FOR BIO-MEMS APPLICATIONS 9

Capillary electrophoresis – MEMS based drug delivery – Micro reservoir – Micro dispensing – Microchip capillary electrophoresis systems for DNA analysis – BioMEMS devices for proteomics – Pharmaceutical analysis using Bio-MEMS

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill Publishers, 2nd edition, 2002
2. Wanjun Wang, Stephen A. Soper, "BioMEMS: Technologies and Applications", CRC Press, 1st edition 2007

REFERENCES:

1. Marc J. Madou, "Fundamentals of Micro-fabrication: The Science of Miniaturization", CRC Press, 1st edition, 2002
2. Chang Liu, "Foundations of MEMS", Pearson Education International, 1st edition, 2006
3. Nitaigour, Premchand Mahalik, "Micro Electro Mechanical Systems (MEMS)", Tata McGraw Hill Publishers, 1st edition, 2007

EVALUATION PATTERN:

<table>
<tr><th colspan="4">Continuous Internal Assessments</th><th rowspan="3">Total Internal Assessments</th><th rowspan="3">End Semester Examinations</th></tr>
<tr><th colspan="2">Assessment I (100 Marks)</th><th colspan="2">Assessment II (100 Marks)</th></tr>
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VERTICAL V – ADVANCED HEALTHCARE SYSTEMS

		Category: PEC				
		L	T	P	J	C
U21BMP34	CRITICAL CARE EQUIPMENT	3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To familiarize with the basic operations involved in critical care unit
- To identify the equipment involved in patient monitoring system
- To explore the different medical gases and airway equipment

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the basic intravenous lines and catheters given to the patient in critical care (Understand)

CO2: Summarize about the working of anesthesia and breathing system (Understand)

CO3: Identify the various types of medical gases and airway equipment (Apply)

CO4: Infer the different parameters used in patient monitoring (Apply)

CO5: Inspect the life support and emergency resuscitation devices (Apply)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I CRITICAL CARE INTRAVENOUS LINES 9

Intravenous cannulae – Central venous catheters – Other vascular access devices monitoring – Incentive spirometry – Syringe pump – Pulmonary artery catheters – Renal replacement therapy in critical care

UNIT II ANESTHESIA AND BREATHING SYSTEM 9

Anesthesia – Working, Types, Administration – Nerve stimulators – Nerve stimulator needles – Spinal needles – Epidural needles – Epidural catheters – Sub-Tenon's set – Introduction to breathing systems – Bag valve mask – Pressure valve – Reservoir bag – Breathing Tubes

UNIT III AIRWAY EQUIPMENT AND MEDICAL GASES 9

Venturi mask – Sealing face masks – Magill forceps – Nasopharyngeal airways – Laryngoscopes – Medical gas cylinders – Medical vacuum and suction – Scavenging

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UNIT IV MONITORING EQUIPMENT 9

The fuel cell – Oxygen failure alarm (Ritchie whistle) Monitoring the patient – Capnograph waveforms – Pneumotachographs – Coagulation testing: TEG and Rotem – Hygrometers

UNIT V LIFE SUPPORT AND EMERGENCY RESUSCITATION DEVICES 9

Cardiopulmonary Resuscitation Equipment – Automated external defibrillator (AED) machine – Oxygen therapy – Extracorporeal membrane oxygenation (ECMO) machines

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Daniel Aston , Angus Rivers, Asela Dharmadasa "Equipment Anaesthesia in and Critical Care", Orient blackswan, 1st edition, 2014
2. Tom Peck, Sue Hill, Mark Williams, "Pharmacology for Anaesthesia and Intensive Care", WB, Cambridge university Press, 3rd edition, 2007

REFERENCES:

1. Edward Scarth, Susan Smith, "Drugs in Anaesthesia and Intensive Care", Oxford University Press, 5th edition, 2016

EVALUATION PATTERN:

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VERTICAL V – ADVANCED HEALTHCARE SYSTEMS

		Category: PEC				
		L	T	P	J	C
U21BMP35	HUMAN ASSIST DEVICES	3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the working of available assist devices in emergency and critical care
- To obtain the knowledge on the principles of sensory assist devices
- To explore the difference between prosthesis and orthoses

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Examine the working of each part of the emergency assist device and their specific application (Understand)

