ANNA UNIVERSITY, CHENNAI

UNDERGRADUATE CURRICULUM (UNIVERSITY DEPARTMENTS)

Campus: CEG Campus

Department: Department of Biomedical Engineering

Programme: B.E. Biomedical Engineering

Regulations: 2023 (Revised 2024), with effect from the AY 2024 – 25 to all the students of UG Programme.

OVERVIEW OF CREDITS

Sem	PCC	PEC	ESC	HSMC	ETC	OEC	SDC	UC	SLC	Total
I			6	11				1		18
II			11	15				1		27
III	11			8			2			21
IV	16					3	2	2		23
V	11	6					5	3		25
VI	11	3			3	3	1	3		24
VII	4	9			3		6		1	23
VIII							8			8
Total	53	18	17	34	6	6	24	10	1	169
% of Category	31.4	10.5	9.9	19.8	3.5	3.5	15.1	5.8	0.6	100

CATEGORY OF COURSES

PCC – Professional Core Course
PEC – Professional Elective Course
ETC – Emerging Technology Course
OEC – Open Elective Course
SLC – Self Learning Course
ESC – Engineering Science Course
HSMC – Humanities Science and Management Course
SDC – Skill Development Course
UC – University Course

For Honours & Minor Degree, please refer the Regulations 2023 (Revised 2024).

SEMESTER – I							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EN23C01	Foundation English	T	2-0-2	4	3	HSMC
2.	MA23C01	Matrices and Calculus	T	3-1-0	4	4	HSMC
3.	CY23C01	Engineering Chemistry	LIT	3-0-2	5	4	HSMC
4.	CS23C04	Programming in C	LIT	2-0-4	6	4	ESC
5.	EE23C01	Basics of Electrical Engineering	T	2-0-0	2	2	ESC
6.	UC23H01	தமிழர்மரபு /Heritage of Tamils	T	1-0-0	1	1	UC
7.	-	NCC/NSO/NSS		0-0-2	2	0	UC
8.	-	Audit Course –I*	-	-	-	-	UC
					Total Credits	**18**	

*** TCP –** Total Contact Period(s)

#**TYPE OF COURSE**

LIT – Laboratory Integrated Theory
T – Theory
L – Laboratory Course
IPW – Internship cum Project Work
PW – Project Work
CDP – Capstone Design Project

SEMESTER – II							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EN23C02	Professional Communication	LIT	2-0-2	4	3	HSMC
2.	MA23C02	Ordinary Differential Equations and Transform Techniques	T	3-1-0	4	4	HSMC
3.	PH23C01	Engineering Physics	LIT	3-0-2	5	4	HSMC
4.	ME23C03	Engineering Mechanics	T	3-1-0	4	4	ESC
5.	BM23201	Data Structures and Object Oriented Programming in C++	T	3-2-0	5	4	ESC
6.	BM23202	Anatomy and Physiology	LIT	3-0-2	5	4	HSMC
7.	UC23H02	தமிழரும்தொழில்நுட்பமும்/ Tamils and Technology	T	1-0-0	1	1	HSMC
8.	ME23C04	Makerspace	L	1-0-4	5	3	ESC
			TOTAL CREDITS			**27**	

SEMESTER – III							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	MA23C03	Linear Algebra and Numerical Methods	T	3-1-0	4	4	HSMC
2.	BM23301	Fundamentals of Biochemistry	LIT	2-0-2	4	3	HSMC
3.	EC23C04	Circuit Analysis	LIT	2-1-2	5	4	ESC
4.	BM23302	Electronic Devices and Circuits	LIT	3-0-2	5	4	PCC
5.	BM23303	Sensors and Measurements	LIT	3-0-2	5	4	PCC
6.	BM23S01	Skill development course - Level I Sensors and System Engineering	LIT	1-0-2	3	2	SDC
7.	-	Audit Course- II*	T	2-0-0	2	0	UC
				Total Credits		**21**	

SEMESTER – IV							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23401	Biomedical Instrumentation	LIT	3-0-2	5	4	PCC
2.	BM23402	Discrete Time Signal Processing	LIT	3-0-2	5	4	PCC
3.	BM23403	Analog and Digital Integrated Circuits	LIT	3-0-4	7	5	PCC
4.	BM23U01	Medical Standards and Regulations	T	3-0-0	3	3	PCC
5.	-	Open Elective I	T	3-0-0	3	3	OEC
6.	BM23S02	Skill development course - Level II Design and Development of Lab prototype for Biomedical Applications	LIT	1-0-2	3	2	SDC
7.	UC23U01	Universal Human Values	LIT	1-0-2	3	2	UC
					Total Credits	**23**	

SEMESTER – V (Preference for Foreign Exchange)							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23501	Diagnostic and Therapeutic Equipment I	LIT	3-0-2	5	4	PCC
2.	BM23502	Control System for Biomedical Engineering	T	3-0-0	3	3	PCC
3.	BM23503	Microcontrollers and Embedded Systems	LIT	3-0-2	5	4	PCC
4.	-	Professional Elective I	T	3-0-0	3	3	PEC
5.	-	Professional Elective II	T	3-0-0	3	3	PEC
6.	-	Industrial Oriented Course I	-	-	-	1	SDC
7.	BM23U02	Sustainability Course	T	3-0-0	3	3	UC
8.	BM23504	Summer Internship	LIT	0-0-4	4	2	SDC

SEMESTER – V (Preference for Foreign Exchange)							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
9.	BM23S03	**Skill Development Course - Level III** Design and Development of Wearable biosensors	LIT	1-0-2	3	2	SDC
					Total Credits	**25**	
Courses for Honours Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23D01	Capstone Design Project – Level I	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – I				3	
2.	-	Honours Elective – II				3	
Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	-	Minor Elective – I				3	
2.	-	Minor Elective – II				3	

SEMESTER – VI (Preference for Foreign Exchange)							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23601	Diagnostic and Therapeutic Equipment II	LIT	3-0-2	5	4	PCC
2.	BM23602	Biomechanics	LIT	3-0-2	5	4	PCC
3.	BM23C02	Radiological Equipment	T	3-0-0	3	3	PCC
4.	-	Emerging Technology - I	T	3-0-0	3	3	ETC
5.	-	Professional Elective – III	T	3-0-0	3	3	PEC
6.	-	Open Elective II	T	3-0-0	3	3	OEC
7.	UC23E01	Engineering Entrepreneurship Development	LIT	2-0-2	4	3	UC
8.	-	Industrial Oriented Course-II	-	-	-	1	SDC
					Total Credits	**24**	
Courses for Honours Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23D02	Capstone Design Project – Level II	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – III				3	
2.	-	Honours Elective – IV				3	
Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	-	Minor Elective – III				3	
2.	-	Minor Elective – IV				3	

SEMESTER – VII							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23701	Digital Image Processing	LIT	3-0-2	5	4	PCC
2.	-	Emerging Technology - II	T	3-0-0	3	3	ETC
3.	-	Professional Elective IV	T	3-0-0	3	3	PEC
4.	-	Professional Elective V	T	3-0-0	3	3	PEC
5.	-	Professional Elective - VI	T	3-0-0	3	3	PEC
6.	BM23L01	Self-learning Course	T	-	-	1	SLC
7.	-	Industrial Oriented Course-III	-	-	-	1	SDC
8.	BM23703	Hospital Training (8 weeks)	L	0-0-6	6	3	SDC
9.	BM23704	Mini Project	L	0-0-4	2	2	SDC
					Total Credits	**23**	
Courses for Honours Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		3 1	3
				L-T-P	-		
1.	BM23D03	Capstone Design Project – Level III	CDP	0-0-12	12	6	SDC
(OR)							
1.	-	Honours Elective – V				3	
2.	-	Honours Elective – VI				3	
Courses for Minor Degree							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	-	Minor Elective – V					
2.	-	Minor Elective – VI					

SEMESTER – VIII							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23801	Project Work / Internship cum Project Work	L	0-0-16	16	8	SDC
Total Credits						**8**	

TOTAL: 169 CREDITS

PRFSSIONAL ELECTIVE COURSES: VERTICALS					
Vertical I Bio Engineering	**Vertical II Biosignal and Medical Image Processing**	**Vertical III Biomedical Device Development**	**Vertical IV Rehabilitation Engineering**	**Vertical V AI in Health care systems**	**Vertical Minor Biomedical Technology**
Medical Physics	Biometric systems	Foundation Skills in Integrated Product Development	Rehabilitation Engineering	Pattern Recognition and Neural Networks	Medical Instrumentation
Pathology and Microbiology	Pattern Recognition and Neural Networks	Biomedical Device Design and development	Assistive technology	Soft Computing and its applications	Biomedical Equipment
Biomaterials and Artificial organs	Biomedical signal processing	Wearable systems	Ergonomics	Artificial Intelligence In Healthcare	Wearable systems
Biomaterials and Characterization	Artificial Intelligence in Healthcare	Body Area Network	Sports Engineering and Technology	HealthCare Data Analytics	Artificial Intelligence in Healthcare
Principles of Tissue Engineering	Medical Image Analysis &its applications	Smart healthcare technologies and systems	Medical Robotics	Virtual, Augmented and mixed Reality in Medicine	Rehabilitation Engineering
Neural Engineering	Soft Computing and its applications	MEMS and its Biomedical Applications	Haptics	Deep Learning	Sports Engineering and Technology
Advanced bioanalytical and therapeutic techniques	Brain computer Interface and its Applications	Bio Micro Fluidic Devices	Physiological Modeling	Telemedicine technology	Medical Robotics
Biostatistics		Medical Optics	Finite Element methods for biomedical engineering		
Indian traditional medical systems			Health care information systems		
			Hospital Management		

Registration of Professional Elective Courses from Verticals: Professional Elective Courses will be registered from Semesters V to 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. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, more than one course is permitted from the same row, provided each course is enrolled in Semester IV/VI and another in semester V/VII. The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2023, Clause 4.11.

VERTICAL I: BIO ENGINEERING							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23001	Medical Physics	T	3-0-0	3	3	PEC
2.	BM23002	Pathology and Microbiology	LIT	2-0-2	4	3	PEC
3.	BM23003	Biomaterials and Artificial organs	T	3-0-0	3	3	PEC
4.	BM23004	Biomaterials and Characterization	T	3-0-0	3	3	PEC
5.	BM23005	Principles of Tissue Engineering	T	3-0-0	3	3	PEC
6.	BM23006	Neural Engineering	T	3-0-0	3	3	PEC
7.	BM23007	Advanced bioanalytical and therapeutic techniques	T	3-0-0	3	3	PEC
8.	BM23008	Biostatistics	T	3-0-0	3	3	PEC
9.	BM23009	Indian traditional medical systems	T	3-0-0	3	3	PEC

VERTICAL II: BIOSIGNAL AND MEDICAL IMAGE PROCESSING							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23010	Biometric systems	T	3-0-0	3	3	PEC
2.	BM23011	Pattern Recognition and Neural Networks	T	3-0-0	3	3	PEC
3.	BM23012	Biomedical signal processing	LIT	2-0-2	4	3	PEC
4.	BM23013	Artificial Intelligence in Healthcare	T	3-0-0	3	3	PEC
5.	BM23014	Medical Image Analysis &its applications	LIT	2-0-2	4	3	PEC
6.	BM23015	Soft Computing and its applications	T	3-0-0	3	3	PEC
7.	BM23016	Brain Computer Interface and its Applications	T	3-0-0	3	3	PEC

VERTICAL III: BIOMEDICAL DEVICE DEVELOPMENT							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	EC23C22	Foundation Skills in Integrated Product Development	T	3-0-0	3	3	PEC
2.	BM23017	Biomedical Device Design and development	T	3-0-0	3	3	PEC
3.	BM23018	Wearable systems	T	3-0-0	3	3	PEC
4.	BM23C01	Body Area Networks	T	3-0-0	3	3	PEC
5.	BM23019	Smart healthcare technologies and systems	T	3-0-0	3	3	PEC
6.	BM23020	MEMS and its Biomedical Applications	T	3-0-0	3	3	PEC
7.	BM23021	Bio Micro Fluidic Devices	T	3-0-0	3	3	PEC
8.	BM23022	Medical Optics	T	3-0-0	3	3	PEC

VERTICAL IV: REHABILITATION ENGINEERING							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23023	Rehabilitation Engineering	T	3-0-0	3	3	PEC
2.	BM23024	Assistive technology	T	3-0-0	3	3	PEC
3.	BM23025	Ergonomics	T	3-0-0	3	3	PEC
4.	BM23026	Sports Engineering and Technology	T	3-0-0	3	3	PEC
5.	BM23027	Medical Robotics	T	3-0-0	3	3	PEC
6.	BM23028	Haptics	T	3-0-0	3	3	PEC
7.	BM23029	Physiological Modelling	LIT	2-0-2	4	3	PEC
8.	BM23030	Finite Element methods for biomedical engineering	T	3-0-0	3	3	PEC
9.	BM23031	Health care information systems	T	3-0-0	3	3	PEC
10.	BM23032	Hospital Management	T	3-0-0	3	3	PEC

VERTICAL V: AI IN HEALTH CARE SYSTEMS							
S. No.	**Course Code**	**Course Name**	**Course Type#**	**Periods / Week**		**Credits**	**Category**
				L-T-P	**TCP***		
1.	BM23011	Pattern Recognition and Neural Networks	T	3-0-0	3	3	PEC
2.	BM23015	Soft Computing and its applications	T	3-0-0	3	3	PEC
3.	BM23013	Artificial Intelligence in Healthcare	T	3-0-0	3	3	PEC
4.	BM23033	Health Care Data Analytics	T	3-0-0	3	3	PEC
5.	BM23034	Virtual Augmented and mixed Reality in Medicine	T	3-0-0	3	3	PEC
6.	BM23035	Deep Learning	T	3-0-0	3	3	PEC
7.	BM23036	Telemedicine technology	T	3-0-0	3	3	PEC

MINOR PROGRAMME ON BIOMEDICAL TECHNOLOGY
Offered by Department of Biomedical Engineering for other Branch students.

S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1.	BM23037	Medical Instrumentation	T	3-0-0	3	3	PEC
2.	BM23038	Biomedical Equipment	T	3-0-0	3	3	PEC
3.	BM23018	Wearable systems	T	3-0-0	3	3	PEC
4.	BM23013	Artificial Intelligence in Healthcare	T	3-0-0	3	3	PEC
5.	BM23023	Rehabilitation Engineering	T	3-0-0	3	3	PEC
6.	BM23026	Sports Engineering and Technology	T	3-0-0	3	3	PEC
7.	BM23027	Medical Robotics	T	3-0-0	3	3	PEC

EMERGING TECHNOLOGIES

S. No.	Course Code	Course Name	Course Type#	Periods / Week		Credits	Category
				L-T-P	TCP*		
1.	BM23E01	Artificial Intelligence and Machine Learning	LIT	2-0-2	4	3	ETC
2.	BM23E02	Internet of Medical Things	T	3-0-0	3	3	ETC
3.	BM23E03	Biosensors	T	3-0-0	3	3	ETC
4.	BM23E04	Embedded System Design	T	2-0-2	4	3	ETC

EN23C01 **FOUNDATION ENGLISH** **L T P C**
2 0 2 3

COURSE OBJECTIVES:

- To develop students' foundational skills in reading, writing, grammar and vocabulary to enable them to understand and produce various forms of communication.
- To enhance students' proficiency in reading comprehension, narrative and comparative writing.
- To comprehend and analyse descriptive texts and visual images
- To articulate similarities and differences in oral and written forms.
- To improve students' proficiency in reading and writing formal letters and emails.

UNIT I BASICS OF COMMUNICATION **6**

Reading - Telephone message, bio-note; Writing – Personal profile; Grammar – Simple present tense, Present continuous tense, wh-questions, indirect questions; Vocabulary – Word formation (Prefix and Suffix).

LAB ACTIVITY: **6**

Listening – Telephone conversation; Speaking Self-introduction; Telephone conversation – Video conferencing etiquette

UNIT II NARRATION **6**

Reading – Comprehension strategies - Newspaper Report, An excerpt from an autobiography; Writing – Narrative Paragraph writing (Event, personal experience etc.); Grammar – Subject-verb agreement, Simple past, Past continuous Tenses; Vocabulary – One-word substitution

LAB ACTIVITY: **6**

Listening – Travel podcast; Speaking – Narrating and sharing personal experiences through a podcast

UNIT III DESCRIPTION **6**

Reading – A tourist brochure, Travel blogs, descriptive article/excerpt from literature, visual images; Writing –Descriptive Paragraph writing, Grammar – Future tense, Perfect tenses, Preposition; Vocabulary – Descriptive vocabulary

LAB ACTIVITY: **6**

Listening – Railway / Airport Announcements, Travel Vlogs; Speaking – Describing a place or picture description

UNIT IV COMPARE AND CONTRAST **6**

Reading – Reading and comparing different product specifications - Writing – Compare and Contrast Essay, Coherence and cohesion; Grammar – Degrees of Comparison; Vocabulary – Transition words (relevant to compare and contrast)

LAB ACTIVITY: **6**

Listening – Product reviews, Speaking – Product comparison based on product reviews - similarities and differences

UNIT V EXPRESSION OF VIEWS **6**

Reading – Formal letters, Letters to Editor ; Writing – Letter writing/ Email writing (Enquiry / Permission, Letter to Editor); Grammar – Compound nouns, Vocabulary – Synonyms, Antonyms

LAB ACTIVITY: **6**

Listening – Short speeches; Speaking – Making short presentations (JAM)

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
- Written assessments
- Assignment

Lab assessment
- Listening
- Speaking

External Assessment
- End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- Use appropriate grammar and vocabulary to read different types of text and converse appropriately.
- Write coherent and engaging descriptive and comparative essay writing.
- Comprehend and interpret different kinds of texts and audio visual materials
- Critically evaluate reviews and articulate similarities and differences
- Write formal letters and emails using appropriate language structure and format

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022
2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES

1. “Interchange” by Jack C.Richards, Fifth Edition, Cambridge University Press, 2017.
2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.
3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019
4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		
CO3										√		√
CO4										√		
CO5										√		√

MA23C01	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To develop the use of matrix algebra techniques in solving practical problems.
- To familiarize the student with functions of several variables.
- To solve integrals by using Beta and Gamma functions.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals.
- To acquaint the students with the concepts of vector calculus which naturally arise in many engineering problems.

UNIT I MATRICES **9+3**

Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors- Cayley-Hamilton theorem (excluding proof) – Diagonalization of matrices - Reduction of Quadratic form to canonical form by using orthogonal transformation - Nature of a Quadratic form.

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

Limit, continuity, partial derivatives – Homogeneous functions and Euler's theorem - Total derivative – Differentiation of implicit functions – Jacobians -Taylor's formula for two variables - Errors and approximations – Maxima and Minima of functions of two variables – Lagrange's method of undermined multipliers.

UNIT III INTEGRAL CALCULUS **9+3**

Improper integrals of the first and second kind and their convergence – Differentiation under integrals - Evaluation of integrals involving a parameter by Leibnitz rule – Beta and Gamma functions-Properties – Evaluation of single integrals by using Beta and Gamma functions..

UNIT IV MULTIPLE INTEGRALS **9+3**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of Solids – Change of variables in double and triple integrals-
Evaluation of double and triple integrals by using Beta and Gamma functions.

UNIT V VECTOR CALCULUS **9+3**

Gradient of a scalar field, directional derivative – Divergence and Curl – Solenoidal and Irrotational vector fields - Line integrals over a plane curve - Surface integrals – Area of a curved surface – Volume Integral - Green's theorem, Stoke's and Gauss divergence theorems (without proofs)– Verification and applications in evaluating line, surface and volume integrals.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students wherever applicable from the content of the course.

General engineering applications / branch specific applications from the content of each units wherever possible will be introduced to students.

Suggested Laboratory based exercises / assignments / assessments :

Matrices

1. Finding eigenvalues and eigenvectors
2. Verification of Cayley-Hamilton theorem
3. Eigenvalues and Eigenvectors of similar matrices
4. Eigenvalues and Eigenvectors of a symmetric matrix
5. Finding the powers of a matrix
6. Quadratic forms

Functions of Several Variables

1. Plotting of curves and surfaces
2. Symbolic computation of partial and total derivatives of functions

Integral Calculus

1. Evaluation of beta and gamma functions
2. Computation of error function and its complement

Multiple Integrals

1. Plotting of 3D surfaces in Cartesian and Polar forms

Vector Calculus

1. Computation of Directional derivatives
2. Computation of normal and tangent to the given surface

OUTCOMES:

CO 1 :Use the matrix algebra methods for solving practical problems.
CO 2 :Use differential calculus ideas on several variable functions.
CO 3 :Apply different methods of integration in solving practical problems by using Beta and Gamma functions.
CO 4 :Apply multiple integral ideas in solving areas and volumes problems.
CO 5 :Apply the concept of vectors in solving practical problems.