CO2: Analyze the design of types of artificial kidney available in the field and summarize the characteristics (Understand)

CO3: Identify the important factors to be considered for the design of sensory assist devices (Understand)

CO4: Explore the use of orthoses for critical conditions and understand the need for patient specific design (Understand)

CO5: Study the mechanics of mobility devices and relate the same to the human body (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-	1	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I EMERGENCY ASSIST DEVICES **9**

Percutaneous mechanical circulatory support – Ventricular Assist Devices (VAD) – Biventricular Assist Devices (BAD) – Cardiac Extracorporeal membrane oxygenation (ECMO) – Heart Lung Machine (HLM)

UNIT II HEMODIALYZERS **9**

Artificial kidney – Dialysis action – Hemodialyzer unit – Membrane dialysis – Portable dialyzer monitoring and functional parameters

UNIT III SENSORY ASSIST DEVICES **9**

Hearing aids and types – Bone Anchored Hearing AIDS (BAHA), signal processing and design considerations – Cochlear implant devices – Cornea and retinal implants procedure – Prosthetic eye

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UNIT IV ORTHOSES OF SPINE AND LIMB 9

Orthoses for spinal deformities, trauma and post operative care – Principle and components of upper limb orthoses – Foot and knee orthoses – Limb joint arthroplasty

UNIT V ASSIST DEVICES FOR MOBILITY 9

Cranes, crutches and walkers – Wheeled Mobility – Seating, positioning, device prescription, remote settings for wheelchair – Adaptation for sports – Neuromuscular electrical stimulation applications – Exoskeletal assist device for mobility

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Webster, Joseph, and Douglas Murphy., "Atlas of Orthoses and Assistive Devices E-Book", Elsevier Health Sciences, 5th edition,2019
2. Valchanov, Kamen, Nicola Jones, and Charles W. Hogue, eds. "Core Topics in Cardiothoracic Critical Care", Cambridge University Press, 2018

REFERENCES:

1. Borle, Sean. "Artificial Eyes by B. Sheen" The Deakin Review of Children's Literature , 1st edition, 2018
2. Khandpur R S, "Handbook of biomedical instrumentation", McGraw-Hill Education, 3rd revised edition, 2014

EVALUATION PATTERN:

Continuous Internal Assessments					
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	End Semester Examinations
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

*Role Play / Group Discussions / Debates / Oral Presentations / Poster Presentations / Technical presentations can also be provided. Course Coordinator can choose any one / two components based on the nature of the course.

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VERTICAL V – ADVANCED HEALTHCARE SYSTEMS

		Category: PEC				
		L	T	P	J	C
U21BMP36	COMMUNICATION NETWORK SYSTEMS	3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To understand the basic concepts of analog and digital communication
- To use multi user radio communication and its standards
- To apply cellular, satellite and bluetooth techniques in various applications

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Discuss the basics of analog modulation techniques (Understand)

CO2: Identify digital communication techniques methods and efficiency (Understand)

CO3: Demonstrate application of wireless communication and standards (Understand)

CO4: Illustrate the mechanism for cellular systems access (Apply)

CO5: Use satellite and Bluetooth technology in applications (Apply)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I ANALOG COMMUNICATION **9**

Introduction to communication – Amplitude modulation – Frequency modulation – Frequency spectrum – Bandwidth – Percentage modulation – modulation index – Power calculation

UNIT II DIGITAL COMMUNICATION **9**

Amplitude shift Keying – Frequency shift keying – Phase shift keying – Quadrature phase shift keying – Quadrature amplitude modulation – Transmitter – Advantages and disadvantages – Comparison of various systems – Bit rate and bandwidth

UNIT III MULTI USER RADIO COMMUNICATION **9**

Introduction to Analog, Digital and wireless Cellular communication – Advanced mobile telephonesystems – Standard 95 (IS 95) – Global system for mobile communication – services – architecture – radio sub systems – specifications

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UNIT IV CELLULAR SYSTEMS AND ACCESS SYSTEMS 9

Cellular concepts – Frequency reuse – Channel allocation – Hands off mechanism – Frequency division multiple access – Time division multiple access – Code division multiple access – Comparison

UNIT V SATELLITE AND BLUETOOTH 9

Satellite communication – Earth station – Satellite channel – Frequency band – Satellite Channel – Multiple access – Digital broadcast satellite – Bluetooth – Networking – Specification – Error correction – Applications

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Wayne Tomasi, "Advanced Electronic Communication Systems", Pearson Education, 6th edition 2015
2. P. Ramakrishna Rao, "Communication Systems", McGraw Hill Education, 1st edition, July 2017

REFERENCES:

1. A. Bruce Carlson, Paul Crilly, Janet Rutledge, "Communication Systems", McGraw Hill Education, 4th edition, 2001
2. R. P. Singh, S. Sapre, " Communication Systems: Analog and Digital", McGraw Hill Education, 3rd Edition, 2017

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

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VERTICAL V – ADVANCED HEALTHCARE SYSTEMS

		Category: PEC				
		L	T	P	J	C
U21BMP37	ROBOTICS IN MEDICINE	3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To impart basic understanding of robotics
- To explore kinematic motion planning for various robotic configurations
- To comprehend on the application of robotics in the field of healthcare

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Infer with the basics of robotic systems (Understand)

CO2: Elucidate the kinematics, motion planning and control involved in design of robotic systems (Understand)

CO3: Outline the concepts of robotics for surgery (Understand)

CO4: Analyze the technical aspects of robotic technology in image guided interventions (Analyze)

CO5: Illustrate the role of robotics in assistive technology (Apply)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I INTRODUCTION **9**

Automation and Robots – Classification – Specification – Notations – Direct kinematics – Dot and cross products – Coordinate frames – Rotations – Homogeneous coordinates – Link coordinates – Arm equation – Four-axis robot

UNIT II KINEMATICS **9**

Inverse Kinematics – General properties of solutions tool configuration – Four axis – Workspace analysis – Trajectory planning work envelope – Examples – Workspace fixtures – Pick and place operations – Continuous path motion – Interpolated motion and straight-line motion

UNIT III ROBOTICS IN SURGERY **9**

Minimally invasive surgery and robotic integration – Surgical robotic sub systems – Synergistic control – Control modes – Orthopedic surgery – Cardiac surgery – Neurosurgery

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UNIT IV IMAGE GUIDED INTERVENTIONS 9

Robot compatibility with medical imagers – Image segmentation and modelling – Tracking devices – Frames and Transformations – Surgical navigation

UNIT V ROBOTS IN PATIENT CARE 9

Rehabilitation for Limbs – Assistive robots – Types of assistive robots – Biologically inspired robots – Application in Rehabilitation – Interactive therapy – Bionic Arm

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Robert Schilling, "Fundamentals of Robotics - Analysis and Control", Prentice Hall, 1st edition, 2003
2. J.J.Craig, "Introduction to Robotics", Pearson Education, 3rd edition, 2005

REFERENCES:

1. Paula Gomes, "Medical robotics minimally invasive surgery", Woodhead, 1st edition, 2012
2. Jocelyne Troccaz, "Medical Robotics", Wiley-ISTE, 1st edition, 2012
3. Matthew, Mauro M.D, "Image-Guided Interventions", Saunders, 2nd edition, 2013
4. Fu K.S, Gonzales R, Lee C.S.G, "Robotics", McGraw Hill, 1st edition, 2008

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
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				100	

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VERTICAL V – ADVANCED HEALTHCARE SYSTEMS

		Category: PEC				
U21BMP38	NUCLEAR MEDICINE	L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21PH202 - Medical Physics
- U21BM301 - Human Anatomy and Physiology

COURSE OBJECTIVES:

- To make the students get familiarized with use of radioisotopes in the field of therapy
- To explore the usage of SPECT and PET concepts in therapy
- To make the students understand concept of organ specific therapy

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Summarize the fundamentals of radioactivity (Understand)

CO2: Examine the potential of radiopharmaceuticals used in SPECT (Understand)

CO3: Examine the potential of radiopharmaceuticals used in PET (Understand)

CO4: Identify the need of organ specific therapy and their potential application to cancer and other disorder treatment (Apply)

CO5: Analyze various cases related to organ specific therapy and conclude about the pros and cons of the treatment (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO5	3	3	-	-	-	-	1	-	-	-	-	-	-	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)					

SYLLABUS:

UNIT I FUNDAMENTALS OF RADIOACTIVITY 9

Radioisotopes–Therapeutic radiopharmaceuticals – Radioactive Decay – Natural and Artificial source of radiation – Interaction of charged and neutral particle with matter – Radiation detectors – ICRP