TEXT BOOKS:

1. Joel Hass, Christopher Heil, Maurice D.Weir "'Thomas' Calculus", Pearson Education., New Delhi, 2018.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 45th Edition, New Delhi, 2020.
3. James Stewart, Daniel K Clegg & Saleem Watson "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2023.

REFERENCES:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.
2. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics",Narosa Publications, 5th Edition, New Delhi, 2017.
4. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
6. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO5 :	3	3	2	3	1	2	1	1	1	1	1	3

PH23C01	ENGINEERING PHYSICS	L	T	P	C
	(Common to all branches of B.E/B.Tech Programmes)	3	0	2	4

COURSE OBJECTIVES

- To familiarize with crystal structure, bonding and crystal growth.
- To impart knowledge on Mechanics of Materials.
- To impart knowledge of oscillations, sound and Thermal Physics
- To facilitate understanding of optics and its applications, different types of Lasers and fiber optics.
- To introduce the basics of Quantum Mechanics and its importance.

UNIT I CRYSTAL PHYSICS 9+6

Crystal Bonding – Ionic – covalent – metallic and van der Walls's/ molecular bonding. Crystal systems - unit cell, Bravais lattices, Miller indices - Crystal structures - atomic packing density of BCC, FCC and HCP structures. NaCl, Diamond, Graphite, Graphene, Zincblende and Wurtzite structures - crystal imperfections- point defects - edge and screw dislocations – grain boundaries. Crystal Growth – Czocharalski method – vapor phase epitaxy – Molecular beam epitaxy- Introduction to X-Ray Diffractometer.

1. Determination of Lattice parameters for crystal systems.
2. Crystal Growth – Slow Evaporation method
3. Crystal Growth Sol – Gel Method

UNIT II MECHANICS OF MATERIALS 9+6

Rigid Body – Centre of mass – Rotational Energy - Moment of inertia (M.I)- Moment of Inertia for uniform objects with various geometrical shapes. Elasticity –Hooke's law - Poisson's ratio - stress-strain diagram for ductile and brittle materials – uses- Bending of beams – Cantilever - Simply supported beams - uniform and non-uniform bending - Young's modulus determination - I shaped girders –Twisting couple – Shafts. Viscosity – Viscous drag – Surface Tension.

1. Non-uniform bending -Determination of Young's modulus of the material of the beam.
2. Uniform bending -Determination of Young's modulus of the material of the beam
3. Viscosity – Determination of Viscosity of liquids.

UNIT III OSCILLATIONS, SOUND AND THERMAL PHYSICS 9+6

Simple harmonic motion - Torsional pendulum –- Damped oscillations –Shock Absorber -Forced oscillations and Resonance –Applications of resonance.- Waves and Energy Transport –Sound waves – Intensity level – Standing Waves - Doppler effect and its applications - Speed of blood flow. Ultrasound – applications - Echolocation and Medical Imaging. Thermal Expansion – Expansion joints – Bimetallic strip – Seebeck effect – thermocouple -Heat Transfer Rate – Conduction – Convection and Radiation.

1. Torsional pendulum-Determination of rigidity modulus of wire and moment of inertia of the disc
2. Melde's string experiment - Standing waves.
3. Ultrasonic interferometer – determination of sound velocity and liquids compressibility

UNIT IV OPTICS AND LASERS 9+6

Interference - Thin film interference - Air wedge- Applications -Interferometers–Michelson Interferometer -– Diffraction - CD as diffraction grating – Diffraction by crystals -Polarization - polarizers -– Laser – characteristics – Spontaneous and Stimulated emission- population – inversion - Metastable states - optical feedback - Nd-YAG laser, CO_2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibers – Total internal reflection – Numerical aperture and acceptance angle – Fiber optic communication – Fiber sensors – Fiber lasers.

1. Laser - Determination of the width of the groove of the compact disc using laser.
   Laser Parameters
   Determination of the wavelength of the laser using grating
2. Air wedge -Determination of the thickness of a thin sheet/wire
3. Optical fibre - Determination of Numerical Aperture and acceptance angle
   -Determination of bending loss of fibre.
4. Michelson Interferometer (Demonstration)

UNIT V QUANTUM MECHANICS 9+6

Black body radiation (Qualitative) – Planck's hypothesis – Einstein's theory of Radiation - Matter waves– de Broglie hypothesis - Electron microscope – Uncertainty Principle – The Schrodinger Wave equation (time-independent and time-dependent) – Meaning and Physical significance of wave function - Normalization - Particle in an infinite potential well-particle in a three-dimensional box - Degenerate energy states - Barrier penetration and quantum tunneling - Tunneling microscope.

1. Photoelectric effect – Determination of Planck's constant.
2. Black Body Radiation (Demonstration)
3. Electron Microscope (Demonstration)

TOTAL: 75 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to

CO1: Understand the significance of crystal structure and bonding. Learn to grow crystals.

CO2: Obtain knowledge on important mechanical and thermal properties of materials and determine them through experiments.

CO3: Conceptualize and visualize the oscillations and sound.

CO4: Grasp optical phenomenon and their applications in real life.

CO5: Appreciate and evaluate the quantum phenomenon.

CO6 Develop skill set to solve engineering problems and design experiments.

TEXT BOOKS:

1. Raymond A. Serway, John W. Jewett, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2013.
2. D. Halliday, R. Resnick and J. Walker, Principles of Physics. John Wiley & Sons, 10th Edition, 2015.
3. N. Garcia, A. Damask and S. Schwarz, Physics for Computer Science Students, Springer-Verlag, 2012.
4. Alan Giambattista, Betty McCarthy Richardson and Robert C. Richardson, College Physics, McGraw-Hill Higher Education, 2012.

REFERENCES:

1. R. Wolfson, Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D. Kleppner and R. Kolenkow. An Introduction to Mechanics, McGraw Hill Education, 2017.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1		1							
CO2	3	2	1	1								
CO3	3	2	1	1								
CO4	3	2	1	1	1							
CO5	3	2	1	1	1							
CO6	3	2	1	2								

CY23C01 ENGINEERING CHEMISTRY L T P C

3 0 2 4

UNIT I WATER TECHNOLOGY

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD, BOD, and heavy metals. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, Calgon, and carbonate treatment. External conditioning – demineralization. Municipal water treatment (screening, sedimentation, coagulation, filtration, disinfection-ozonolysis, UV treatment, chlorination), Reverse Osmosis – desalination.

PRACTICAL:

- Estimation of HCl using Na_2CO_3 as the primary standard
- Determination of alkalinity in the water sample.
- Determination of hardness of water by EDTA method.
- Determination of DO content of water sample by Winkler's method.

UNIT II NANOCHEMISTRY

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties (optical, electrical, mechanical, magnetic and catalytic). Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro-spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Applications of nanomaterials – medicine including AYUSH, automobiles, electronics, and cosmetics.

PRACTICAL:

- Preparation of nanoparticles by Sol-Gel method/sonication method.
- Preparation of nanowire by Electrospinning.
- Study of morphology of nanomaterials by scanning electron microscopy

UNIT III CORROSION SCIENCE

Introduction to corrosion – chemical and electrochemical corrosions – mechanism of electrochemical and galvanic corrosions – concentration cell corrosion-soil, pitting, inter-granular, water line, stress and microbiological corrosions-galvanic series-factors influencing corrosion- measurement of corrosion rate. Electrochemical protection – sacrificial anodic protection and impressed current cathodic protection. Protective coatings-metallic coatings (galvanizing, tinning), organic coatings (paints). Paints: Constituents and functions.

PRACTICAL:

- Corrosion experiment-weight loss method.
- Salt spray test for corrosion study.
- Corrosion prevention by electroplating.
- Estimation of corroded Iron by Potentiometry/UV-visible spectrophotometer

UNIT IV ENERGY SOURCES

Electrochemical cell, redox reaction, electrode potential – oxidation and reduction potential. Batteries – Characteristics; types of batteries; primary battery (dry cell), secondary battery (lead acid, lithium-ion battery) and their applications. Emerging energy sources – metal hydride battery, hydrogen energy, Fuel cells – H_2-O_2 fuel cell. Supercapacitors –Types and Applications, Renewable Energy: solar heating and solar cells. Recycling and disposal of batteries.

PRACTICAL:

- Study of components of Lead acid battery.
- Measurement of voltage in a photovoltaic cell.
- Working of $H_2 – O_2$ fuel cell

UNIT V POLYMER CHEMISTRY

Introduction: Functionality-degree of polymerization. Classification of polymers (Source, Structure, Synthesis and Intermolecular forces). Mechanism of free radical addition polymerization. Properties of polymers: Tg, tacticity, molecular weight-number average, weight average, viscosity average and polydispersity index (Problems). Techniques of polymerization: Bulk, emulsion, solution and suspension. Compounding and Fabrication Techniques: Injection, Extrusion, Blow and Calendaring. Polyamides, Polycarbonates and Polyurethanes – structure and applications. Recycling of polymers.

PRACTICAL:

- Determination of molecular weight of a polymer using Ostwald viscometer.
- Preparation of a polymer.
- Determination of molecular weight by Gel Permeation Chromatography.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

CO1: To demonstrate knowledge of water quality in various industries and develop skills in analyzing water quality parameters for both domestic and industrial purposes.

CO2: To identify and apply fundamental concepts of nanoscience and nanotechnology for engineering and technology applications, and to develop skills in synthesizing nanomaterials and studying their morphology.

CO3: To apply fundamental knowledge of corrosion protection techniques and develop skills to conduct experiments for measuring and preventing corrosion.

CO4: To study the fundamentals of energy storage devices and develop skills in constructing and experimenting with batteries.

CO5: To recognize and apply basic knowledge of different types of polymeric materials and develop skills in preparing and determining their applications for futuristic material fabrication needs.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. Dara S.S., “A Textbook of Engineering Chemistry”, Chand Publications, 2004.
4. Laboratory Manual - Department of Chemistry, CEGC, Anna University (2023).

REFERENCES:

1. Schdeva M.V., “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd, 2011.
2. Friedrich Emich, “Engineering Chemistry”, Medtech, 2014.
3. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.
4. Vogel’s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

CO - PO Mapping

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

1’ = Low; ‘2’ = Medium; ‘3’ = High

CS23C04	PROGRAMMING IN C	L T P C 2 0 4 4

UNIT I BASICS OF C PROGRAMMING 6+12

Introduction to programming paradigms –- Structure of C program - C programming: Data Types - Constants - Keywords - Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements - Decision making statements - Switch statement.

PRACTICALS

1. Designing programs with algorithms/flowchart
2. Programs for i/o operations with different data types

SUGGESTED ACTIVITIES:

- EL - Programs using integer type, arithmetic operators and basic input/output.
- EL - Programs using other data types and operators.
- EL: Programs using else-if, switch

UNIT II LOOP CONTROL STATEMENTS AND ARRAYS 6+12

Iteration statements: For, while, Do-while statements, nested loops, break & continue statements - Introduction to Arrays: Declaration, Initialization - One dimensional array -Two dimensional arrays – Searching and sorting in Arrays – Strings – string handling functions - array of strings

PRACTICALS

1. Programs using various operators
2. Programs using decision making and branching statements
3. Programs using for, while, do-while loops and nested loops.
4. Programs using arrays and operations on arrays.
5. Programs implementing searching and sorting using arrays
6. Programs implementing string operations on arrays

SUGGESTED ACTIVITIES:

- EL: Programs using while, for,do-while, break, continue, enum.
- EL - Programs using arrays and operations on arrays.
- EL - Programs implementing string operations on arrays.
- EL - Programs using functions.

UNIT III FUNCTIONS AND POINTERS 6+12

Modular programming - Function prototype, function definition, function call, Built-in functions – Recursion – Recursive functions - Pointers - Pointer increment, Pointer arithmetic - Parameter passing: Pass by value, Pass by reference, pointer and arrays, dynamic memory allocation

PRACTICALS

1. Programs using functions
2. Programs using recursion
3. Programs using pointers & strings with pointers
4. Programs using Dynamic Memory Allocation

SUGGESTED ACTIVITIES:

- EL - Programs using recursion.

- EL - Programs using pointers and arrays, address arithmetic.
- EL - Programs using Dynamic Memory Allocation, two dimensional arrays and pointers.
- EL - Programs using Pointers and strings.

UNIT IV STRUCTURES AND UNION 6+12

Storage classes, Structure and union, Features of structures, Declaration and initialization of structures, array of structures, Pointer to structure, structure and functions, typedef , bit fields , enumerated data types, Union.

PRACTICALS

1. Programs using Structures
2. Programs using Unions
3. Programs using pointers to structures and self-referential structures.

SUGGESTED ACTIVITIES:

- EL - Programs using structures and arrays.
- EL - Programs using Pointers to structures, Self-referential structures.

UNIT V MACROS AND FILE PROCESSING 6+12

Preprocessor directives – Simple and Conditional macros with and without parameters - Files - Types of file processing: Sequential and Random access – File operations – read, write & seek.

PRACTICALS

1. Programs using pre-processor directives & macros
2. Programs to handle file operations
3. Programs to handle file with structure

SUGGESTED ACTIVITIES:

- EL - Programs using file operations in real-world applications

TOTAL: 90 (30+60) PERIODS

TEXT BOOKS:

1. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2015.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

REFERENCE BOOKS:

1. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
2. Ashok N Kamthane, Programming in C, Pearson, Third Edition, 2020
3. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
4. Paul Deitel and Harvey Deitel, "C How to Program with an Introduction to C++", Eighth edition, Pearson Education, 2018.
5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C'" McGraw-Hill Education, 1996.
6. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", 1st Edition, Pearson Education, 2013.

COURSE OUTCOMES:

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

CO1: Write simple C programs using basic constructs.

CO2: Design searching and sorting algorithms using arrays and strings.

CO3: Implement modular applications using Functions and pointers.

CO4: Develop and execute applications using structures and Unions.

CO5: Illustrate algorithmic solutions in C programming language using files.

Total Hours: 90 (30+60)

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1	3	2	1	-	-	-	2	-	3	1	2	2
2	2	1	1	3	2	1	-	-	-	-	-	3	1	2	2
3	2	2	1	3	2	1	-	-	3	-	3	3	1	2	2
4	2	1	1	3	2	1	-	-	3	-	3	3	1	2	2
5	2	3	1	3	2	1	-	-	-	2	3	3	1	2	2

1 - low, 2 - medium, 3 – high

EE23C01 **BASICS OF ELECTRICAL ENGINEERING** **L T P C**
2 0 0 2

UNIT I BASIC CIRCUITS 6

Electrical circuit elements (R, L and C)- Ohm's Law- Kirchhoff's laws - mesh current and node voltage methods (Analysis with only independentsource) - Phasors – RMS-Average values-sinusoidal steady state response of simple RLC circuits.

UNIT II THREE PHASE CIRCUITS and DOMESTIC WIRING 6

Star connection – Delta connection –Balanced and Unbalanced Loads- Power in three-phase systems. Types of wiring- Domestic wiring - Specification of Wires-Earthing-Methods-Protective devices.

UNIT III MAGNETIC CIRCUITS 6

Magnetic circuits-Definitions-MMF, Flux, Reluctance, Magnetic field intensity, Flux density, Fringing, self and mutual inductances-simple problems.

UNIT IV DC MACHINES 6

Working principle of DC generator, motor-EMF and Torque equation-Types –Shunt, Series and Compound-Applications, Stepper motor-Applications

UNIT V AC MACHINES 6

Working principle of transformer-EMF equation-Operating principles of three phase induction motor-Applications. Working principles of alternator-EMF equation-Operating principles of Synchronous motor.

TOTAL: 3 0 PERIODS

OUTCOMES:
Students will be able to

CO1 Analyze the concepts of electrical circuits
CO2 Analyze the three phase circuits and wiring
CO3 Understand the concept of magnetic fields
CO4 Understand the operating principle of DC machines
CO5 Understand the operating principle of AC machines

TEXT BOOKS:

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 2014.
2. Salivahanan S, Rangaraj R, Venkatakrishnan G R, "Basic Electrical Electronics and Measurement Engineering", McGraw Hill, 2018.

REFERENCES:

1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", McGraw Hill, 2010.
2. Mehta V.K. & Mehta Rohit, "Principles of Electrical Machines", S. Chand Publishing, second edition 2006.
3. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, 2nd Edition, New Delhi, 1989.
4. John Bird, "Electrical Circuit theory and technology", Routledge; 5th Edition, 2013.

Mapping COs and POs:																
COs	**POs**												**PSOs**			
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**
CO1	2	2	2	1	-	-	1	-	-	-	-	1	-	-	-	-
CO2	2	2	2	1	-	-	1	-	-	-	-	1	-	-	-	-
CO3	2	2	2	1	-	-	1	-	-	-	-	1	-	-	-	-
CO4	2	2	2	1	-	-	1	-	-	-	-	1	-	-	-	-
CO5	2	2	2	1	-	-	1	-	-	-	-	1	-	-	-	-
Avg	2	2	2	1	-	-	1	-	-	-	-	1	-	-	-	-

UC23H01 தமிழர்மரபு /HERITAGE OF TAMILS L T P C
1 0 0 1

அலகு I <u>மொழி மற்றும் இலக்கியம்</u>: 3

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

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

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

அலகு III <u>நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்</u>: 3

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

அலகு IV <u>தமிழர்களின் திணைக் கோட்பாடுகள்</u>: 3

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

அலகு V <u>இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு</u>: 3

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல்

துறை வெளியீடு)

4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H01 **HERITAGE OF TAMILS** **L T P C**
1 0 0 1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).

8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

NCC Credit Course Level 1*

UC23P01	(ARMY WING) NCC Credit Course Level - I	L	T	P	C
		2	0	0	2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour 'Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P02	(NAVAL WING) NCC Credit Course Level – I	L T P C 2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

NCC Credit Course Level 1*

UC23P03	(AIR FORCE WING) NCC Credit Course Level – I	L T P C 2 0 0 2

NCC GENERAL		**6**
NCC 1	Aims, Objectives & Organization of NCC	1
NCC 2	Incentives	2
NCC 3	Duties of NCC Cadet	1
NCC 4	NCC Camps: Types & Conduct	2
NATIONAL INTEGRATION AND AWARENESS		**4**
NI 1	National Integration: Importance & Necessity	1
NI 2	Factors Affecting National Integration	1
NI 3	Unity in Diversity & Role of NCC in Nation Building	1
NI 4	Threats to National Security	1
PERSONALITY DEVELOPMENT		**7**
PD 1	Self-Awareness, Empathy, Critical & Creative Thinking, Decision Making and Problem Solving	2
PD 2	Communication Skills	3
PD 3	Group Discussion: Stress & Emotions	2
LEADERSHIP		**5**
L 1	Leadership Capsule: Traits, Indicators, Motivation, Moral Values, Honour Code	3
L 2	Case Studies: Shivaji, Jhasi Ki Rani	2
SOCIAL SERVICE AND COMMUNITY DEVELOPMENT		**8**
SS 1	Basics, Rural Development Programmes, NGOs, Contribution of Youth	3
SS 4	Protection of Children and Women Safety	1
SS 5	Road / Rail Travel Safety	1
SS 6	New Initiatives	2
SS 7	Cyber and Mobile Security Awareness	1

TOTAL : 30 PERIODS

EN23C02	PROFESSIONAL COMMUNICATION	L T P C
		2 0 2 3

COURSE OBJECTIVES:

- To read and comprehend different forms of official texts.
- To develop students' writing skills in professional context.
- To actively listen, read and understand written and oral communication in a professional context.
- To comprehend and analyse the visual content in authentic context.
- To write professional documents with clarity and precision

UNIT I CAUSE AND EFFECT 6

Reading – Newspaper articles on Social and Environmental issues; Writing – Instructions, Cause and effect essay; Grammar - Modal verbs; Vocabulary – Cause and effect, Idioms

LAB ACTIVITY: 6

Listening and Speaking – Listen to news reports and summarise in oral form.

UNIT II CLASSIFICATION 6

Reading – An article, social media posts and classifying based on the content; Writing – Definition, Note making, Note taking (Cornell notes etc.) and Summarising; Grammar – Connectives; Vocabulary – Phrasal verbs

LAB ACTIVITY: 6

Listening and speaking: Social interaction (Conversation including small talk)

UNIT III PROBLEM AND SOLUTION 6

Reading – Visual content (Tables/charts/graphs) for comprehension; Writing - Problem and Solution Essay; Grammar – If conditionals; Vocabulary – Sequential words.

LAB ACTIVITY: 6

Listening – Group discussion; Speaking – Participating in a group discussion

UNIT IV REPORT 6

Reading – Formal report on accidents (industrial/engineering); Writing – Industrial Accident report; Grammar – Active and passive voice, Direct and Indirect speech; Vocabulary – Numerical adjectives.

LAB ACTIVITY: 6

Listening / watching – Television documentary and discussing its content, purpose etc.

UNIT V JOB APPLICATION AND INTERVIEW 6

Reading - Job advertisement and company profile; Writing – Job application (cover letter and CV) Grammar – Mixed Tenses; Vocabulary – Collocations related to work environment

LAB ACTIVITY: 6

Listening – Job interview; Speaking – Mock interviews

TOTAL: 60 PERIODS

TEACHING METHODOLOGY

Interactive lectures, role plays, group discussions, listening and speaking labs, technology enabled language teaching, flipped classroom.

EVALUATION PATTERN

Internal Assessment
- Written assessments
- Assignment

Lab Assessment
- Group discussion (Peer assessment)
- Listening

External Assessment
End Semester Examination

LEARNING OUTCOMES

By the end of the courses, students will be able to

- To apply appropriate language structure and vocabulary to enhance both spoken and written communication in formal contexts.
- Comprehend different forms of official documents
- Write professional documents coherently and cohesively.
- Interpret verbal and graphic content in authentic context
- Analyse and evaluate verbal and audio visual materials.

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume 2 by Orient Blackswan, 2022
2. “English for Science & Technology - II” by Cambridge University Press, 2023.

REFERENCES:

1. “Communicative English for Engineers and Professionals” by Bhatnagar Nitin, Pearson India, 2010.
2. ”Take Off – Technical English for Engineering” by David Morgan, Garnet Education, 2008.
3. “Advanced Communication Skills” by Mathew Richardson, Charlie Creative Lab, 2020.
4. www.uefap.com

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										√		√
CO2										√		√
CO3										√		√
CO4										√		√
CO5										√		√

MA23C02	ORDINARY DIFFERENTIAL EQUATIONS AND TRANSFORM TECHNIQUES	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To acquaint the students with Differential Equations which are significantly used in engineering problems.
- To make the students to understand the Laplace transforms techniques.
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series.
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic.
- To develop Z- transform techniques in solving difference equations.

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 9+3

Homogeneous linear ordinary differential equations of second order -superposition principle - general solution- Particular integral - Operator method - Solution by variation of parameters - Method of undetermined coefficients - Homogeneous equations of Euler–Cauchy and Legendre's type – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 9+3

Existence theorem - Transform of standard functions – Transform of Unit step function and Dirac delta function – Basic properties - Shifting theorems - Transforms of derivatives and integrals – Transform of periodic functions - Initial and Final value theorem - Inverse Laplace transforms- Convolution theorem (without proof) – Solving Initial value problems by using Laplace Transform techniques.

UNIT III FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Computation of harmonics.

UNIT IV FOURIER TRANSFORMS 9+3

Fourier integral theorem – Fourier transform pair - Fourier sine and cosine transforms – Properties – Transform of elementary functions – Inverse Fourier Transforms - Convolution theorem (without proof) – Parsevals's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3

Z-transform – Properties of Z-transform – Inverse Z-transform – Convolution theorem – Evaluation of Inverse Z transform using partial fraction method and convolution theorem - Initial and final value theorems – Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.

Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

Ordinary differential equations

1. Symbolic computation of linear ordinary differential equations
2. Solving System of simultaneous linear differential equations using ODE SOLVER

Laplace transforms

1. Symbolic computation of Laplace transform and Inverse Laplace transform
2. Plotting Laplace transforms

Fourier Series

1. Symbolic computation of Fourier Coefficients
2. Computation of harmonics
3. Plotting truncated Fourier Series

Fourier Transform

1. Symbolic computation of Fourier Transforms
2. Plotting truncated Fourier Transforms

Z – transform

1. Symbolic computation of Z-Transforms

OUTCOMES:

CO1 :Solve higher order ordinary differential equations which arise in engineering applications.
CO2 :Apply Laplace transform techniques in solving linear differential equations.
CO3 :Apply Fourier series techniques in engineering applications.
CO4 :Understand the Fourier transforms techniques in solving engineering problems.
CO5 :Understand the Z-transforms techniques in solving difference equations.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 45th Edition, New Delhi, 2020.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Pvt Ltd., New Delhi, 2018.

REFERENCES:

1. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
2. Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5 th Edition, New Delhi, 2017.
4. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7 th Edition, New Delhi , 2012.
5. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

ME23C03	ENGINEERING MECHANICS	L T P C
		3 1 0 4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

- Determining the resultant forces acting on a particle in 2D and 3D and for applying methods of equilibrium on a particle in 2D and 3D.
- Evaluating the reaction forces for bodies under equilibrium, for determining the moment of a force, moment of a couple, for resolving force into a force-couple system and for analyzing trusses
- Assessing the centroids of 2D sections / center of gravity of volumes and for calculating area moments of inertia for the sections and mass moment of inertia of solids.
- Evaluating the frictional forces acting at the contact surfaces of various engineering systems and for applying the work-energy principles on a particle.
- Determining kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I STATICS OF PARTICLES 9+3

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II EQUILIBRIUM OF RIGID BODIES AND TRUSSES 9+3

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections – Analysis of Trusses – Method of Joints and Method of Sections.

UNIT III DISTRIBUTED FORCES 9+3

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration , Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION AND WORK PRINCIPLES 9+3

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance, Ladder friction. Work of a Force, Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

UNIT V DYNAMICS OF PARTICLES AND RIGID BODIES 9+3

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles. Kinetics- Newton's Second Law of Motion -Equations of Motions, Dynamic Equilibrium, Energy and Momentum Methods – Kinematics of Rigid Bodies and Plane Kinetics.

TOTAL : 60 PERIODS

COURSE OUTCOMES:

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

1. To determine the resultant forces acting on a particle in 2D and 3D and to apply methods of equilibrium on a particle in 2D and 3D.
2. Evaluate the reaction forces for bodies under equilibrium, to determine moment of a force, moment of a couple, to resolve force into a force-couple system and to analyze trusses
3. Assess the centroids of 2D sections / center of gravity of volumes and to calculate area moments of inertia for the sections and mass moment of inertia of solids.
4. Evaluate the frictional forces acting at the contact surfaces of various engineering systems and apply the work-energy principles on a particle. evaluate the kinetic and kinematic parameters of a particle.
5. Determine kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 12th Edition, 2019.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	3									3		
2	3	3	2	3									3		
3	3	3	2	3									3		
4	3	3	2	3									3		
5	3	3	2	3									3		
Avg	3	3	2	3									3		

BM23201	DATA STRUCTURES AND OBJECT ORIENTED PROGRAMMING IN C++	L	T	P	C
		3	2	0	4

UNIT I DATA ABSTRACTION & OVERLOADING 9

Overview of C++ – Structures – Class Scope and Accessing Class Members – Reference Variables – Initialization – Constructors – Destructors – Member Functions and Classes – Friend Function – Dynamic Memory Allocation – Static Class Members – Container Classes and Integrators – Proxy Classes – Overloading: Function overloading and Operator Overloading.

UNIT II INHERITANCE & POLYMORPHISM 9

Base Classes and Derived Classes – Protected Members – Casting Class pointers and Member Functions – Overriding – Public, Protected and Private Inheritance – Constructors and Destructors in derived Classes – Implicit Derived – Class Object To Base – Class Object Conversion – Composition Vs. Inheritance – Virtual functions – This Pointer – Abstract Base Classes and Concrete Classes – Virtual Destructors – Dynamic Binding.

UNIT III LINEAR DATA STRUCTURES 9

Asymptotic Notations: Big-Oh, Omega and Theta – Best, Worst and Average case Analysis: Definition and an example – Arrays and its representations – Stacks and Queues – Linked lists – Linked list based implementation of Stacks and Queues – Evaluation of Expressions – Linked list based polynomial addition.

UNIT IV NON-LINEAR DATA STRUCTURES 9

Trees – Binary Trees – Binary tree representation and traversals – Threaded binary trees – Binary tree representation of trees – Application of trees: Set representation and Union-Find operations – Graph and its representations – Graph Traversals – Connected components.

UNIT V SORTING & SEARCHING 9

Insertion sort – Merge sort – Quick sort – Heap sort – Linear Search – Binary Search

TOTAL:45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Ability to comprehend and appreciate the significance and role of this course in the present contemporary world
- **CO2** Select suitable data structure for specific Application.
- **CO3** Compare Linear and nonlinear data structures for different application
- **CO4** Perform different searching and sorting techniques.
- **CO5** Identify connected components in trees
- **CO6** Analyze asymptotic notations

TEXT BOOKS:

1. Deitel and Deitel, — C++, How To Program‖, Fifth Edition, Pearson Education, 2005.

2. Ellis Horowitz, Sartaj Sahni and Dinesh Mehta, Fundamentals of Data Structures in C++, Galgotia, New Delhi, 1995.

REFERENCES:

1. Mark Allen Weiss, —Data Structures and Algorithm Analysis in C++‖, Third Edition, Addison Wesley, 2007.
2. Bhushan Trivedi, —Programming with ANSI C++, A Step-By-Step approach‖, Oxford University Press, 2010.
3. Goodrich, Michael T., Roberto Tamassia, —David Mount. Data Structures and Algorithms in C++‖, 7th ed, Wiley. 2004.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1															
CO2															
CO3															
CO4															
CO5															
Avg															

BM23202	ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	2	4

UNIT I INTRODUCTION TO HUMAN BODY 9L

Cell: Structure and organelles - Functions of each component in the cell. Cell membrane – transport across membrane – Origin of cell membrane potential – Action potential - Recording of Membrane Potential. Homeostasis - Body Cavities -Tissue: Epithelial, Connective, Muscular and Nervous tissue. Physiology of GI tract and Endocrine system.

UNIT II RESPIRATORY SYSTEM AND URINARY SYSTEM 9L+6P

Respiratory System: Organization of respiratory system – Respiratory organs - Respiratory Mechanism. Types of respiration - Respiratory volumes and Recording of respiratory volume. Oxygen and carbon dioxide transport and acid base regulation. Urinary system: Basic Structure of Kidney and Nephron. Mechanism of Urine formation – JXT apparatus - Urinary reflex – Water and blood pressure regulation by urinary system.

Practical:

- **Respiratory Volume Test - Spirometry**

UNIT III CARDIOVASCULAR, BLOOD AND LYMPHATIC SYSTEM 9L+12P

Composition of Blood - functions of blood – Blood Cells: RBC - Functions - WBC - Types and functions - Platelet. Blood groups – importance of identification. Blood vessels: Vein, Artery and Capillaries - Structure of heart – Properties of Cardiac muscle – Conducting system of heart – Cardiac cycle – Heart sound -Volume and pressure changes and regulation of heart rate – Coronary Circulation. Lymph - Lymphatic vessels - Lymph nodes and Lymphatic Channel.

Practical:

- **Heart Conduction system Study - ECG**
- **Blood Test - WBC differential Count & Blood Grouping Test**

UNIT IV SKELETAL AND SPECIAL SENSORY SYSTEM 9L+6P

Skeletal system: Bone types and functions – Axial Skeleton and Appendicular Skeleton. Joint - Types of Joint – Cartilage structure, types and functions. Special Sensory system- Eye: Layers of Eye- Mechanism of Vision - Errors of Refraction. Ear: Ear Divisions - Mechanism of Hearing - Hearing Conditions – Skin: Layers of Skin - Functions of Skin.

Practicals:

- **Eye Function study - Snellen's Chart & Ishihara's Chart**
- **Ear Function study - Weber's and Rinne's Test**

UNIT V NERVOUS SYSTEM 9L+6P

Structure of a Neuron – Types of Neuron. Neuroglial Cells - Synapses and types. Brain – Divisions of brain lobes – Cross Sectional Anatomy of Brain - Cortical localizations and functions - Methods to Record Cortical Functions. Spinal cord – Tracts of spinal cord – Spinal Nerve - Reflex mechanism – Types of reflex. Autonomic nervous system and its functions.

Practicals:

- **Brain Waves Recording study - EEG**

TOTAL: 45L+30P = 75 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the basic structural and functional elements of the human body.
CO2 Understand the gaseous exchange and fluid maintenance in the human body.
CO3 Understand the organs and structures involved in system formation and functions.
CO4 Analyze the functions of physiological system
CO5 Comprehend the activity of sensory and motor nerves
CO6 Analyze and Interpret Different Physiological Conditions in the Human Body.

TEXT BOOKS:

1. Elaine.N. Marieb, “Essential of Human Anatomy and Physiology”, Pearson Education New Delhi, 8th Edition, 2007.
2. Gillian Pocock, Christopher D. Richards, "The Human Body An introduction for Biomedical and Health Sciences", Oxford University Press, USA, 2009.

REFERENCES:

1. William F. Ganong,"Review of Medical Physiology”, Mc Graw Hill, New Delhi, 25th Edition, 2015.
2. Eldra Pearl Solomon. "Introduction to Human Anatomy and Physiology", W.B.Saunders Company, 2003.
3. Arthur C. Guyton, "Text book of Medical Physiology", Elsevier Saunders, 11th Edition, 2006

CO-PO & PSO MAPPING

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	PSO1	PSO2	PSO3
CO1	3	2											3		
CO2	3	2	1	1						1		1	3		
CO3	3	2	1	1						1		1	3		
CO4	3	2	1	1						1		1	3		
CO5	3	2	1	1						1		1	3		
Avg	3	2	1	1						1		1	3		

UC23H02 **தமிழரும் தொழில்நுட்பமும்** **L T P C**

1
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அலகு I **நெசவு மற்றும் பானைத் தொழில்நுட்பம்**: **3**

சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II **வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்**: **3**

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III **உற்பத்தித் தொழில் நுட்பம்**: **3**

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV **வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்**: **3**

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V **அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**: **3**

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும்
   கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

UC23H02 **TAMILS AND TECHNOLOGY** **L T P C**
1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

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

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

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

UNIT III MANUFACTURING TECHNOLOGY 3

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

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

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

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

ME23C04	MAKERSPACE	L	T	P	C
		1	0	4	3

COURSE OBJECTIVES:

1. To practice the usage of various tools towards assembly and dis-assembly of different items / equipment.
2. To make simple part / component using welding processes.
3. To train on the basic wiring practices of boards, machines, etc.
4. To provide a hands-on experience on the use of electronic components, equipment, sensors and actuators.
5. To expose to modern computer tools and advanced manufacturing / fabrication processes.

LIST OF ACTIVITIES **1L,4P**

(A). Dis-assembly & Assembly Practices

i. Tools and its handling techniques.

ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine.

iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators.

iv. Dis-assembly and assembly of a Bicycle.

(B). Welding Practices

i. Welding Procedure, Selection & Safety Measures.

ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes.

iii. Hands-on session of preparing base material & Joint groove for welding.

iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.

(C). Electrical Wiring Practices

i. Electrical Installation tools, equipment & safety measures.

ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box,

iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells.

iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.

(D). Electronics Components / Equipment Practices

i. Electronic components, equipment & safety measures.

ii. Dis-assembly and assembly of Computers.

iii. Hands-on session of Soldering Practices in a Printed Circuit Breaker.

iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier.

v. Hands-on session of integration of sensors and actuators with a Microcontroller.

vi. Demonstration of Programmable Logic Control Circuit.

(E).Contemporary Systems

i. Demonstration of Solid Modelling of components.

ii. Demonstration of Assembly Modelling of components.

iii. Fabrication of simple components / parts using 3D Printers.

iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.

TOTAL: 75 Periods (15 Lecture + 60 Practical)

COURSE OUTCOMES:

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

CO1: Assemble and dis-assemble various items / equipment.
CO2: Make simple parts using suitable welding processes.
CO3: Setup wiring of distribution boards, machines, etc.
CO4: Utilise the electronic components to fabricate a simple equipment, aided with sensors and actuators.
CO5: Take advantage of modern manufacturing practices.

REFERENCES:

1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014.
2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013.
3. Code of Practice for Electrical Wiring Installations (IS 732:2019)
4. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Oxford University Press, 7th ed. (Indian edition), 2017.
5. Mazidi, Naimi, Naimi, AVR Microcontroller and Embedded Systems: Using Assembly and C, Pearson India, 1st edition 2013.
6. Visualization, Modeling, and Graphics for Engineering Design, D.K. Lieu, S.A. Sorby, Cengage Learning; 2nd edition.

MA23C03	LINEAR ALGEBRA AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To understand Vector spaces and its basis and dimension.
- To understand the linear maps between vector spaces and their matrix representations.
- To understand the diagonalizatition of a real symmetric matrix.
- To understand Inner product spaces and its projections.
- To understand numerical techniques for solving linear systems, eigenvalue problems and generalized inverses.

UNIT I VECTORSPACES 9+3

Vector Spaces – Subspaces – Linear Combinations - Linear Span – Linear Dependence - Linear Independence – Bases and Dimensions.

UNIT II LINEAR TRANSFORMATIONS 9+3

Linear Transformation – Null Space, Range Space - Dimension Theorem - Matrix representation of Linear Transformation – Eigenvalues and Eigenvectors of Linear Transformation – Diagonalization of Linear Transformation – Application of Diagonalization in Linear System of Differential Equations.

UNIT III INNER PRODUCT SPACES 9+3

Inner Products and Norms - Inner Product Spaces - Orthogonal Vectors – Gram Schmidt Orthogonalization Process – Orthogonal Complement – Least Square Approximations.

UNIT IV NUMERICAL SOLUTION OF LINEAR SYSTEM OF EQUATIONS 9+3

Solution of Linear System of Equations – Direct Methods: Gauss Elimination Method – Pivoting, Gauss Jordan Method, LU Decomposition Method and Cholesky Decomposition Method - Iterative Methods: Gauss-Jacobi Method, Gauss-Seidel Method and SOR Method.

UNIT V NUMERICAL SOLUTION OF EIGENVALUE PROBLEMS AND GENERALISED INVERSES 9+3

Eigen Value Problems: Power Method – Inverse Power Method – Jacobi's Rotation Method - QR Decomposition - Singular Value Decomposition Method.

TOTAL: 60 PERIODS

Laboratory based exercises / assignments / assessments will be given to students from the content of the course wherever applicable.
Branch specific / General Engineering applications based on the content of each units will be introduced to students wherever possible.

Suggested Laboratory based exercises / assignments / assessments :

1. Linear independence/dependence of vectors
2. Computation of eigenvalues and eigenvectors
3. Diagonalization of Linear Transformation
4. Gram Schmidt Orthogonalization Process

5. Solution of algebraic and transcendental equations
6. Matrix Decomposition methods (LU / Cholesky Decomposition)
7. Iterative methods of Gauss-Jacobi and Gauss-Seidel
8. Matrix Inversion by Gauss-Jordan method
9. Eigen values of a matrix by Power method and by Jacobi's method
10. QR decomposition method
11. Singular Value Decomposition Method

OUTCOMES:

CO1: Solve system of linear equations using matrix operations and vector spaces using Algebraic methods.
CO2: Understand the linear maps between vector spaces and its utilities.
CO3: Apply the concept of inner product of spaces in solving problems.
CO4: Understand the common numerical methods and how they are used to obtain approximate solutions
CO5: Analyse and evaluate the accuracy of common numerical methods.

TEXT BOOKS:

1. Faires, J.D. and Burden, R., "Numerical Methods", Brooks/Cole (Thomson Publications), Fourth Edition, New Delhi, 2012.
2. Friedberg, S.H., Insel, A.J. and Spence, E., "Linear Algebra", Pearson Education, Fifth Edition, New Delhi, 2018.
3. Williams, G, "Linear Algebra with Applications", Jones & Bartlett Learning, First Indian Edition, New Delhi, 2019.

REFERENCES:

1. Bernard Kolman, David R. Hill, "Introductory Linear Algebra", Pearson Education, First Reprint, New Delhi, 2010.
2. Gerald, C.F, and Wheatley, P.O., "Applied Numerical Analysis", Pearson Education, Seventh Edition, New Delhi, 2004.
3. Kumaresan, S., "Linear Algebra – A geometric approach", Prentice – Hall of India, Reprint, New Delhi, 2010.
4. Richard Branson, "Matrix Operations", Schaum's outline series, Mc Graw Hill, New York, 1989.
5. Strang, G., "Linear Algebra and its applications", Cengage Learning, New Delhi, 2005.