UNIT II SINGLE PHOTON EMISSION RADIOPHARMCEUTICALS 9

General localization mechanism for SPECT pharmaceuticals – 99mTC labeled radiopharmaceuticals – Indium 111 labeled radiopharmaceuticals – Radio iodinated imaging agents – Lung ventilation radiopharmaceuticals

UNIT III POSITRON EMISSION RADIOPHARMCEUTICALS 9

Radiolabeling strategies – F, C, Ga labelled radiopharmaceuticals –Tissue hypoxia imaging agents – Amyloid imaging agents – Neo angiogenesis imaging agents – Apoptosis imaging agents

UNIT IV RADIONUCLIDE THERAPY FOR ORGAN SPECIFIC APPLICATIONS - I 9

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UNIT IV RADIONUCLIDE THERAPY FOR ORGAN SPECIFIC APPLICATIONS - I 9

Musculoskeletal disease – Hemato-oncology – Thyroid disorders – non-thyroidal endocrinological disorders

UNIT V RADIONUCLIDE THERAPY FOR ORGAN SPECIFIC APPLICATIONS - II 9

Neuro endocrine tumors – Tumors of liver and Biliary tract – Pediatrics – Molecular guidance for planning external guidance radiation therapy

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Volterrani, Duccio, et al., eds. "Nuclear Medicine Textbook: Methodology and Clinical Applications" New York, NY, USA: Springer, 1st edition, 2019
2. Youxin Mao, "Biomedical Imaging", In-tech India, 1st edition, 2010

REFERENCES:

1. Saha, Gopal B. "Physics and radiobiology of nuclear medicine", Springer Science & Business Media, 1st edition, 2012

EVALUATION PATTERN:

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<tr><td colspan="4" rowspan="2">Total</td><td>40</td><td>60</td></tr>
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VERTICAL V – ADVANCED HEALTHCARE SYSTEMS

U21BMP39	EMBEDDED SYSTEMS FOR BIOMEDICAL APPLICATIONS	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- Nil

COURSE OBJECTIVES:

- To introduce the basic principles of embedded systems
- To impart knowledge on the design of embedded systems, memory and communication interface
- To render knowledge on real time operating systems and software development tools

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Explain the fundamentals of an embedded system (Understand)

CO2: Infer the custom-single purpose processors (Understand)

CO3: Identify the general-purpose processors (Apply)

CO4: Analyze the communication interfaces (Analyze)

CO5: Apply the architecture of embedded kernel and software for Medical Application and the RTOS (Apply)

CO-PO MAPPING:

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

Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

SYLLABUS:

UNIT I INTRODUCTION TO EMBEDDED SYSTEM **9**

Embedded System Overview – Design challenge – Processor technology – General purpose Processor, Single Purpose Processor, Application Specific Processor -IC technology – Full-Custom VLSI, Semi-custom VLSI – Design technology

UNIT II CUSTOM SINGLE PURPOSE PROCESSOR **9**

Single purpose processors – RT level combinational logic – Sequential logic – RT level – Custom single purpose processor design – RT level and optimization techniques – Optimizing the Original program – Optimizing FSMD – Optimizing FSMD – Optimizing the FSM

UNIT III GENERAL PURPOSE PROCESSORS **9**

Basic architecture – Operation – Pipelining – Programmer's view – Development environment – Application Specific Instruction set Processors (ASIPs) – Micro controllers and digital signal processors – Case Study: General purpose processors in Medical Devices

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Communication basics – Serial Communication – USB – IEEE 1394 - Parallel Communication – PCI Bus – Arm Bus – Wireless Communication – IrDA - IEEE 802.11 – Bluetooth – Case study: Patient monitoring systems

UNIT V REAL TIME OPERATING SYSTEMS 9

Architecture of the kernel – Tasks and task scheduler – Interrupt Service Routines – Semaphores – Mutexes – Mailboxes – Message queues – Event registers – Pipes – Signals – Timers – Priority inversion problem – Embedded operating systems – Types of Embedded OS – Application in Medical Imaging systems

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS:

1. Frank Vahid and Tony D. Givargis, "Embedded System Design A Unified Hardware/Software Introduction", 1st edition, John Wiley, 2006
2. Prasad K.V.K.K, "Embedded / Real Time Systems", 1st edition, Dreamtech Press, 2005

REFERENCES:

1. Steve Heath, "Embedded Systems Design", 2nd edition, Newness, 2005
2. David E. Simon, "An Embedded Software Prime", 1st edition, Pearson Education Asia, 2000
3. Raj Kamal, "Embedded Systems Architecture, Programming and Design", 3rd edition, Tata McGraw Hill, New Delhi, 2009
4. Steve Heath, "Embedded System Design", 2nd edition, 2004

EVALUATION PATTERN:

Continuous Internal Assessments					End Semester Examinations
Assessment I (100 Marks)		Assessment II (100 Marks)		Total Internal Assessments	
*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test	*Individual Assignment / Case Study / Seminar / Project / MCQ	Written Test		
40	60	40	60	200	100
Total				40	60
				100	

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U21BMP40	VLSI FOR MEDICAL DEVICES	Category: PEC				
		L	T	P	J	C
		3	0	0	0	3

PRE-REQUISITES:

- U21BM201 – Linear Integrated Circuits
- U21ECG01 - Digital Electronics

COURSE OBJECTIVES:

- To gain knowledge on MOS Transistors and Inverters
- To explore the construction of different MOS Logic Circuits
- To explain the design principles and application of VLSI circuits for medical devices

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

CO1: Infer the basics of fabrication of various MOS Transistors (Understand)

CO2: Understand the operation and characteristics of MOS Inverters (Understand)

CO3: Outline the function of various MOS Logic Circuits (Understand)

CO4: Identify the design principles and methodologies of VLSI circuits (Apply)

CO5: Make use of VLSI circuits for modelling of medical devices (Apply)

CO-PO MAPPING:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	3	-	-	-	-	-	-	-	-	-	-	1	1	-
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CO5	3	1	1	-	-	1	-	-	-	-	-	1	1	-
Correlation levels:	1: Slight (Low)			2: Moderate (Medium)						3: Substantial (High)				

SYLLABUS:

UNIT I INTRODUCTION TO MOS TECHNOLOGIES 9

Basics of MOS Transistors: Enhancement mode and Depletion mode, I-V characteristics, C-V Characteristics – Fabrication Process: nMOS, CMOS and BiCMOS – E-beam Mask

UNIT II MOS INVERTERS 9

Ideal Inverter – nMOS Inverter – Resistive load Inverter – Inverters with n-type MOSFET load – CMOS inverter – Static and Switching Characteristics

UNIT III OVERVIEW OF LOGIC CIRCUITS 9

Combinational MOS logic circuits – Sequential MOS logic circuits – Dynamic logic circuits – Low-power CMOS logic circuits – BiCMOS logic circuits

UNIT IV VLSI DESIGN METHODOLOGIES 9

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VLSI Design Flow – Design Hierarchy – Design styles: Filed Programmable Gate Array (FPGA), Gate Array (GA), Standard Cell Based Design – Design Quality

UNIT V APPLICATIONS OF VLSI CIRCUITS 9

VLSI in Ultrasonic Imaging – VLSI in Electrocardiography – VLSI in Holter Monitoring – Safety and Reliability Considerations for VLSI in Medical Electronics

Contact Periods:

Lecture: 45 Periods Tutorial: – Periods Practical: – Periods Project: – Periods

Total: 45 Periods

TEXT BOOKS:

1. Sung Mo Kang, Yusuf Leblebici and Chulwoo Kim, "CMOS Digital Integrated Circuits – Analysis and Design", 4th Edition, Mc Graw Hill India, 2016
2. Douglas A. Pucknell and Kamran Eshraghian, "Basic VLSI Design", Prentice-Hall Inc., 3rd Edition, 1995

REFERENCES:

1. Neil H.E. Weste and David Money Harris, "CMOS VLSI Design: A Circuits and Systems Perspective", Pearson Education India, 4th Edition, 2011
2. Norman G. Einspruch and Robert D. Gold, "VLSI in Medicine", Academic Pres, Inc., 2011
3. Krzysztof Iniewski, "VLSI Circuits for Biomedical Application", Artech House, Inc., 2008
4. Sudeb Dasgupta, "CMOS Digital VLSI Design", https://nptel.ac.in/courses/108107129

EVALUATION PATTERN:

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