CO – PO Mapping:

Course Outcomes	PROGRAMME OUTCOMES											
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 2 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 3 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 4 :	3	3	2	3	1	2	1	1	1	1	1	3
CO 5 :	3	3	2	3	1	2	1	1	1	1	1	3

BM23301	FUNDAMENTALS OF BIOCHEMISTRY	L	T	P	C
		2	0	2	3

UNIT I ACID-BASE AND ITS IMBALANCE 6L+4P

Water as a biological solvent, acid and bases, pH and buffers, Henderson- Hassel Balch equation, biological buffers-bicarbonate buffer, phosphate buffer, amino acid buffer. Acid-base imbalance- acidosis and alkalosis. Surface phenomenon- surface tension, adsorption, viscosity and their applications in biological systems.

PRACTICALS:

- Measurement of pH of solutions using pH meter.
- Preparation of serum and plasma from blood.

UNIT II CARBOHYDRATES 6L+8P

Definition of carbohydrates, Classification of carbohydrates, Stereoisomers, racemisation and mutarotation. Physical and chemical properties of carbohydrates. Metabolic pathways-glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. Citric acid cycle and electron transport chain.

PRACTICALS:

- Qualitative analysis of carbohydrates.
- Estimation of Glucose by manual and automatic methods.

UNIT III LIPIDS 6L+7P

Definition of lipids, classification of lipids. Nomenclature of fatty acid, essential fatty acids. Saponification number, Reichert-Meissel number and iodine number. Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism, ketogenesis, lipid micelles. Structural architecture and significance of biological membrane.

PRACTICALS:

- Qualitative analysis of lipids.
- Estimation of cholesterol by manual and automatic methods.

UNIT IV NUCLEIC ACID & PROTEIN 6L+7P

Structure of purines and pyrimidines, DNA act as a genetic material, Watson and crick model of DNA. Structure of RNA and its types. Classification, structural organization of proteins, classification and properties of amino acids. Separation of protein: gel filtration, electrophoresis and ultracentrifugation. Protein databases-protein sequence and structure databases (UNIPROT, SWISS-PROT & PDB), Protein sequence file Format (FASTA) and Visualization softwares.

PRACTICALS:

- Qualitative analysis of amino acids.
- Estimation of urea by manual and automatic methods.

UNIT V ENZYME AND ITS KINETICS 6L+4P

Definition of enzymes, mechanism of action of enzymes, kinetics of enzymes: Michaelis-Menten equation. Factors affecting enzymatic activity: Inhibition of enzyme action: Competitive inhibitors and its clinical applications. Regulation of enzyme-allosteric and covalent regulation. Clinical significance of enzymes and its interpretation in diagnosis.

PRACTICALS:

- Estimation of creatinine by manual and automatic methods.

TOTAL: 45L+30P=75PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the structure and functions of biomolecules in living systems. Acquire basic laboratory skills in handling apparatus.

CO2 Assess the significance of biomolecules in biological systems. Ability to separate and analyze sugar molecules from body fluids.

CO3 Acquire a broad knowledge in integrating biological aspects and chemical functioning of biomolecules with special emphasis on human health. Ability to separate and analyze lipid molecules in body fluids.

CO4 Understand the mechanisms of inter and intracellular communication from biochemical perception and able to interpret the clinical inference. Ability to separate and analyze protein molecules in body fluids.

CO5 Develop skills to consolidate, integrate and apply biochemical information in their area of interest. Ability to carry out the analysis of creatinine

CO6 Ability to interpret the laboratory results and aids in clinical diagnosis. Also able to implement experimental protocols and adopt to plan and carry out simple investigations.

TEXT BOOKS:

1. David L.Nelson, Michael M.Cox, Lehninger “Principles of Biochemistry Macmillan”, 6th Edition 2013.
2. Keith Wilson and John Walker, “Practical Biochemistry– Principles &Techniques”, Oxford University press, 7th Edition, 2010.
3. Biochemistry: U Satyanarayana, U.Chakrapani, Elsevier, 4th Ed. 2016

REFERENCES:

1. Trevorpalmer, “Understanding Enzymes”, Ellis Horwood LTD, 4th Edition, 1995.
2. Pamela. C. Champe and Richard. A. Harvey, “Biochemistry Lippincott’s Illustrated Reviews. Lippincott” Raven publishers, 6th Edition, 2013.
3. Biochemistry with Clinical Concepts and Case Studies: Satyanarayana , U. &Chakrapani, U.,Elsevier, edition4th, 2013.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3							3	3			3		
CO2	3	3	2						3	3			3		
CO3	3	-	2						3	3			3		
CO4	3	3	2						3	3			3		
CO5	3	2	2						3	3			3		
CO6	3	3	2						3	3			3		
Avg	3	3	2						3	3			3		

EC23C04	CIRCUIT ANALYSIS	L	T	P	C
		2	1	2	4

UNIT I DC CIRCUIT ANALYSIS 9L+6P

Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchhoff's Current Law, Kirchhoff's voltage law, the single Node – Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis & Mesh analysis using Independent and Dependent Sources. Super Mesh, Super Node.

PRACTICALS:

- Verification of Mesh Analysis for DC Circuits.
- Verification of Nodal Analysis for DC Circuits.

UNIT II NETWORK THEOREM AND DUALITY 9L+6P

Useful Circuit Analysis techniques using Independent and Dependent Sources - Linearity and superposition, Reciprocity Theorem, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion. Duals, Dual circuits.

PRACTICALS:

- Verification of Thevenin, Norton & Super Position Theorems for DC Circuits.
- Verification of Maximum Power Transfer & Reciprocity Theorems for DC Circuits

UNIT III SINUSOIDAL STEADY STATE ANALYSIS 9L+6P

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

PRACTICALS:

- Verify mesh and nodal analysis for AC circuits.
- Determine phasor relationship, real power (P), reactive power (Q), apparent power (S) and power factor in AC circuits using LTspice

UNIT IV TRANSIENTS AND RESONANCE IN RLC CIRCUITS 9L+6P

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

PRACTICALS:

- Determination of Resonant Frequency of Series & Parallel RLC Circuits.
- Study of DC transients in RL, RC and RLC circuits

UNIT V TOPOLOGY, COUPLED CIRCUITS & TWO PORT NETWORKS 9L+6P

Magnetically Coupled Circuits, mutual Inductance, the Linear Transformer, the Ideal Transformer, An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis, Two port Network Analysis- Z, Y, G and H parameters

PRACTICALS:

- Determination of polarity marking, coupling coefficient, self and mutual inductance of coupled circuits using LTspice
- Determination of open circuit (Z) and short circuit (Y) and hybrid (H) parameters using LTspice

TOTAL: 45L+30P = 75 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Ability to apply the basic laws for DC and AC circuits Analysis
CO2 Ability to apply Network Theorems in DC and AC circuits.
CO3 Ability to analyse AC circuits for phase relationship and power calculation
CO4 Ability to design and analyse first and second order AC circuits
CO5 Ability to analyse inductively coupled circuits and two port networks
CO6 Ability to implement and analyse two port networks

TEXT BOOKS:

1. Hayt JackKemmerly, Steven Durbin, "Engineering Circuit Analysis",Mc Graw Hill education, 9th Edition, 2018.
2. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014.

REFERENCES:

1. Charles.K.Alexander, Mathew N.O.Sadiku," Fundamentals of Electric Circuits", McGraw Hill, 5th Edition, 2012.
2. D.R.Cunningham, J.A. Stuller, "Basic Circuit Analysis", Jaico Publishing House, 2005.
3. David Bell, "Fundamentals of Electric Circuits", Oxford University press, 7 th Edition, 2009.
4. John O Mallay, Schaum's Outlines "Basic Circuit Analysis", The Mc Graw Hill companies, 2nd Edition, 2011.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	1				2	2	1		1	3		
CO2	3	3	2	2				2	2	1		1	3		
CO3	3	3	3	3				2	2	1		1	3		
CO4	3	3	3	3				2	2	1		1	3		
CO5	3	3	3	2				2	2	1		1	3		
Avg	3	3	2	2				2	2	1		1	3		

BM23302	ELECTRONIC DEVICES AND CIRCUITS	L	T	P	C
		3	0	2	4

OBJECTIVES:

The main objective of this course is to

- Understand the structure of basic electronic devises
- Exposing themselves to the operation and applications of electronic devices

UNIT I PN JUNCTION DEVICES 9+6

PN junction diode–structure, operation and V-I characteristics, diffusion and transient Capacitance-Rectifiers–Half Wave and Full Wave Rectifier, Zener diode-characteristics-Zener Reverse characteristics–Zener as regulator, Display devices-LED-characteristics, Laser diodes.

PRACTICAL

- PN Junction Diode Characteristics and application as half wave and full wave rectifiers
- Zener Diode Characteristics and application as voltage regulator

UNIT II TRANSISTORS 9+6

BJT, JFET, MOSFET structure, operation, characteristics and biasing. UJT, Thyristor - SCR Structure and characteristics.

PRACTICAL

- Voltage Divider Bias- BJT Circuit
- JFET Characteristics

UNIT III AMPLIFIERS 9+6

BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response. MOSFET small signal model–Analysis of CS and Source follower–Gain and frequency Response-High frequency analysis of CE amplifier.

PRACTICAL

- Frequency Response of CB, CE and CC Amplifier

UNIT IV MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9+6

Differential amplifier – Common mode and Differential mode analysis, Single tuned amplifiers – Gain and frequency response–Neutralization methods. Cascode Amplifier, Introduction to Power amplifiers–Class A, Class B and Class AB.

PRACTICAL

- Design and Analysis of Differential Amplifier
- Design and analysis of amplifier circuits using simulation tools.

UNIT V FEEDBACK AMPLIFIERS AND OSCILLATORS 9+6

Basic concepts of feedback -Properties of negative feedback, series, Shunt feedback – Positive feedback – Condition for oscillations – RC phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators. Introduction to PCB Design.

PRACTICAL

- Design and Analysis of Feedback Amplifiers
- Design of RC Oscillators and LC Oscillators using BJT.
- Design and analysis of oscillator circuits using simulation tools.

TOTAL: 45+30 HOURS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the structure and characteristics of basic electronic devices
CO2 Perform DC analysis and AC analysis of Circuits
CO3 Apply positive feedback principle and design oscillators.
CO4 Analyze and design amplifier circuits.
CO5 Experiment and analyse the characteristics of basic electronic devices and circuits.
CO6 Design simple electronics circuits using simulation tools.

TEXT BOOKS:

1. David A. Bell, “Electronic Devices and Circuits”, Prentice Hall of India,5th Edition,2008.
2. Sedra and Smith, “Microelectronic circuits”, Oxford University Press, 7thEdition,2017.

REFERENCES:

1. Muhammad H. Rashid, “Microelectronic Circuits: Analysis and Design”, Cengage Learning, 6th Edition,2013.
2. Thomas L. Floyd, “Electronic devices” PrenticeHall”,10thEdition,2018.
3. Donald A Neamen, “Electronic Circuit Analysis and Design”, TataMcGrawHill,4thEdition,2009.
4. Robert L. Boylestad, “Electronic Devices and Circuit Theory”, 11thEdition,2021.
5. Robert B. Northrop, “Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation”, CRC Press, 2ND Edition, 2012.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3											3		
CO2	3	3	2										3		
CO3	3	3											3		
CO4	3	3	2		2				2	2		2	3		
CO5	3	3	2		2				2	2		2	3		
CO6	3	3			2				2	2		2	3		
Avg	3	3	2		2				2	2		2	3		

BM23303	SENSORS AND MEASUREMENTS	L	T	P	C
		3	0	2	4

OBJECTIVES:

The main objective of this course is to

- Acquire knowledge about the various blocks of a typical measurement system
- Study the characteristics of different transducers, signal conditioning circuit and display devices.

UNIT I SCIENCE OF MEASUREMENT 7

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

UNIT II DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS 11+10

Resistive Transducers: Strain Gauge: Gauge factor, sensing elements, configuration, strain gauge as displacement & pressure transducers, biomedical applications. RTD materials & range, Characteristics, thermistor characteristics, biomedical applications of Temperature sensors, Capacitive transducer, Inductive transducer, LVDT, Active type: Thermocouple – characteristics. Case study on various application of transducers.

PRACTICALS:

- Characteristics of strain gauges.
- Displacement measurement using LVDT.
- Characteristics of temperature transducer-thermistor
- Characteristics of temperature transducer-RTD.
- Characteristics of thermocouple

UNIT III PHOTOELECTRIC AND PIEZOELECTRIC SENSORS 9+8

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

- Characteristics of Photo electronic transducers-LDR, Photo Diode, Photo Transistor.
- Characteristics of Piezoelectric Transducer.

UNIT IV SIGNAL CONDITIONING & DISPLAY DEVICES 9+8

AC and DC Bridges – Wheat stone bridge, Kelvin, Maxwell, Hay, Schering – Concepts of filters, low pass, high pass, band pass, band stop, notch-Pre-amplifier, differential amplifier – impedance matching circuits – isolation amplifiers, Spectrum analyzer, Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO.

PRACTICALS:

- Wheatstone Bridge and Kelvin's Bridge for Measurement of Resistance.
- Measurement of capacitance using bridge circuits.
- Measurement of inductance using bridge circuits.
- Characteristics of passive filters.

UNIT V BIOSENSORS 9+4

Biosensors- Advantages and limitations, various components of biosensors, Classification of Biosensors Based on Type of Transduction - Electrochemical, Optical, Acoustic, Calorimetric. Classification of Biosensors Based on Biological Element - Enzyme Sensor, Immunosensors, Cell-based Sensors. Ion selective Field Effect Transistor (ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors.

PRACTICALS:

Simulation of Biosensor using simulation tools.

TOTAL: 45+30 =75 HOURS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Recognize the purpose, characteristics, and methods of measurements.
CO2 Understand the principles and Characteristics of different sensors, signal conditioning circuits and display devices.
CO3 Understand the principles and Characteristics of biosensors.
CO4 Experiment and Analyse the characteristics of various sensors.
CO5 Experiment and Analyse the characteristics of signal conditioning circuits.
CO6 Design of suitable measurement system for any application.

TEXT BOOKS:

1. Doebelin E.O. and Manik D.N., “Measurement Systems”, Tata McGraw-Hill Education Pvt. Ltd., 7th Edition, 2019.
2. A.K. Sawhney, “Electrical & Electronics Measurement and Instrumentation”, Dhanpat Rai&Co, New Delhi, 2023.

REFERENCES:

1. L.A Geddes and L.E. Baker, “Principles of Applied Biomedical Instrumentation,” – John Wiley and sons, 3rd Edition, Reprint 2008.
2. Albert D.Helfrick and William D.Cooper, “Modern Electronic Instrumentation and Measurement Techniques”, Prentice Hall of India, 2015.
3. Joseph J. Carr and John M. Brown, Introduction to Biomedical equipment technology, Pearson Education, 4th Edition, 2014.
4. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
5. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, “Biomedical Instrumentation and Measurement”, Prentice Hall India Pvt. Ltd, New Delhi, 2nd Edition, Reprint, 2013.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3												3		
CO3	3												3		
CO4	3	2	2						2	2		2	3		
CO5	3	2	2						2	2		2	3		
CO6	3	2											3		
Avg	3	2	2						2	2		2	3		

BM23S01 **SKILL DEVELOPMENT COURSE - LEVEL I** **L T P C**
SENSORS AND SYSTEM ENGINEERING **1 0 2 2**

I. Overview

This course aims to teach beginners to understand the sensors and the signal conditioning circuits that are used in biomedical applications, identify the various active and passive components, build circuits effectively using a breadboard. By the end of the course, students will be able to identify and handle components, read schematics, and set up simple circuits used in biomedical applications. The teaching method involves a step-by-step approach with practical demonstrations. This course is intended for individuals to use breadboards and become confident in circuit building.

II. Contents

i. Introduction to sensors-Force sensor, Flex sensor, Optical sensor, Temperature sensor, Accelerometer (IMU sensor), ultrasound
ii. Study of various signal conditioning
iii. Familiarizing Data sheets and technical specifications of sensors, components, ICs, etc.,
iv. Design considerations of sensors.
v. Design and development of sensor and signal conditioning circuits using bread board.
vi. Testing and trouble shooting
vii. Demonstrating the Electronic system developed for an application.

COURSE OUTCOMES:

After completing the first level of skill development course, the student will be able to

CO1 Understand and analyze the various sensors, components.
CO2 Analyze the specifications from data sheets
CO3 Understand the design considerations involved in the circuits to be developed and implemented
CO4 Build electronic circuits using breadboards
CO5 Test, troubleshoot and demonstrate the circuits developed
CO6 Prepare a report

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3							2	2		2	3	3	
CO2	3	3							2	2		2	3	3	
CO3	3	3							2	2		2	3	3	
CO4	3	3	2						2	2		2	3	3	
CO5	3	3	2						2	2		2	3	3	
CO6	3	3							2	2		2	3		
Avg	3	3	2						2	2		2	3	3	

BM23401	BIOMEDICAL INSTRUMENTATION	L	T	P	C
		3	0	2	4

UNIT I INTRODUCTION TO ELECTROPHYSIOLOGY 9L

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode– skin interface, half-cell potential, impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits, Motion Artifacts.

UNIT II BIOPOTENTIAL MEASUREMENT 9L+6P

Bio signal characteristics– frequency and amplitude ranges. ECG – Einthoven‘s triangle, standard 12 lead system, block diagram. Measurements of heart sounds - PCG. EEG – 10-20 electrode system, unipolar, bipolar and average mode, Functional block diagram. EMG – unipolar and bipolar mode, block diagram, EOG and ERG.

Practical

Measurement of heart sounds using PCG.
Measurement of vital parameters using Patient Monitoring System.

UNIT III BIOPOTENTIAL AMPLIFIER 9L+12P

Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Artifacts and removal.

Practical

Design of low noise pre-amplifier.
Design of ECG amplifier with Right Leg Driven circuit and Measurement of heart rate.

UNIT IV NONELECTRICAL PARAMETER MEASUREMENT 9L+9P

Blood Pressure: direct methods - Pressure amplifiers - systolic, diastolic, mean detector circuit, indirect methods - auscultatory method, Oscillo metric method, ultrasonic method. Pulse rate measurements, Plethysmography, Pulse oximetry. Temperature, respiration rate measurement.

Practical

Design of pulse-rate circuit using Photo transducer.
Measurement of blood pressure using sphygmomanometer.
Measurement of respiration rate.

UNIT V BLOOD FLOW METER AND BLOOD CELL COUNTER 9L+3P

Blood flow - Electromagnetic and ultrasound blood flow measurement. Cardiac output measurement- Indicator dilution, dye dilution and thermodilution method. Blood cell counting- Manual and Automatic Counting of RBC, WBC and Platelets.

Practical

Measurement of blood flow velocity using ultrasound transducer.

TOTAL: 45+30=75 HOURS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 **Recall the Electrophysiology of bio potentials and electrodes for its measurement.**
CO2 **Describe the Bio signal characteristics and** get practical knowledge.
CO3 Design preamplifiers for Bio signal measurements.
CO4 Design and implement amplifiers for various bio electrical signal measurements.
CO5 Describe the principle of various non electrical measurement.
CO6 Perform various non electrical measurement in practical.

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation Application and Design," JohnWiley and Sons, New York, 5th Edition, 2020.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology,"Pearson Education, 4th Edition, 2014.
3. **Leslie Cromwell, Biomedical Instrumentation and measurement, Prentice Hall of India, New Delhi, 2nd edition, 2015.**

REFERENCES:

1. L.A Geddes and L. E. Baker, Principles of Applied Biomedical Instrumentation, 3rd Edition, 2008.
2. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill, 2003.
3. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd edition, 2014.
4. Richard S. Cobbold, "Transducers for Biomedical Measurements; Principle and applications," John Wiley and sons, 1992.
5. Joseph Bronzino and Donal R. Peterson, "Handbook of Biomedical Engineering," 2015, 4th Edition, CRC Press, Florida.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													3	
CO2	3													3	
CO3	3	3	3		2				2	2		2		3	
CO4	3	3			2				2	2		2		3	
CO5	3													3	
CO6	3	3							2	2		2		3	
Avg	3	3	3		2				2	2		2		3	

BM23402	DISCRETE TIME SIGNAL PROCESSING	L	T	P	C
		3	0	2	4

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9L+12P

Continuous time signals - Discrete time signals – Step, Ramp, Pulse, Impulse, Exponential - classification of CT and DT signals – periodic and aperiodic signals, random signals, Energy & Power signals. Sampling Theorem. CT systems and DT systems - Classification of systems. Convolution, Correlation.

PRACTICALS:

- Generation of discrete time signals
- linear convolution.

UNIT II ANALYSIS OF LTI SYSTEMS 9

DTFS, DTFT and its properties, Frequency response, Analysis of Discrete Time LTI Systems – Z Transform - Properties of ROC– Inverse Z Transform

UNIT III DISCRETE FOURIER TRANSFORM 9L+12P

DFT and its properties, magnitude and phase representation-Circular Convolution, Overlap-add and overlap-save methods. FFT - Decimation in Time Algorithm, Decimation in Frequency Algorithm. Use of FFT in Linear Filtering.

PRACTICALS:

DFT, FFT, circular convolution.

UNIT IV DESIGN OF INFINITE IMPULSE RESPONSE FILTERS 9L+12P

Analog filters – Butterworth filters, Chebyshev Type I filters (upto 3rd order), Analog Transformation of prototype LPF to BPF /BSF/ HPF. Transformation of analog filters into equivalent digital filters using Impulse invariant method and Bilinear Z transform method - Realization structures for IIR filters – direct, cascade and parallel forms.

PRACTICALS:

- IIR filter design.

UNIT V DESIGN OF FINITE IMPULSE RESPONSE FILTERS 9L+24P

Design of linear phase FIR filters - windowing and Frequency sampling methods. Realization structures for FIR filters – Transversal and Linear phase structures, Comparison of FIR and IIR. Introduction to DSP processor.

PRACTICALS:

- FIR filter design, decimation and interpolation, study of architecture of digital signal processor, MAC operation using various addressing nodes, implementation of difference equation, waveform generation, linear and circular convolution using DSP processor.

TOTAL: 75 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Describe the continuous time and discrete time signals and systems
CO2 Analyze the signals in discrete time and compute the spectrum
CO3 Implement linear, circular convolution and FFT using MATLAB
CO4 Design IIR and FIR filter to process real world signals
CO5 Implement discrete time systems using DSP processors
CO6 Apply signal processing techniques for various applications

TEXT BOOKS:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, “Signals and Systems”, Pearson, Indian Reprint, 2nd Edition, 2015.
2. S. Haykin and B. Van Veen, "Signals and Systems", Wiley, 2 nd Edition, 2007.
3. John G Proakis and Manolakis, “Digital Signal Processing Principles, Algorithms and Applications”, Pearson, 4 th Edition, 2014
4. A.V.Oppenheim, R.W. Schafer and J.R. Buck, “Discrete-Time Signal Processing”, Indian Reprint, Pearson, 3 rd Edition, 2014.

REFERENCES:

1. H P Hsu, “Signals and Systems, Schaum‘s Outlines”, Tata McGraw Hill, 3 rd Edition, 2013.
2. B. P. Lathi, “Principles of Linear Systems and Signals”, Oxford, 2nd Edition, 2009.
3. John Alan Stuller, “An Introduction to Signals and Systems”, Cengage Learning, 2007
4. Emmanuel Ifeachor, Barrie Jervis, “Digital Signal Processing- A practical approach”, Pearson, 2 nd Edition, 2002.
5. M. H. Hayes, “Digital Signal Processing, Schaum’s outlines”, Tata McGraw Hill, 2nd Edition, 2011.
6. 6. Sanjit K. Mitra, “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill Education, 4th Edition, 2013.

COURSE OUTCOMES	**PROGRAMME OUTCOMES**														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PS01**	**PS02**	**PS03**
CO1	3	3													3
CO2	3	3													3
CO3	3	3			3				3	3		2			3
CO4	3	3	3	3											3
CO5	3	3	3	3	3				3	3		2			3
CO6	3	3	3	3											3
Av	3	3	3	3	3				3	3		3			3

BM23403	ANALOG AND DIGITAL INTEGRATED CIRCUITS	L	T	P	C
		3	0	4	5

UNIT I **INTRODUCTION TO OPERATIONAL AMPLIFIER AND ITS APPLICATIONS** **9+12**

Operational amplifier – ideal characteristics, Performance parameters, Linear and non-linear Circuits and their analysis – voltage follower, Inverting amplifier, Non - inverting Amplifiers, Differentiator, Integrator, Voltage to Current converter, Instrumentation amplifier, Low pass, High pass filter and band pass filters, Comparator, Multivibrator and Schmitt trigger, Triangular wave generator.

Practicals

Inverting, non-inverting amplifier and comparator, Integrator and Differentiator, Integrator and Differentiator, Design and analysis of active filters using op-amp

UNIT II **DIGITALTO ANALOG AND ANALOG TO DIGITAL CONVERTERS AND PLL** **9+12**

Analog switches, High speed sample and hold circuit and IC's, Types of D/A converter – Weighted resistor, R-2R ladder DAC, D/A Accuracy and Resolution, A/D converter - Flash, Dual slope, Successive approximation, A/D Accuracy and Resolution. Voltage controlled oscillator, PLL- Closed loop analysis of PLL, Frequency multiplication/ division.

Practicals

Schmitt trigger using operational amplifier, Instrumentation amplifier using operational amplifier, RC and LC oscillators, Multivibrators using IC555 Timer

UNIT III **THE BASIC GATES AND COMBINATIONAL LOGIC CIRCUITS** **9+12**

Number Systems – Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes – Binary, BCD, 84-2-1, 2421, Excess 3, Biquinary, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Min terms and Maxterms, Karnaugh map and Tabulation methods. Logic families -TTL, MOS, CMOS.

Practicals

Study of logic gates

UNIT IV **COMBINATIONAL LOGIC CIRCUITS** **9+12**

Problem formulation and design of combinational circuits - Code-Converters, Half and Full Adders, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Decoder, Encoder, Mux / Demux, ROM, PLA and PAL.

Practicals

Half adder and Full adder, Encoder and BCD to 7 segment decoder, Multiplexer and demultiplexer using digital ICs

UNIT V **SEQUENTIAL LOGIC CIRCUITS** **9+12**

Flip flops – SR, JK, T, D, Master / Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – state minimization, state assignment, Circuit implementation. Counters,

Ripple Counters. Types of Registers, Serial In - Serial Out, Serial In - Parallel out, Parallel In-Serial Out, Parallel In-Parallel Out.

Practicals

Universal shift register using flip flops, Design of mod-N counter, Simulation and analysis of circuits using softwares

TOTAL: 105 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Design and develop analog Integrated circuit based systems
CO2 Understand the application of data converters in real time systems
CO3 Apply Boolean algebra to digital logic systems and implement using logic gates
CO4 Design various combinational digital circuits
CO5 Design and analyse synchronous and asynchronous sequential circuits
CO6 Design and simulate various analog and digital circuits

TEXT BOOKS:

1. Sergio Franc “Design with operational amplifiers and analog integrated circuits”, McGraw Hill Education, 3rdEdition, 2017.
2. M.Morris Mano and MichaelD. Ciletti, “Digital Design”, Pearson, 6th Edition, 2018.
3. Charles H. Roth, Larry L. Kinney, and Raghunandan G. H., “Fundamentals of Logic Design”, Cengage India Private Limited, 2019.

REFERENCES:

1. Gray and Meyer, “Analysis and Design of Analog Integrated Circuits”, Wiley International, 5th Edition, 2009.
2. Ramakant A. Gayakwad, “OP-AMP and Linear IC’s”, Prentice Hall, 4th Edition 2015.
3. Taub and Schilling, “Digital Integrated Electronics”, Mc Graw Hill, 2017.
4. Coughlin and Driscoll, “Operational amplifiers and Linear Integrated Circuits”, Prentice Hall, 2016.
5. Floyd T. L., “Digital Fundamentals”, Pearson Education, 11th Edition, 2017.
6. John.F. Wakerly, “Digital design principles and practices”, Pearson Education, 5thEdition, 2018.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	3	3		2				3	3		3	3		
CO2	3	3	3		2				3	3		3	3		
CO3	3	3	3		2				3	3		3	3		
CO4	3	3	3		2				3	3		3	3		
CO5	3	3	3		2				3	3		3	3		
CO6	3	3	3		2				3	3		3	3		
Avg	3	3	3		2				3	3		3	3		

BM23U01	MEDICAL STANDARDS AND REGULATIONS	L	T	P	C
		3	0	0	3

UNIT I **INTRODUCTION TO MEDICAL ETHICS, THEORIES AND PRINCIPLES** **9**

Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor and Society. Theories- Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles- Non-Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice, Bioethics, Ethics committee- its members and functions - Evidence Based Medicine

UNIT II **MEDICAL DATA STANDARDS** **9**

Evolution of Medical Standards - HL7 – DICOM – IRMA - LOINC – HIPPA - Medical Vocabulary standards – Diagnosis Related Group (DRG) – ICD10 – MeSH – SNOMED – UMLS.

UNIT III **HOSPITAL ACCREDITATION AND SAFETY STANDARDS** **9**

Quality Planning of Hospital Support System, Quality Assurance to Patients, National Accreditation Board for Hospitals (NABH) – Patient centred and Healthcare Organization Management standards - Electrical Safety Solution in Hospitals according to" IEC 60364-7-710" & NEC_SP30_2023_Medical. Life Safety Standards- Protecting Occupants, Protecting the Hospital from Fire, Smoke, and Heat, Protecting Individuals from Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards - AERB Compliance – Radiation protection AE(RP)R-2004, Safety Code AE/RF-MED/SC-3. - Managing Hazardous Material and Biomedical Waste.

UNIT IV **ICMED 13485 Plus** **9**

Key aspects of Indian Certification of Medical Devises Plus (ICMED) 13485 Plus – Implementation - Quality Management Systems - Management Responsibility - Resource Management - Product Realization - Measurement, Analysis and Improvement.

UNIT V **MEDICAL EQUIPMENT SAFETY STANDARDS** **9**

General requirements for basic safety & essential performance of medical equipment. IEC 60601 standards - Based Standard-general requirement of electrical medical devices, Collateral Standards- EMC radiation protection &programmable medical device system, Particular Standards-type of medical device. ISO/IEC 17025:2017 standard – General requirements for the competence of Testing and Calibration laboratories

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Discuss the ethical practices and general regulations of medical devices.

CO2 Examine the ethical practices and quality management systems for medical device manufacture.

CO3 Compare the approval process for new medical devices in different jurisdictions.

CO4 Interpret risk assessment management, safety and clinical testing approaches for new medical devices.

CO5 Evaluate the product development methodologies for medical devices.

CO6 Medical device and testing, personnel involved, quality assurance, quality management system.

REFERENCES:

1. https://www.bis.gov.in
2. https://www.qcin.org/public/uploads/ckdocs/1668347882.7%20ICMED_%20Section%204B_Certification%20Process%20for%20ICMED%20%2013485%20Plus.pdf
3. https://www.iso.org/ISO-IEC-17025-testing-and-calibration-laboratories.html
4. https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/standard_review/Standard_review/Isdetails?ID=MjQ5OTA%3D
5. https://www.services.bis.gov.in/php/BIS_2.0/bisconnect/knowyourstandards/Indian_standards/isdetails/MjgwODc=
6. Ramachandra Lele, Computers in Medicine Progress in Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005``
7. Mohan Bansal M S, Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005
8. Johnna Fisher, Biomedical Ethics: A Canadian Focus., Oxford University Press Canada, 2009.
9. Robert M Veatch, The Basics of Bio Ethics, 3rd Edition. Routledge, 2011.
10. Joint Commission Accreditation Standards for Hospitals, 6th Edition 2018.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2					3	3	1				1	3		
CO2	2					3	3	1				1	3		
CO3				3	3	3				1		1	3		
CO4		3	3	3	3							1	3		
CO5		3	3	3	3					1		1	3		
CO6		3	3	3	3		3		1	1		1	3		
Avg	2	3	3	3	3	3	3	1	1	1		1	3		

BM23S02 **SKILL DEVELOPMENT COURSE – LEVEL II** **L T P C**
DESIGN AND DEVELOPMENT OF LAB PROTOTYPE FOR BIOMEDICAL APPLICATIONS **1 0 2 2**

I. Overview

This course will teach teams of students to design and fabricate PCB for prototyping as well as in Industrial Production environment. This will help students to innovate faster with electronics technology. This course would promote Professional Skill Development Activities (PSDA) such as Study the concept of designing single layer and multilayer PCB, develop a PCB for any application provided, Study the testing procedures of PCB, Need for validation and the Standards involved in the process of commercialization.

Content

- Design and simulation of Bioamplifier (ECG, EMG, EOG, EEG) using simulation tools.
- Implementation of Bioamplifier using breadboard.
- Introduction to Electronic Design Automation (EDA) tools for PCB design.
- Schematic Design: Familiarization of the Schematic Editor, Schematic creation, Annotation, Netlist generation, Gerber files.
- PCB fabrication and component assembly processes
- Testing and validation of the Bioamplifier in PCB.

COURSE OUTCOMES:

After completing the skill development course, the student will be able to

CO1 Design and Simulate the Bioamplifier.
CO2 Implement the Bioamplifiers.
CO3 Design the PCB layout using PCB design tools.
CO4 Fabrication the PCB and Assemble the Components in the PCB Board
CO5 Test and validate the PCB Board.
CO6 Design and Develop the Laboratory Prototype for Biomedical applications.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2		2				2	2		2	3	3	
CO2	3	3	2		2				2	2		2	3	3	
CO3	3	3	2		2				2	2		2	3	3	
CO4	3	3							2	2			3	3	
CO5	3	3							2	2			3	3	
CO6	3	3	2		2				2	2		2	3	3	
Avg	3	3	2		2				2	2		2	3	3	

UC23U01 **UNIVERSAL HUMAN VALUES** **L T P C**
1 0 2 2

COURSE OBJECTIVE:

The objective of the course is four-fold:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Module I: Introduction **(3L,6P)**

Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration– Its content and process; 'Natural acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

Practical Session: *Include sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking*

Module II: Harmony in the Human Being **(3L,6P)**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' - happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer), Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.

Practical Session: *Include sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.*

Module III: Harmony in the Family and Society **(3L,6P)**

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship, Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive

Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.

Practical Session*: Include sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives*

Module IV: Harmony in the Nature and Existence (3L,6P)

Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.

Practical Session: *Include sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.*

Module V: Implications of Harmony on Professional Ethics (3L,6P)

Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations, Sum up.

Practical Session: *Include Exercises and Case Studies will be taken up in Sessions E.g. To discuss the conduct as an engineer or scientist etc.*

TOTAL: 45 (15 Lectures + 30 Practicals) PERIODS

COURSE OUTCOME:

By the end of the course, the students will be able to:

1. Become more aware of themselves, and their surroundings (family, society, nature);
2. Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
3. Have better critical ability.
4. Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
5. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

REFERENCES:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel

Books, New Delhi, 3rd revised edition, 2023.
2. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews.
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

Web URLs:

1. Class preparations: https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php
2. Lecture presentations: https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php
3. Practice and Tutorial Sessions: https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Articulation Matrix:

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

BM23501	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT – I	L	T	P	C
		3	0	2	4

UNIT I CARDIAC EQUIPMENT 9L +6P

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

Practical

- Recording and analysis of ECG signals
- Simulation of ECG – detection of QRS complex and heart rate

UNIT II NEUROLOGICAL EQUIPMENT 9L +6P

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

Practical

- Recording and analysis of EEG signals.

UNIT III MUSCULAR EQUIPMENT 9L +6P

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

Practical

- Recording and analysis of EMG signal and plotting of fatigue characteristics.

UNIT IV PATIENT MONITORING AND BIOTELEMETRY 9L +6P

Patient monitoring systems - ICU/CCU Equipment, Infusion pumps, bed side monitors, Central monitoring console. Architecture of Biotelemetry system – single and multi-channel Biotelemetry - Inductively coupled Biotelemetry - Optical Biotelemetry - readout formats. Concept of m-Health 2.0, Point of care devices – disposable hematology sensors.

Practical

- Design of biotelemetry system

UNIT V EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES 9L +6P

Need for heart lung machine, Functioning of bubble, Disc type and membrane type oxygenators, finger pump, roller pump. Hemodialyser unit, Peritoneal dialyser unit, Wearable artificial kidney. Lithotripsy, Cryogenic technique, Thermography – Recording Principle and clinical application. Tonometer, Auto Refractometer. Audiometer- Beksey's type, Pure tone, Speech. Galvanic skin resistance (GSR)- polygraph, Surgical equipments.

Practical

- Measurement of GSR
- Recording of Audiogram.

TOTAL: 45L+30P= 75 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the functionality of cardiac and neurological equipment.
CO2 Analyze the evoked response of somatosensory, visual and auditory response
CO3 Build patient monitoring unit with biotelemetry
CO4 Understand the biofeedback system and its applications
CO5 Understand the need for diagnostic and therapeutic equipment
CO6 Comprehend the measurement parameters of diagnostic equipment

TEXT BOOKS:

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology", Pearson Education, 4th Edition, 2014.
2. John G.Webster, "Medical Instrumentation Application and Design", John Wiley and Sons, New York, 4th Edition, 2009.

REFERENCES:

1. Myer Kutz, "Biomedical Engineering & Design Handbook: Volume 2", McGraw-Hill Publisher, 2nd Edition, 2009.
2. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", John Wiley and Sons, 3rd Edition, Reprint 2008.
3. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Pearson Education India; 2nd Edition, 2015.
4. Antony Y.K.Chan, "Biomedical Device technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008

COURSE OUTCOMES	PROGRAMME OUTCOMES														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3		2				3	3		1	3		
CO2	3	3	3						3	3		1	3		
CO3	3	3	3						3	3		1	3		
CO4	3	2	3						3	3		1	3		
CO5	3	2	3		2				3	3		1	3		
CO6	3	3	3						3	3		1	3		
Avg	3	3	3		2				3	3		1	3		

BM23502	CONTROL SYSTEM FOR BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I CONTROL SYSTEM MODELING 9

Terminology and basic structure of control system, example of a closed loop system, transfer function, modeling of electrical systems, translational and rotational mechanical systems, and electromechanical systems, block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph, conversion of block diagram to signal flow graph. Need for modeling physiological system.

UNIT II TIME RESPONSE ANALYSIS 9

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

UNIT III STABILITY ANALYSIS 9

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

UNIT IV FREQUENCY RESPONSE ANALYSIS 9

Frequency response, Nyquist stability criterion, Nyquist plot and determination of closed loop stability, definition of gain margin and phase margin, Bode plot, determination of gain margin and phase margin using Bode plot, use of Nichol‘s chart to compute frequency and bandwidth.

UNIT V PHYSIOLOGICAL CONTROL SYSTEM 9

Example of physiological control system, difference between engineering and physiological controlsystems, generalized system properties, models with combination of system elements, Study of steady state analysis of muscle stretch reflex action, Study of transient response analysis of neuromuscular reflex model action, Study of frequency response of circulatory control model, Stability analysis of Pupillary light reflex, introduction to simulation. Illustration with real time applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Explain the need for mathematical modelling of various systems, representation of systems in block diagrams and signal flow graphs and are introduced to biological control systems.

CO2 Examine the time response of various systems and discuss the concept of System stability.

CO3 Analyze the frequency response characteristics of various systems using different plots.

CO4 Explore the concept of modelling basic physiological systems.

CO5 Comprehend the application aspects of time and frequency response analysis in physiological control systems.

TEXT BOOKS:

1. J.Nagrath and M.Gopal, “Control System Engineering”, New Age International Publishers, 7thEdition, 2021.

2. Michael C K Khoo, “Physiological control systems”, IEEE Press, Prentice Hall of India, 2005.

REFERENCES:

1. Farid Golnaraghi, Benjamin C. Kuo, “Automatic Control Systems”, McGraw-Hill Education, 10th Edition, 2017.
2. M. Gopal, “Control System, Principles and Design”, McGraw-Hill, 2012.
3. Constantine H.Houpis, Stuart N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, CRC Press, 6th Edition, 2013.
4. Richard C.Dorf & Robert H. Bishop, “Modern Control Systems”, Pearson Education, 13th Edition,2017.
5. Joseph J.Di Stefano, Allen R. Stubberud, Schaum's, “Outline of Feedback and Control Systems”, McGraw-Hill Education, 3rd Edition, 2013.
6. Ogata, Katsuhiko and Yanjuan Yang, Modern control engineering, 6th edition, Pearson Education, 2010.
7. Bhattacharya and Sriman Kumar, Control systems engineering, Pearson Education India, 3rd Edition, 2013.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	3						2			3		
CO2	3	3	3	3				1		2			3		
CO3	3	3	3	3				1		2			3		
CO4	3	3	3	3					2				3		
CO5	3	3	3	3	2			1	2			1	3		
Avg	3	3	3	3	2			1	2	2		1	3		

BM23503	MICROCONTROLLERS AND EMBEDDED SYSTEMS	L	T	P	C
		3	0	2	4

UNIT I 8- BIT and 16 - BIT MICROPROCESSOR 9L +6P

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

Practical

- Basic programs using 8085 -- Arithmetic, Logical, Data transfer, Branching and control instructions.
- Basic programs using 8086 -- Arithmetic, Logical, Data transfer, Branching and control instructions.

UNIT II PERIPHERALS AND INTERFACING 9L +6P

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

Practical

- Interfacing ADC and DAC with 8085, 8086
- Interfacing 8279, 8255 with 8085, 8086

UNIT III 8 - BIT MICROCONTROLLER 9L +6P

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

Practical

- Basic programs using 8051 -- Arithmetic, Logical, Data transfer
- Basic programs using 8051 -- Branching and control instructions.

UNIT IV 8 BIT MICROCONTROLLER BASED SYSTEM DESIGN 9L +6P

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

Practical

- Interfacing of LCD display with 8051
- Interfacing stepper motor with 8051.
- DC motor speed control using 8051..

UNIT V EMBEDDED SYSTEMS IN BIOMEDICAL APPLICATIONS 9L +6P

RISC Vs CISC Architecture, ARM Processor Architecture, ARM Core data flow model, ARM processor modes and families, ARM instruction Set and its Programming. Introduction to Arduino architecture —Arduino programming, Introduction to Raspberry Pi Architecture – IDE – IoT interface and Python programming – Biomedical applications.

Practical

- Arduino programming for biomedical applications.
- IoT application in healthcare using Raspberry Pi

TOTAL: 45L+30P= 75 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand and analyze the pin configuration and functional architecture of microprocessor, microcontrollers and embedded systems

CO2 Interface peripheral devices with microprocessors, microcontrollers and embedded systems

CO3 Do programming in assembly language with microprocessors, microcontrollers and embedded systems

CO4 Do python programming in IDE

CO5 Design and develop real world applications using microcontroller and embedded systems

CO6 Apply the knowledge of embedded systems and develop Healthcare applications through IoT platform

TEXT BOOKS:

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085". Penram International Publishing reprint, 6th Edition, 2017.
2. Douglas V. Hall, "Microprocessor and Interfacing, Programming and Hardware", Tata McGrawHill, Revised 2nd Edition 2006, 11th reprint 2015.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley, "The 8051 Microcontrollerand Embedded Systems", 2nd Edition, Pearson Education 2008. 12th impression 2018
4. Getting Started with Raspberry Pi, Matt Richardson & Shawn Wallace, O'Reilly(SPD), 2014,
5. ISBN: 9789350239759
6. N.Sloss, Dominic Symes, Chris Bright, ”ARM System Developer’s Guide, Designing and Optimizing system software”, Andrew 2014 Edition, Morgan Kaufmann Publishers.

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1. Krishna Kant, “Microprocessor and Microcontroller Architecture, programming and systemdesign using 8085, 8086, 8051 and 8096’’, PHI, 2007, 7th Reprint, 2015.
2. Kenneth J. Ayala., “The 8051 Microcontroller, 3rd Edition, Thompson Delmar Learning’’, 2012.
3. A.K. Ray, K.M. Bhurchandi, “Advanced Microprocessor and Peripherals’’, Tata McGraw-Hill, 2nd Edition, 2010.
4. Barry B. Brey, “The Intel Microprocessors Architecture, Programming and Interfacing’’, PearsonEducation, 2007, 2nd impression, 2010.
5. Raspberry Pi Cookbook, Software and Hardware Problems and solutions, Simon Monk, O'Reilly (SPD), 2016, ISBN 7989352133895

6. "Exploring Raspberry Pi: Interfacing to the Real World with Embedded Linux" by Derek Molloy.
7. https://how2electronics.com/interfacing-max30100-pulse-oximeter-sensor-arduino/
8. https://docs.arduino.cc/built-in-examples/basics/AnalogReadSerial/

COURSE OUTCOMES:
On completion of this course, the student will be able to

CO1 Understand and analyze the pin configuration and functional architecture of microprocessor, microcontrollers and embedded systems
CO2 Interface peripheral devices with microprocessors, microcontrollers and embedded systems
CO3 Do programming in assembly language with microprocessors, microcontrollers and embedded systems
CO4 Do python programming in IDE
CO5 Design and develop real world applications using microcontroller and embedded systems
CO6 Apply the knowledge of embedded systems and develop Healthcare applications through IoT platform

COURSE OUT COMES	**PROGRAM OUTCOMES**												**PSO**		
CO / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3												3	
CO2	3	3	3		3				3			3		3	
C03		3	3		3				3	3				3	
C04		3	3		3				3	3		3		3	
C05		3	3	2	3	2			3	3		3		3	
CO6		3	3	2	3	2			3	3		3		3	
CO (Avg)	3	3	3	2	3	2			3	3		3		3	

BM23U02	PERSPECTIVES OF SUSTAINABLE DEVELOPMENT – BIOMEDICAL ENGINEERING	L	T	P	C
		2	0	2	3

MODULE I – INTRODUCTION **6**

Principles & Historical perspectives, Importance and need for sustainability in engineering and technology, impact and implications. United Nations Sustainability Development Goals (SDG), UN summit – Rio & outcome, Sustainability and development indicators.

MODULE II – ENVIRONMENTAL SUSTAINABILITY **6**

Climate change, Biodiversity loss, Pollution and waste management, Renewable vs. non-renewable resources, Water and energy conservation, Sustainable agriculture and forestry. National and international policies, Environmental regulations and compliance, Ecological Footprint Analysis

MODULE III – SOCIAL & ECONOMIC SUSTAINABILITY **9**

Equity and justice, Community development, Smart cities and sustainable infrastructure, Cultural heritage and sustainability, Ethical considerations in sustainable development.

Triple bottom line approach, Sustainable economic growth, Corporate social responsibility (CSR), Green marketing and sustainable product design, Circular economy and waste minimization, Green accounting and sustainability reporting.

MODULE IV – HEALTHCARE SUSTAINABILITY **9**

Introduction, Green disposal of medical waste, Toxics in Healthcare-Chemicals, Pharmaceuticals, Water conservation, Renewable energy integration, Waste reduction strategies, Recycling, Green procurement, Digital health records, Telehealth and eHealth, Reduction of carbon footprint - Medical Devices, Green Electronics, Green Hospital, Benefits of Sustainable Healthcare

MODULE V – SUSTAINABILITY PRACTICES **30**

Suggested Practices not limited to

- Energy efficiency – how to save energy (energy efficient equipment, energy saving behaviours).
- Chemical use and storage - the choice of chemicals being procured, the safe disposal of leftover chemicals, the impact of chemicals on the environment and long-term health impacts on humans.
- Green building, green building materials, green building certification and rating: green rating for integrated habitat assessment (GRIHA), leadership in energy and environmental design (LEED)
- Tools for Sustainability - Environmental Management System (EMS), ISO14000, life cycle assessment (LCA)
- Ecological footprint assessment using the Global Footprint Network spreadsheet calculator

- National/Sub national Status of Sustainable Development Goals

TOTAL: 60 PERIODS

REFERENCES:

1. Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.
2. Munier, N. (2005). Introduction to sustainability (pp. 3558-6). Amsterdam, The Netherlands: Springer.
3. Blackburn, W. R. (2012). The sustainability handbook: The complete management guide to achieving social, economic and environmental responsibility. Routledge.
4. Clini, C., Musu, I., & Gullino, M. L. (2008). Sustainable development and environmental management. Published by Springer, PO Box, 17, 3300.
5. Bennett, M., James, P., & Klinkers, L. (Eds.). (2017). Sustainable measures: Evaluation and reporting of environmental and social performance. Routledge.
6. Seliger, G. (2012). Sustainable manufacturing for global value creation (pp. 3-8). Springer Berlin Heidelberg.
7. Stark, R., Seliger, G., & Bonvoisin, J. (2017). Sustainable manufacturing: Challenges, solutions and implementation perspectives. Springer Nature.
8. Davim, J. P. (Ed.). (2013). Sustainable manufacturing. John Wiley & Sons.

BM23504 **SUMMER INTERNSHIP** **L T P C**
0 0 4 2

OBJECTIVE:

- To train the students in the field work so as to have a firsthand knowledge of practical problems related to health sector and medical field in carrying out engineering tasks.

The students individually undertake training in reputed industries during the summer vacation for a specified duration of four weeks. At the end of training, a detailed report on the work done should be submitted. The students will be evaluated through a viva-voce examination by a team of internal staff.

OUTCOME:
On completion of the course, the student is expected to be able to

CO1 Understand the real world applications.
CO2 Gain technical knowledge
CO3 Develop professional skills and create a Professional Network.
CO4 Develop Time Management and Communication skill.
CO5 Acquittance with the Professional workplace and its operations.
CO6 Prepare technical documentation

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3				3	3					3	3	2	
CO2	3	3				3	3					3	3	2	
CO3						3		3	3	3		3	3	2	
CO4										3	3				
CO5											3	3			
CO6								2	2			3	3		
Avg	3	3				3	3	2.5	2.5	3	3	3	3	2	

BM23S03 SKILL DEVELOPMENT COURSE - LEVEL III L T P C
DESIGN AND DEVELOPMENT OF WEARABLE BIOSENSOR 1 0 2 2

I. Overview

This course will better prepare students for understanding the functional mechanism of Biosensors and its design. Students will learn the basic sensing principles, sensing elements (chemical, biochemical, optical, semiconductor) concepts to identify the right sensing system and to design, analyze and evaluate wearable biosensors. Students will also learn various applications associated with those sensing principles.

II. Contents

- Introduction to wearable biosensors and their mechanism, type, and functions.
- Design of electrochemical, optical, and other biosensors by integrating concepts of molecular recognition, transduction, biomaterials and microfabrication;
- Design simple biosensors for the detection of bio-analytes.
- Virtually analyze the functionalities and performance of the designed biosensors using simulation tools.
- Fabricate the designed sensors using 3D printing and other flexible printing techniques.
- Evaluate and characterize the performance of the fabricated biosensors.
- Investigate the applications of the fabricated sensors.

COURSE OUTCOMES:

After completing the skill development course, the student will be able to do

CO1 : Explain the basic principles of wearable sensor design.
CO2 Understand the fabrication techniques related to wearable biosensor applications
CO3 Design and fabricate wearable biosensor devices.
CO4 Analyse the performance of wearable biosensor virtually
CO5 : Fabricate the wearable biosensors and evaluate its performance.

References:

1. Wearable Electronics Sensors: For safe and heathy living, edited by Mukhopadhyay, Subhas C; Springer International Publishing, 2015.
2. Flexible Electronics: Materials and Applications, edited by Wong, William S., Salleo, Alberto; Springer International Publishing, 2009.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3												2	
CO2	3	3												2	
CO3	3	3	2		2				2	2		2		2	3
CO4	3	3	2		2				2	2				2	3
CO5	3	3							2	2				2	3
Avg	3	3	2		2				2	2		2		2	3

BM23601	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT – II	L	T	P	C
		3	0	2	4

UNIT I RESPIRATORY MEASUREMENT AND ASSIST SYSTEMS 10L+6P

Lung Volume and vital capacity, Spirometer, measurements of residual volume. pneumotachometer – Airway resistance measurement, Whole body plethysmography. Intra-Alveolar and Thoracic pressure measurements, Apnea Monitor. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators, Neonatal ventilators and Incubators. Broncoscope, Thoracoscope, Cardiopulmonary exercise testing.

Practical

- Measurement of Respiratory parameters using spirometry

UNIT II LASER BASED EQUIPMENTS 8L+6P

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

Practical

- Simulation of tissue interaction with laser

UNIT III DIATHERMY 9L+6P

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

Practical

- Study of shortwave and ultrasonic diathermy.
- Analysis the characteristics of surgical diathermy.

UNIT IV ULTRASOUND EQUIPMENT 9L+6P

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

Practical

- Study of ultra sound scanners

UNIT V PATIENT SAFETY 9+6P

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

Practical

- Electrical safety measurements.

TOTAL: 45L+30P=75 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the measuring parameters related to respiratory system.
CO2 Comprehend the principles of laser in diagnosis and treatment
CO3 Analyze different types of diathermy units.
CO4 Analyze the ultrasound principles for diagnostic applications
CO5 Analyze the electrical hazards and Implement it in patient safety.
CO6 Comprehend the measurement parameters of diagnostic equipment

TEXT BOOKS:

1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Pearson Education India; 2nd Edition, 2015.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology",Pearson Education, 4th Edition, 2014.
3. Leon Goldman, "The Biomedical Laser: Technology and Clinical applications", Springer –Verlag Newyork Inc., 2013.

REFERENCES:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
2. Richard Aston, "Principles of Biomedical Instrumentation and Measurement" Merril PublishingCompany, 1990.
3. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition,John Wiley and Sons, Reprint 2008.
4. John G.Webster, "Medical Instrumentation Application and Design", John Wiley and Sons,New York, 4th edition, 2009.
5. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design" – McGraw-Hill Publisher, 2003.
6. Antony Y.K.Chan, "Biomedical Device technology, Principles and design'', Charles ThomasPublisher Ltd, Illinois, USA, 2008.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3						3	3		1	3		
CO2	3	3	3						3	3		1	3		
CO3	3	3	3						3	3		1	3		
CO4	3	3	3						3	3		1	3		
CO5	3	3	3						3	3		1	3		
CO6	3	3	3						3	3		1	3		
Avg	3	3	3						3	3		1	3		

BM23602	BIOMECHANICS	L	T	P	C
		3	0	2	4

UNIT I INTRODUCTION **9L+3P**

Scope of mechanics in medicine, Forms of motion, kinetics of human motion, loads on the human body, Stress- strain characteristics, viscoelasticity and its models, levers and its type, review on Anthropometry.

Practical

- Simple machine fulcrum balance experiment

UNIT II BIO FLUID MECHANICS **9L+6P**

Newtonian and non-Newtonian fluids, Blood rheology, Laminar and turbulent flow, Heart valves, power developed by the heart, dynamics of fluid flow in cardiovascular system and effect of vibration - shear stresses in extra-corporeal circuits, microcirculation.

Practical

- Analysis of fluids in blood vessels.

UNIT III ORTHOPAEDIC MECHANICS **9L+6P**

Mechanics of bone structure, mechanical properties of bone, Mechanical properties of cartilage, diffusion properties of articular cartilage, kinetics and kinematics of joints, Lubrication of joints.

Practical

- Kinetic and kinematic analysis of joints

UNIT IV MATHEMATICAL MODELS **9L+6P**

Introduction to Finite Element Analysis, Mathematical models – case study-application in design of implants. Pulse wave velocities in arteries, determination of in-vivo elasticity of blood vessel, dynamics of fluid filled catheters.

Practical

- Finite element analysis of blood vessels
- Design of implants using FEM

UNIT VAPPLICATIONS OF BIOMECHANICS **9L+9P**

Dynamics analysis of human locomotion - Gait analysis (determination of instantaneous joint reaction analysis), Mechanics of knee joint during standing and walking, occupant response to vehicular vibration, Sports mechanics. Case study on exoskeleton.

Practical

- Characteristics of IMU sensor
- Measurement of joint angles
- Gait parameter measurement

TOTAL: 45L +30P= 75 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Comprehend the use of mechanics in medicine.
CO2 Apply the mechanics to analyze the concept of physiological systems.
CO3 Analyze the strength of material properties to model implants
CO4 Analyze the kinetics and kinematics of joints
CO5 Compute the rheology of bio fluids
CO6 Analysis of human gait

TEXT BOOKS:

1. Y.C.Fung,—Bio-Mechanics, "Mechanical Properties ofTissues'',Springer-Verilog,1998.
2. C. Ross Ether and Craig A.Simmons, "Introductory Biomechanics from cells to organisms",Cambridge University Press, New Delhi, 2009.

REFERENCES:

1. Susan J Hall, "Basics of Biomechanics'', Mc Graw Hill Publishing.co. New York, 5th Edition,2007.
2. Dhanjoo N.Ghista, "Orthopaedic Mechanics", Academic Press, 1990.
3. B.H.Brown, PV Lawford, RH Small wood, DR Hose, Dc Barber, "Medical Physics and Biomedical Engineering'', CRC Press, 1999.
4. Subrata pal, Text book of Biomechanics, Viva education private limited, 2009.
5. David A. Winter, Biomechanics and Motor Control of Human Movement
6. Margareta Nordin and Victor H. Frankel, Basic Biomechanics of the Musculoskeletal System

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3						3	3		1		3	
CO2	3	3	3	3	2				3	3		1		3	
CO3	3	3	3	3	2				3	3		1		3	
CO4	3	3	3		2			1	3	3		1		3	
CO5	3	3	3		2			1	3	3		1		3	
CO6	3	3	3						3	3		1		3	
Avg	3	3	3	3	2			1	3	3		1		3	

BM23C02	RADIOLOGICAL EQUIPMENT	L	T	P	C
		3	0	0	3

UNIT I MEDICAL X-RAY EQUIPMENT 10

Physics of Radiography. Nature of X-rays, X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, collimator, Bucky Grid, power supply. Digital Radiography- Computed radiography, CCD-Based, TFTs based and CMOS based Digital Radiography Systems. Fluoroscopy - X-ray Image Intensifier tubes – Digital Fluoroscopy. Angiography - cine Angiography, Digital subtraction Angiography. Mammography.

UNIT II COMPUTED TOMOGRAPHY 8

Principles of tomography, CT Generations - X- Ray sources, collimation, X- Ray detectors, Viewing systems, CT Numbers, Imaging Artifacts, spiral CT scanning, ultra-fast CT scanners. Image reconstruction techniques- back projection, iterative method and Fourier slice Theorem.

UNIT III MAGNETICRESONANCE IMAGING 9

Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radiofrequency wave, rotation and precession. Induction of magnetic resonance signals – bulk Magnetization, Relaxation processes T1 and T2, Spin echo, MR image acquisition, Imaging parameters- TE, TR and image contrast, Slice selection, frequency encoding and phase encoding. Block Diagram approach of MRI system- system Magnet (Permanent, Electromagnet and Super conductors), Gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components. fMRI.

UNIT IV NUCLEAR IMAGING SYSTEM 9

Radioactivity- Radioactivity decay law, Radio Isotopes- alpha, beta, and gamma radiations. Radiopharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors. Gamma camera- Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit, pulse height Analyzer. Principles of SPECT and PET, PETCT.

UNIT V RADIATION THERAPY AND RADIATION SAFETY 9

Effects of radiation- direct and indirect. Radiation therapy – linear accelerator, Tele gamma Machine. Recent Techniques in radiation therapy - Stereotaxic Radiosurgery, Stereotaxic Radiotherapy, Proton beam therapy, 3D CRT, IMRT, IGRT and Cyber knife. Radiation measuring Instruments-Dosimeter, film Badges, Thermo Luminescent dosimeters-electronic dosimeter. Radiation protection in medicine- radiation protection principles, ICRP, AERB.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Explain the physics of different diagnostic medical imaging techniques.
- **CO2** Demonstrate the Instrumentation behind the medical imaging equipment.
- **CO3** Understand and apply the image reconstruction methods for image formation.
- **CO4** Discuss the principle and operation of various types of radiation detectors
- **CO5** Understand the concepts of various radiation therapy equipment.

CO6 Demonstrate the effects of radiation, radiation safety and protection methods.

TEXT BOOKS:

1. Steve Webb, “The Physics of Medical Imaging’’, Adam Hilger,Philadelpia, 1988.
2. Jerry L.Prince and Jonathan M.Links, Medical Imaging Signals and Systems Pearson Education Inc. 2014.
3. Jerrold T.Bushberg, J.Anthony Seibert, Edwin M.Leidholdt,Jr, John M.Boone, ‘The Essential Physics of Medical Imaging’’, Lippincott Williams and Wilkins, 3rd Edition, 2012.

REFERENCES:

1. Gopal B. Saha, “Physics and Radiobiology of Nuclear Medicine’’, Springer, 3 rd Edition 2006.
2. B.H.Brown, PV Lawford, RH Smallwood, DR Hose, DC Barber, “Medical physics and Biomedical Engineering’’, - CRC Press,1999.
3. Myer Kutz, “Standard handbook of Biomedical Engineering and design”, McGraw Hill, 2003.
4. P.Ragunathan, “Magnetic Resonance Imaging and Spectroscopy in Medicine concepts and Techniques’’, Orient Longman,2007.
5. R.Hendee and Russell Ritenour, “Medical Imaging Physics”, William,Wiley- Liss, 4 th Edition, 2002.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3									2		1	3		
CO3	3	1											3		
CO4	3			1								1	3		
CO5	3							1					3		
CO6	-			1		1	1	1		2		1	3		
Avg	3	1		1		1	1	1		2		1	3		

UC23E01 ENGINEERING ENTREPRENEURSHIP DEVELOPMENT

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
2. Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
3. Analyse market types, conduct market estimation, identify customers, create customer persona, develop the skills to create a compelling value proposition and build a Minimum Viable Product
4. Explore business models, create business plan, conduct financial analysis and feasibility analysis to assess the financial viability of a venture ideas & solutions built with domain expertise
5. Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE – I: ENTREPRENEURIAL MINDSET **4L,8P**

Introduction to Entrepreneurship: Definition – Types of Entrepreneurs – Emerging Economies – Developing and Understanding an Entrepreneurial Mindset – Importance of Technology Entrepreneurship – Benefits to the Society.

Case Analysis: Study cases of successful & failed engineering entrepreneurs - Foster Creative Thinking: Engage in a series of Problem-Identification and Problem-Solving tasks

MODULE – II: OPPORTUNITIES **4L,8P**

Problems and Opportunities – Ideas and Opportunities – Identifying problems in society – Creation of opportunities – Exploring Market Types – Estimating the Market Size, - Knowing the Customer and Consumer - Customer Segmentation - Identifying niche markets – Customer discovery and validation; Market research techniques, tools for validation of ideas and opportunities

Activity Session: Identify emerging sectors / potential opportunities in existing markets - Customer Interviews: Conduct preliminary interviews with potential customers for Opportunity Validation - Analyse feedback to refine the opportunity.

MODULE – III: PROTOTYPING & ITERATION **4L,8P**

Prototyping – Importance in entrepreneurial process – Types of Prototypes - Different methods – Tools & Techniques.

Hands-on sessions on prototyping tools (3D printing, electronics, software), Develop a prototype based on identified opportunities; Receive feedback and iterate on the prototypes.

MODULE – IV: BUSINESS MODELS & PITCHING **4L,8P**

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest Assumptions in Business Model Design – Using Business Model Canvas as a Tool – Pitching Techniques: Importance of pitching - Types of pitches - crafting a compelling pitch – pitch presentation skills - using storytelling to gain investor/customer attention.

Activity Session: Develop a business model canvas for the prototype; present and receive feedback from peers and mentors - Prepare and practice pitching the business ideas- Participate in a Pitching Competition and present to a panel of judges - receive & reflect feedback

MODULE – V: ENTREPRENEURIAL ECOSYSTEM **4L,8P**

Understanding the Entrepreneurial Ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors. Financing models – equity, debt, crowdfunding, etc, Support from the government and corporates. Navigating Ecosystem Support: Searching & Identifying the Right Ecosystem Partner – Leveraging the Ecosystem - Building the right stakeholder network

Activity Session: Arrangement of Guest Speaker Sessions by successful entrepreneurs and entrepreneurial ecosystem leaders (incubation managers; angels; etc), Visit one or two entrepreneurial ecosystem players (Travel and visit a research park or incubator or makerspace or interact with startup founders).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types

CO2: Comprehend the process of opportunity identification through design thinking, identify market potential and customers

CO3: Generate and develop creative ideas through ideation techniques

CO4: Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP

CO5: Analyse and refine business models to ensure sustainability and profitability Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCES:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition
2. Bill Aulet (2024). Disciplined Entrepreneurship: 24 Steps to a Successful Startup. John Wiley & Sons.
3. Bill Aulet (2017). Disciplined Entrepreneurship Workbook. John Wiley & Sons.
4. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business
5. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch
6. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons
7. Marc Gruber & Sharon Tal (2019). Where to Play: 3 Steps for Discovering Your Most Valuable Market Opportunities. Pearson.

BM23701	DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	2	4

UNIT I DIGITAL IMAGE FUNDAMENTALS 9L +6P

Elements of digital image processing systems, Image sensing and Acquisition, - Elements of visual perception, Mach band effect, Color image fundamentals - RGB, HSI models, Image sampling, Quantization, dither, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT, KLT, SVD.

Practical

- Pre-processing of Medical images, Conversion between color spaces

UNIT II IMAGE ENHANCEMENT AND RESTORATION 9L +6P

Point processing, Histograms, Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional Smoothing, Median, Geometric mean, Harmonic mean, Contra harmonic mean filters, Homomorphic filtering, Color image enhancement. Image Restoration- degradation model, Unconstrained and Constrained restoration. Geometric transformations.

Practicals

- Spatial domain filtering, Frequency domain filtering

UNIT III IMAGE SEGMENTATION 9L +6P

Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Segmentation by morphological watersheds –Hybrid methods – Image Registration

Practicals

- Edge detection using Operators, Medical image Segmentation, Image Registration

UNIT IV IMAGE FEATURE EXTRACTION AND SELECTION 9L +6P

Features- Feature space, Statistical features, Texture features-co-occurrence features and Run length features, shape features. Feature selection - Need - PCA, statistical analysis and selection of features.

Practicals

- Feature extraction in medical images, Feature selection

UNIT V IMAGE COMPRESSION 9L +6P

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, Vector Quantization, LZW compression, Transform coding, JPEG standard, MPEG.

Practicals

- Medical Image Compression, Medical image fusion

TOTAL: 75 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Understand basic principles of image acquisition, process color images and apply image transforms
- **CO2** Pre-process the images using image enhancement and filtering techniques
- **CO3** Restore the degraded images
- **CO4** Segment the region of interest and extract significant features
- **CO5** Apply various compression techniques on images
- **CO6** Develop image processing algorithms for various applications

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing’’, Pearson, Education, Inc., 4th Edition, 2017.
2. Anil K. Jain, “Fundamentals of Digital Image Processing’’, Pearson Education, Inc., 1st Edition, 2015.
3. Milan Sonka, Vaclav Hlavac and Roger Boyle, “Image Processing, Analysis and Machine vision’’, Cengage, 3rd Edition, 2013.

REFERENCES:

1. Kenneth R. Castleman, "Digital Image Processing", Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, "Digital Image Processing using MATLAB", Pearson Education, Inc., 2004.
3. William K. Pratt, "Digital Image Processing", John Wiley, New York, 2002.
4. Alan C. Bovik, "Handbook of image and Video Processing", Elsevier Academic press, 2005.
5. S. Sridhar, "Digital Image Processing" Oxford University press, Edition 2011.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			3				3	3		3			3
CO2	3	3			3				3	3		3			3
CO3	3	3			3				3	3		3			3
CO4	3	3			3				3	3		3			3
CO5	3	3			3				3	3		3			3
CO6	3	3			3				3	3		3			3
Avg	3	3			3				3	3		3			3

BM23703 **HOSPITAL TRAINING** **L T P C**
0 0 6 3

OBJECTIVES:

The student should be able to

- Understand the hospital organization and Management
- Understand the working principle and operation of Medical Equipment
- Observe the connections and recording of the equipment in hospital setting
- Understand the trouble shooting of medical equipment

Students need to complete training in Government hospital / any leading Multi-specialty hospital for a period of 8 weeks (2 months). They need to prepare an extensive report and submit. The students should give a detailed presentation of the equipment, laboratory and the facilities in all the departments of the Hospital.

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1	Describe the role, function, operation and management of medical equipment.
CO2	Troubleshoot the medical equipment
CO3	Implement basic and fire safety measures mandated
CO4	Comprehend the hospital organogram and management.
CO5	Manage and dispose Biowaste.
CO6	Prepare technical Report and presentation.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3										3	3	3		
CO2	3	2										3	3		
CO3						3	3	3	3			3	3		
CO4									3		3	3	3		
CO5						3	3	3				3	3		
CO6										3		3	3		
Avg	3	2				3	3	3	3	3	3	3	3		

BM23704 **MINI PROJECT** **L T P C**
0 0 4 2

OBJECTIVES:

- To solve the identified problem statement based on the formulated methodology.
- To develop skills to analyze and infer the results, and make conclusions.

The student should carry out literature survey and experimental works on selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners.

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Appropriately do a literature survey and outline the objectives and scope of the chosen project.
CO2 Make proper decisions on materials and methods needed.
CO3 Understand the need for societal role, environment sustainability, professional ethics, and teamwork.
CO4 meet the timelines and budget.
CO5 Implement the project as conceived.
CO6 Develop Report Writing and Presentation Skills.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3			3	3	3		3	3	3	3
CO2	3	3	3	3	3				3	3		3	3	3	3
CO3	3					3	3	3	3	3		3	3		
CO4	3								3	3	3	3	3		
CO5	3								3	3		3	3	3	3
CO6	3								3	3		3	3		
Avg	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

BM23801 PROJECT WORK / SEMESTER LONG INTERNSHIP L T P C
0 0 16 8

OBJECTIVES:

- To solve the identified problem statement based on the formulated methodology.
- To develop skills to analyze and infer the results, and make conclusions.

Project:

The student should carryout literature survey and experimental works on selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report and the viva-voce examination by a panel of examiners including one external examiner.

Semester Long Internship:

The students individually undertake training in reputed medical industries and have to find solution for the industrial problems during the internship. At the end of training, a detailed report on the work done should be submitted and will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Conceptualize an innovative idea and develop proof of concept
CO2 validate in a relevant environment and prototype demonstration
CO3 Understand the need for societal role, environment sustainability, professional ethics, and teamwork.
CO4 Meet Timelines and budget
CO5 Gain Collective Knowledge, Interactions and up-dation.
CO6 Develop Report Writing and Presentation Skills.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3			3	3	3		3	3	3	3
CO2	3	3	3	3	3				3	3		3	3	3	3
CO3	3					3	3	3	3	3		3	3	3	3
CO4	3								3	3	3	3	3		
CO5	3								3	3		3	3		
CO6	3								3	3		3	3		
Avg	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

VERTICAL I: BIO ENGINEERING

BM23001	MEDICAL PHYSICS	L	T	P	C
		3	0	0	3

UNIT I NON IONIZING RADIATION AND ITS MEDICAL APPLICATION 9

Overview of non-ionizing radiation effects-Low Frequency Effects- Higher frequency effects. Thermography – Application. Ultrasound Transducer - Interaction of Ultrasound with matter; Cavitations, Conditions for reflection, Transmission-Scanning systems – Artefacts-Ultrasound- Doppler-Double Doppler shift Clinical Applications.

UNIT II PRINCIPLES OF RADIOACTIVE NUCLIDES 9

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

UNIT III INTERACTION OF RADIATION WITH MATTER 9

Interaction of charged particles with matter –Specific ionization, Linear energy transfer range, Bremsstrahlung, Annihilation, Interaction of X and Gamma radiation with matter-Photoelectric effect, Compton Scattering, Pair production, Attenuation of Gamma Radiation, Interaction of neutron with matter and their clinical significance.

UNIT IV PRINCIPLES OF RADIATION DETECTION AND DOSIMETERS 9

Principles of radiation detection, Properties of dosimeters, Theory of gas filled detectors, Ionization Chamber, Proportional chamber, G.M. Counter, Film dosimetry, luminescence dosimetry, scintillation detectors, Radiation detection instruments, Area survey meters, Personal Radiation monitoring device, Film badge, TLD, OSLD.

UNIT V BASIC RADIATION QUANTITIES 9

Introduction -exposure- Inverse square law-KERMA-Kerma and absorbed dose -stopping power - relationship between the dosimetric quantities - Bremsstrahlung radiation, Bragg‟s curve- concept of LD 50- Stochastic and Non-stochastic effects, Different radiation Unit, Roentgen, gray, Sievert.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Understand the effect of non-ionizing radiation in human body and applications in the field ofmedicine.
- **CO2** Understand radioactive decay and production of radio nuclides.
- **CO3** Understand the interaction of radiation with matter
- **CO4** Demonstrate the need and principle of measurement of ionizing radiation.
- **CO5** Enumerate the effect of ionizing radiation in human body.

TEXT BOOKS:

1. JohnR Cameron, James G Skofronick, “Medical Physics”, John-Wiley&Sons,1978.
2. W.J.Meredith andJ.B. Massey, “Fundamental Physics of Radiology” Varghese Publishing house.1992.

REFERENCES:

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

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2			3		
CO2	3									2			3		
CO3	3	3					1			2			3		
CO4	3							1		2		1	3		
CO5	3							1		2		1	3		
Avg	3	3					1	1		2		1	3		

BM23002	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
		2	0	2	3

UNIT I CELL DEGENERATION, REPAIR AND NEOPLASIA 6+6

Cell injury-reversible and irreversible, necrosis, apoptosis, intracellular accumulations, cellular adaptations of growth and differentiation-atrophy, hypertrophy, hyperplasia, dysplasia, metaplasia. Inflammation, wound healing and repair including fracture healing, neoplasia, benign and malignant tumors, spread of tumor, staging and grading of tumor and biopsy.

Practical

1. Visualization of histopathological slides of benign and malignant tumors.

UNIT II FLUID AND HEMODYNAMIC DERRANGEMENTS 6+6

Edema, normal hemostasis, thrombosis, embolism, disseminated intravascular coagulation, infarction-myocardial infarction, artherosclerosis, ischemic disease, shock, gangrene. Hematological disorders-bleeding disorders, leukaemias, lymphomas. Autoanalyzer-coagulation analyzer and body fluid analyzer

Practical

1. Visualization of hematology slides of anemia and leukemia (acute and chronic).
2. Bleeding time and clotting time.

UNIT III MICROSCOPES 6+6

Principle, assembly, working and applications of light microscope- bright field, dark field, phase contrast, fluorescence. Principle, assembly and working of electron microscope (TEM & SEM). Preparation of samples for electron microscope-negative staining and freeze etching technique. Staining methods of light microscopes -simple, gram staining, AFB staining, hematoxylin and eosin staining.

Practical

1. Staining methods of light microscopes -simple, hematoxylin and eosin staining.

UNIT IV MICROBIAL CULTURES 6+6

Morphological features and structural organization of bacteria, motility, arrangement of bacterial colonies, growth curve, asepsis, hospital acquired infections, disinfection and sterilization techniques – physical and chemical methods, identification of bacteria, essentials of bacterial growth requirements, culture media and its types, culture techniques and observation of culture. Health programmes in India. Deep freezer, Incubator, BOD, centrifuge, biosafety cabinet, CSSD.

Practical

1. Demonstration on sterilization techniques

UNIT V IMMUNOLOGY 6+6

Natural and artificial immunity, cell mediated and humoral mediated immunity, phagocytosis, inflammation, structure of antibodies and its types, antigen and antibody reactions, hypersensitivity, immunological techniques- immuno electrophoresis,

radioimmunoassay and enzyme linked immunosorbent assay, Widal test and Coombs test, protocol for the synthesis of monoclonal antibodies and its applications. Polymerase chain reaction and MALTI-TOF. Disease caused by bacteria and protozoa-sources, transmission, pathology, symptoms and treatment. ELISA reader and washer.

Practical

5% Visualization of slides of malarial parasites, microfilaria and leishmaniadonovani.

TOTAL: 60PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the concepts and mechanism of cell injury in normal and pathological c

CO2 Discuss on the importance of public health.

CO3 Analyze structural and functional aspects of living organisms.

CO4 Perform practical experiments on tissue processing, sterilization techniques a processes.

CO5 Develop and subsequently interpret the test results and quality management pro the laboratory.

TEXT BOOKS:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, “Pathologic Basis of diseases”, WB Saunders Co. 7th Edition, 2005.
2. Harsh Mohan, “Text book of Pathology”. Jaypee Brothers Medical publishers private Limited edition 7th, 2014.
3. PranabeswarChakraborthy, A Textbook of Microbiology, New Central Book Agency, 3rd edition, 2013

REFERENCES:

1. Underwood JCE, “General and Systematic Pathology”,Churchill Livingstone,3rd ed,2000.
2. Ananthanarayanan, “Microbiology”, Panicker University press. 9th edition, 2013.
3. Dubey RC and MaheswariDK,“Microbiology”, S. Chand Publications, 3th Edition, 2010
4. Prescott, Harley, Klein, “Microbiology”, Mc Graw Hill, 9th Edition, 2013.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3		2						2	2		1	3		
CO2	2		3			2			2	2		1	3		
CO3	3		3						2	2		1	3		
CO4	3	3	3	2	3	2		3	2	2		1	3		
CO5	3	2	3	3	3	3		2	2	2	2	1	3		
Avg	3	3	3	3	3	3		3	2	2	2	1	3		

BM23003	BIOMATERIALS AND ARTIFICIAL ORGANS	L	T	P	C
		3	0	0	3

UNIT I STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY **9**

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

UNIT II MATERIALS FOR IMPLANT **9**

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

UNIT III POLYMERIC IMPLANT MATERIALS **9**

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

UNIT IV TISSUE REPLACEMENT IMPLANTS **9**

Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft- tissue replacements, types of transplant by stem cell, sutures, surgical tapes, Tissue adhesive/glue. Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, Pancreas replacement.

UNIT V ARTIFICIAL ORGANS **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Analyze different types of materials and its application in biomedical field.

CO2 Assess compatibility and functioning of artificial organs inside the living system.

CO3 Comprehend the responses of biomaterials in living system.

CO4 Analyze the properties of biopolymers.

CO5 Develop biomaterial based scaffold for biomedical application.

TEXT BOOKS:

1. Sujata V. Bhatt, “Biomaterials”, Narosa Publishing House, 7th Edition, 2005.
2. JoonB.Park Joseph D. Bronzino, “Biomaterials - Principles and Applications”, CRC press, 2003.

REFERENCES:

1. H.H.Willard, D.L.Merrit, “Instrumental Methods of Analysis”, CBS Publishers, 1992.
2. ParkJ.B., “Biomaterials Science and Engineering’’, Plenum Press,1984.

3. Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill, 2003.
4. John Enderle, Joseph D Bronzino, Susan M. Blanchard “Introduction to Biomedical Engineering”, Elsevier, 2005.
5. AC Anand, JF Kennedy, M. Miraftab, S.Rajendran, “Medical Textiles and Biomaterials for Health Care’’, Woodhead Publishing Limited, 2006.
6. D F Williams, “Medical and Dental Materials: A comprehensive Treatment-Volume 14”, VCH Publishers, 1992.
7. BD Ratner, AS Hoffmann,FJ Schoen, JE Lemmons, “”An introduction to Materials in Medicine”, Academic Press, 1996.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3								1		1		3	
CO2	3	3						1				1		3	
CO3	3	3						1				1		3	
CO4	3	3	2							1		1		3	
CO5	3	3	2		2			1	1	1		1		3	
Avg	3	3	2		2			1	1	1		1		3	

BM23004	BIOMATERIALS AND CHARACTERISATION	L	T	P	C
		3	0	0	3

UNIT I BIOMATERIALS AND PROPERTIES 9

Introduction to biomaterials and requirements for biomaterial. Classification of biomaterials metallic, ceramic, synthetic and natural polymers, nanocomposites. Properties of biomaterials: bulk properties and surface properties, ethics.

UNIT II PHYSIO-CHEMICAL CHARACTERIZATION 9

Material Characterization-x-ray diffraction analysis (XRD), FT-raman and micro raman analysis, electron spectroscopy for chemical Analysis (ESCA) and x-ray photo electron spectroscopy (XPS), mechanical testing: tensile, compression, wears, fatigue, corrosion studies and fracture toughness. Thermal and viscoelastic properties.

UNIT III SURFACE CHARACTERIZATION 9

Surface properties and adhesion, contact angle measurement, scanning electron microscopy (SEM), transmission electron microscopy (TEM), scanning tunnelling microscopy and atomic force microscopy (AFM).Secondary ion mass spectrometry and confocal laser scanning microscopy.

UNIT IV BIOMATERIAL TESTING 9

Biofunctionality and biocompatibility, preservation techniques for biomaterials, testing with tissue culture- in vitro & in vivo assessment, blood properties, testing of blood-materials, testing with soft tissues and testing at non thrombogenic surface-blood compatibility and thromobogenicity, animal models, ethics, patents, regulatory bodies, policies and commercialization of medical device.

UNIT V BIOMATERIALS IN MEDICINE 9

Design of materials for biomedical application- materials for bone and joint replacement - stainless steel, titanium based materials and porous metals. Ceramics- alumina, zirconia, calcium phosphate and bioactive glass, bone cement. Polymers: PMMA and polyethylene, rubber and fluorocarbon polymers. Materials for oral and maxillofacial surgery, ophthalmology and smart materials for medical applications. Achievements and challenges in implant fixation, failure analysis of medical devices and implants.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Analyze different types of materials and their properties.
- **CO2** Explain the basic principles and features of materials and understand their key relationship between the structure, property and their processing steps.
- **CO3** Analyze the roles of biomaterials in designing the medical device.
- **CO4** Apply the knowledge of science and engineering and to function on multidisciplinary team.
- **CO5** Develop biomaterial based scaffold for biomedical application.

TEXT BOOKS:

1. Sujata V. Bhatt, “Biomaterials”, Narosa Publishing House, 7th Edition, 2005.
2. JoonB.Park Joseph D. Bronzino, “Biomaterials - Principles and Applications”, CRC press, 2003.

3. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons. Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, 2004, USA.

REFERENCES:

1. T. M. Wright, and S. B. Goodman. Implant Wear in Total Joint Replacement: Clinical and Biologic Issues, Material and Design Considerations. American Academy of Orthopaedic Surgeons, 2001.
2. L Ambrosio. Biomedical composites, Woodhead Publishing Limited, UK, 2009.
3. K.C. Dee, D.A. Puleo and R. Bizios. An Introduction to Tissue-Biomaterial Interactions. Wiley 2002, ISBN: 0-471-25394-4.
4. T.S. Hin (Ed.) Engineering Materials for Biomedical Applications. World Scientific. 2004. ISBN 981-256-061-0.
5. B. Rolando (Ed.) Integrated Biomaterials Science. Springer. 2002. ISBN: 0-306-46678-3.
6. Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill, 2003.
7. John Enderle, Joseph D. Bronzino, Susan M. Blanchard, “Introduction to Biomedical Engineering’’, Elsevier, 2005.
8. AC ANAND, J F Kennedy, M. Miraftab, S. Rajendran, “Medical Textiles and Biomaterials for Healthcare”, Woodhead Publishing Limited, 2006.

COURSE OUTCOMES	**PROGRAMME OUTCOMES**												**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2												3		
CO2	3												3		
CO3	3		2				3						3		
CO4	3	3	3	3	2				3	2	3	3	3		
CO5	3	3	3	3	3	3	2	3				2	3		
Avg	3	3	3	3	3	3	3	3	3	2	3	3	3		

BM23005	PRINCIPLES OF TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I FUNDAMENTALS OF TISSUE ENGINEERING 9

Tissue Engineering: Introduction - Objectives of tissue engineering - Laboratory set up for tissue engineering. Tissue development and Tissue exchange - Cell cycle and differentiation - cell adhesion - cell adhesion molecules - cell migration - cell aggregation and tissue equivalent.

UNIT II COMPONENTS OF TISSUE ENGINEERING 9

Cell: Cell harvesting In Vitro – Medium: Synthetic and Biological media – Scaffold: Natural and Synthetic scaffold: Cell and Drug delivery systems - Transplantation – Implantation - Nanotechnology in tissue engineering – Biocompatibility studies In Vitro and In Vivo.

UNIT III STEM CELLS 8

Definition of stem cells – types of stem cells – differentiation, dedifferentiation maturation, proliferation, pleuripotency and immortalization. Sources of stem cells: haematopoetic – fetal - cord blood – placenta - bone marrow - primordial germ cells - cancer stem cells - induced pleuripotent stem cells.

UNIT IV MATERIALS IN TISSUE ENGINEERING 9

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

UNIT V APPLICATION OF TISSUE ENGINEERING 10

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Understand the basic concepts of tissue engineering
- **CO2** Acquire ability to function on multi-disciplinary teams
- **CO3** Apply the knowledge of professional and ethical responsibility in use of stem cells and gene therapy in creating tissue engineered therapies
- **CO4** Design and develop different biomaterial in tissue engineering application.
- **CO5** Develop research or clinical application on tissue repair/ engineering.

TEXT BOOKS:

1. W. Mark Saltzman, “Tissue Engineering – Engineering principles for design of replacementorgans and tissue”, Oxford University Press Inc New York, 2004.
2. CS Potten, “Stem cells”, Elsevier, 1996.

REFERENCES:

1. Gary E. Wnek, Gary L Browlin, “Encyclopedia of Biomaterials and Biomedical Engineering”, Marcel Dekker Inc, New York, 2008.
2. R. Lanza, Anthony Atala (Eds), “Essential of Stem Cell Biology”, Academic Press, USA, 2013.

3. R. Lanza, Anthony Atala,“ Handbook of Stem Cells’’, Academic Press, USA, 2012.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2			3		
CO2	2					2			2	2			3		
CO3	3	3	3							2		1	3		
CO4	3	3						1		2		1	3		
CO5	3	3	3	2	2			1	2	2		1	3		
Avg	3	3	3	2	2	2		1	2	2		1	3		

BM23006	NEURAL ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I BASICS OF NEURON STRUCTURE AND FUNCTIONS 9

Nervous system development. Trophic factors, extra cellular matrix components in nervous system development. Neuron: structure – function – classification. Glial cells – myelination. Neurotransmitter – types and functions. Synapses - Transport of materials and impulse in neurons.

UNIT II BRAIN, BRAIN STEM AND SPINAL CORD 9

Brain: structures – lobes – functional areas. Brain stem: structures – functional areas. Spinal cord: structure – functions. Concepts of nuclei – sensory and motor Tracts - Reticular formation. Blood supply to Brain and spinal cord.

UNIT III NEURONAL DISEASES AND DISORDERS 9

Neuro degeneration: Degenerative, Demyelinated and injury related disorders associated with nervous system, Wallerian Degeneration, Neuronal plasticity – CNS acting drugs and their pharmacokinetics. Alzheimer‘s, Parkinson‘s and Prion diseases.

UNIT IV NEUROPHYSIOLOGY & NEURORADIOLOGY 9

Physiology of nerve conduction. Peripheral nerves – structure & Functions. Synaptic transmission and cellular signaling of Neurons. Electrical activity of the Brain and recording of brain waves. Evoked potentials. Visualization of nervous system. Neuromotor-machine interface: human voluntary motor control system.

UNIT V NERVE RECONSTRUCTION AND REHABILITATION 9

Neural plasticity; Neurological dysfunctions - Regeneration of the peripheral nervous system. Neural tissue engineering; Nerve graft; Drug delivery system in CNS. Rehabilitation: Mechanisms for Neuromotor rehabilitation; Robotics and virtual reality in physical therapy; Transcranial magnetic stimulation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the basic structure and functions of human nervous system.
CO2 Comprehend on diseases and degeneration related to nervous system.
CO3 Analyze visualization and radiological assessment of nervous system.
CO4 Apply neural tissue engineering for rehabilitation.
CO5 Understand the Regeneration of nervous system.

TEXT BOOKS:

1. Mathews G.G., “Neurobiology”, 2nd edition, Blackwell Science, UK, 2000.
2. Malcom Carpenter, “Textbooks of Neuroanatomy”, Mc. Graw hill Edition, 1996.

REFERENCES:

1. W. Mark Saltzman, “Tissue Engineering – Engineering principles for design of replacement organs and tissue’’, Oxford University Press Inc New York, 2004.
2. Park J.B., “ACS Biomaterials Science and Engineering”, Plenum Press, 2014. Saunders, 2006.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2			3		
CO2	3									2			3		
CO3	3	3						1	1	2		1	3		
CO4	3	3	3					1	1	2		1	3		
CO5	3									2			3		
Avg	3	3	3					1	1	2		1	3		

BM23007	ADVANCED BIO ANALYTICAL AND THERAPEUTIC TECHNIQUES	L	T	P	C
		3	0	0	3

UNIT I ANALYTICAL TECHNIQUES 9

Principle, instrumentation and application of electrophoresis-SDS, native gel and agarose. Ultra violet, visible and infrared spectroscopy-principle, assembly, working and its applications. Spectrophotometry, fluorimetry and NMR-principle, instrumentation and application in medical sciences.

UNIT II ENZYMES AS DIAGNOSTIC TOOL 9

Clinical enzymology-isoenzymes and their screening techniques, enzyme pattern in health and diseased condition- lipase, amylase, alkaline phosphatase, acid phosphatase, serum glutamate, oxaloacetate transaminase, serum glutamate pyruvate transaminase, lactate dehydrogenase and creatinine phosphokinase. Biosensors- enzyme based, antibody based, DNA based and optical biosensor. Northern, southern and western blotting and automation in clinical laboratory.

UNIT III RADIOISOTOPIC TECHNIQUES 9

Definition of radioisotopes and its types, measurement of radioactivity-Geiger Muller counter and liquid scintillation counter. Units of measurements, clinical applications of radioisotopes, radiodating, autoradiography, biological hazards of radioisotopes, safety measures in handling isotopes, disposal of labeled compounds and dosimetry.

UNIT IV GENE THERAPY 9

Human genome project, central concept of gene therapy, prerequisite of human gene therapy, biological basis of gene therapy strategies, vehicles for gene transfer, gene transfer methods, clinical gene therapy case studies for hereditary disease, cancer and HIV. Ethical issues in human gene therapy.

UNIT V NANOTHERAPEUTICS 9

Introduction to nanoparticles – definition, types of nanocarriers in drug delivery, synthesis and physiochemical properties of particles at nanoscale. Transport across biological barriers, Nanotechnology in cancer therapy, bone treatment, oral vaccination and skin disease. Nanorobotics in medicine. Fate of nanoparticle and its toxicity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Report and discuss on chemical analytical aspects relevant for the selection of proper analytical techniques
- **CO2** Understand the aspects of clinical enzymology and its implementation in diagnosis.
- **CO3** Discuss on preventive measures of radioactive pollution and regulations regarding safety measures for radiation exposure.
- **CO4** Analyze the underlying etiology of the disease and choose precise therapy.
- **CO5** Describe the basic science behind the properties of materials at nanoscale and the principles behind advanced experimental and computational techniques for studying nanomaterials

TEXT BOOKS:

1. Douglas A, “Principles of Instrumental Analysis”, Skoog Brooks Cole publisher, 6th edition 2006.
2. Keith Wilson & John Walker, “Practical Biochemistry – Principles and Techniques”, Oxford University Press, 7th edition, 2010.

REFERENCES:

1. Trevor Palmer, “Understanding Enzymes”, Published by Ellis Horwood LTD, 4th edition, 1995.
2. Harvey Lodish W. H, “Molecular Cell Biology”, Freeman publisher 7th edition, 2012.
3. G. Louis Hornyak, John J. Moore, Harry F. Tibbals and Joydeep Dutta, “Fundamentals of Nanotechnology”, CRC press, 1st edition, 2008.
4. Gabor L. Hornyak, Joydeep Dutta, H.F. Tibbals, Anil Rao, “Introduction to NanoScience”, CRC Press, 2008.
5. Harry.F. Tibbals, Perspectives in Nanotechnology: Medical Nanotechnology and Nanomedicine. CRC Press, Taylor & Francis Group, 1st edition 2011, ISBN-13: 978-1-4398-08740.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2	3					2		2		3	
CO2	3				2					2	3	2		3	
CO3	3		2		3	2		2		2		2		3	
CO4	2	3	2	3	3				3	2		2		3	
CO5	3	3	2	2	3	2		3	3	2		2		3	
Avg	3	3	2	2	3	2		3		2	3	2		3	

BM23008	BIOSTATISTICS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION **9**

Medical data, Introduction to probability, likelihood & odds, distribution variability.

UNIT II STATISTICAL PARAMETERS **6**

Statistical parameters p-values, computation and level chi square test and distribution.

UNIT III REGRESSION ANALYSIS **6**

Regression, correction use of regression, multiple regression.

UNIT IV INTERPRETING DATA **12**

Interpreting life tables clinical trials, epidemical reading and interpreting of epidemical studies, application in community health.

UNIT V META ANALYSIS **12**

META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 : Demonstrate and understand the central concepts of modern statistical theory and their probabilistic foundation.

CO2 : Compare the various parameters used in statistical significance.

CO3 : Explain the techniques used in regression analysis.

CO4 : Interpret results of the principal methods of statistical inference and design.

CO5 : Apply the statistical approach to combine the results from multiple studies.

REFERENCES:

1. Joseph A. Ingelfinger, Frederick Mosteller, Lawrence A. Thibodeau, James H. Ware “Biostatistics in Clinical Medicine” (third edition), Singapore, 1994.
2. A.K Sharma, “Text Book of Biostatistics I” . India: Discovery Publishing House Pvt. Limited, 2005.
3. A.K. Sharma ,“Text Book of Correlations and Regression”. India: Discovery Publishing House, 2005.
4. Walter T. Ambrosius, “Topics in Biostatistics United Kingdom”: Humana Press, 2007.
5. Malhotra, Rajeev Kumar., Indrayan, Abhaya, “Medical Biostatistics”. United States: CRC Press, 2017.
6. Chan, Bertram K.C. United States. “Biostatistics for Epidemiology and Public Health Using R” by: Springer Publishing Company, 2015.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1			3	1						2				3	
CO2		3								2				3	
CO3			3							2		1		3	
CO4		3	3			1		1		2		1		3	
CO5	2	3	3		1		1	1		2		1		3	
Avg	2	3	3	1	1	1	1	1		2		1		3	

BM23009	INDIAN TRADITIONAL MEDICAL SYSTEM	L	T	P	C
		3	0	0	3

UNIT I FUNDAMENTALS OF INDIAN TRADITIONAL MEDICAL SYSTEM **9**

Introduction to Indian Traditional Medicine systems- Ayurveda, Yoga & Naturopathy, Unani, Siddha, Homoeopathy and Sowa-rigpa- Principles and concepts of Indian Traditional Medicine - Understanding the human body from the perspective of Indian Traditional Medicine- Integration of Indian Traditional Medicine with modern biomedical practices--wearable devices to monitor physiological changes during treatments.

UNIT II BIOSENSORS, BIOCHEMICAL ANALYSIS AND IMAGING TECHNIQUES IN ITMS **9**

Sensors- Force, pressure, humidity, IR, temperature and pressure profiles estimation, applications in Unani hammam regime therapeutic procedures Microscopic evaluation, Phytochemical testing, Physicochemical analysis, Centrifuge, Autoclave, Bod Incubator, Ball mills, Microbial analysis, UV spectrometry, Thin Layer Chromatography (TLC), High Performance Thin Layer Chromatography (HPTLC)

UNIT III RESEARCH AND MED-TECH INNOVATIONS IN ITMS **9**

Three radial pulse measurement - Nadi yantra, Nadi tarangini, Naadi Parisothanai- Nasal Cycle Analyser - Pranogram- Urine Analyser – (Taila Bindu / Neikuri)- Wrist Circumetric Sign – (Manikadainool)- Automatic Shirodhara Yantra (ASY)- Automated system for Therapeutic Emesis- Auto Fumigator.

UNIT IV ICT IN ITMS **9**

Introduction to Systems Biology - Health informatics (ISO TC 215), Hospital Information and management System for Indian Traditional Medical System- E-Dietetics- OCR Palm Leaf Reader- Augment /Virtual Reality and Multimedia Applications in ITMS- Wearable Device Applications in AYUSH medical system. - Applications for identification and e-learning of single drugs used in Unani Medicine

UNIT V QUALITY CONTROL AND SAFETY CONSIDERATIONS IN BIOMEDICAL INSTRUMENTATION AS PER ITMS **9**

Future prospects and challenges of Medical electronics in ITMS, Introduction to Indian Certification of Medical Devices Scheme (ICMED) – Overview, importance, benefits, certification requirements and levels. Quality control and safety considerations in biomedical instrumentation as per ITMS

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1	Understand the fundamentals of Indian Traditional Medical Systems
CO2	Apply biosensors, biochemical analysis, and imaging techniques in ITMS
CO3	Explore research and med-tech innovations in ITMS
CO4	Utilize ICT in ITMS

CO5	Understand quality control and safety considerations in biomedical instrumentation as per ITMS

TEXT BOOKS:

1. Introduction to Biomedical Engineering" by John Enderle and Joseph Bronzino
2. Medical instrumentation by John G Webster
3. Biomedical instrumentation by RS khandpur
4. Biochemistry by Sathyanaraynan
5. Principles of Medical Imaging, K. Kirk Shung, Michael Smith, Benjamin M.W. Tsui, 1st Edition –2012
6. Biomedical signal analysis by Rangaraj M. Rangayyan
7. Biomedical digital signal processing by Tompkins

COURSE OUTCOMES	**PROGRAMME OUTCOMES**												**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3											1	3		
CO2	3											1	3		
CO3	3	2										1	3		
CO4	3	2										1	3		
CO5	3											1	3		
Avg	3	2										1	3		

VERTICAL II: BIOSIGNAL AND MEDICAL IMAGE PROCESSING

BM23010	BIOMETRIC SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO BIOMETRICS 9

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

UNIT II FINGERPRINT TECHNOLOGY 9

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

UNIT III FACE RECOGNITION AND HAND GEOMETRY 9

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

UNIT IV IRIS RECOGNITION 9

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

UNIT V VOICE SCAN AND MULTIMODAL BIOMETRICS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Understand the principles of biometric systems
- **CO2** Develop fingerprint recognition technique
- **CO3** Design face recognition and hand geometry system.
- **CO4** Design iris recognition system.
- **CO5** Develop speech recognition and multimodal biometric systems
- **CO6** Design and develop Biometric system for a given application

TEXT BOOKS:

1. James Wayman& Anil Jain, “Biometric Systems- Technology Design and PerformanceEvaluation”, Springer, 2011.
2. Paul Reid, “Biometrics for Network Security”, Pearson Education, 2004.

REFERENCES:

1. Nalini K Ratha, Ruud Bolle, “Automatic fingerprint recognition system’’, Springer, 2003.
2. L C Jain, I Hayashi, S B Lee, U Halici, “Intelligent Biometric Techniques in Fingerprint andFace Recognition”, CRC Press, 1st Edition, 1999.
3. S.Y. Kung, S.H. Lin, M.W., “Biometric Authentication: A Machine Learning Approach”,Prentice Hall, 2004.
4. John Chirillo, Scott Blaul, “Implementing Biometric Security”, John Wiley & Sons, 2003.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3								2				3	
CO2	3	3	3		1				1	2		1		3	
CO3	3	3	3		1			1	1	2		1		3	
CO4	3	3	3		1			1	1	2		1		3	
CO5	3	3	3		1			1	1	2		1		3	
CO6	3	3	3		1			1	1	2		1		3	
Avg	3	3	3		1			1	1	2		1		3	

BM23011	PATTERN RECOGNITION AND NEURAL NETWORKS	L	T	P	C
		3	0	0	3

UNIT I STATISTICAL PATTERN RECOGNITION 9

Overview of Pattern recognition, Types of Pattern recognition, Parametric and Nonparametric approach, Bayesian classifier, Discriminant function, non-parametric density estimation, histograms, kernels, window estimators, k- nearest neighbor classifier, estimation of error rates.

UNIT II CLUSTERING ANALYSIS AND FEATURE SELECTION 9

Unsupervised learning- Hierarchical clustering- Single-linkage Algorithm, Complete – linkage Algorithm, Average - Linkage Algorithm and Ward‘s method. Partitional clustering- Forgy‘s Algorithm and k-means algorithm. Feature Selection- PCA, ICA, Case studies.

UNIT III INTRODUCTION TO NEURAL NETWORK 9

Elementary neurophysiology and biological neural network –Artificial neural network – Architecture, biases and thresholds, Hebb net, Perceptron, Adaline and Madaline.

UNIT IV BACK PROPAGATION NETWORK AND ASSOCIATIVE MEMORY 9

Back propagation network, generalized delta rule, Bidirectional Associative memory, Hopfield Network, Case study- Simulation in BPN Network

UNIT V NEURAL NETWORKS BASED ON COMPETITION 9

Kohonen Self organizing map, Learning Vector Quantisation, Counter Propagation network, Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Classify patterns using statistical pattern classifier

CO2 Perform unsupervised classification using clustering techniques.

CO3 Apply and Analyze the fundamentals of Supervised neural networks.

CO4 Demonstrate the analysis of Back Propagation and Hopfield network.

CO5 Perform classification using competitive neural networks.

TEXT BOOKS:

1. Duda R.O, Hart P.G, “Pattern Classification and scene analysis’’, Wiley Edition, 2000.
2. Earl Gose, Richard Johnsonbaugh Steve Jost, “Pattern Recognition and Image Analysis”,Prentice Hall of India Pvt Ltd., New Delhi,1999.
3. Freeman J. A., and Skapura B.M, “Neural networks, algorithms, applications and programming techniques”, Addison- Wesley,2003

REFERENCES:

1. Simon Hawkins, “Neural Network- A Comprehensive foundation” ,9th edition, Pearson Education, Prentrce hall-2005.
2. Hagan, Demuth and Beale, “Neural Network Design’’, Vikas Publishing House Pvt Ltd., NewDelhi, 2002.

3. Robert Schalkoff, “Pattern recognition, Statistical, Structural and neural approaches”, JohnWiley and Sons (Asia) Pvt Ltd., Singapore, 2005.
4. Laurene Fausett, “Fundamentals of Neural Networks Architectures Algorithms andApplication”, Prentice Hall, 1994.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			3			1		2				3	
CO2	3	3		3	3					2				3	
CO3	3	3	3	3	3			1		2				3	
CO4	3	3	3	3	3	3				2		2		3	
CO5		3	3	3	3	3		1		2	1	2		3	
Avg	3	3	3	3	3	3		1		2	1	2		3	

BM23012	BIOMEDICAL SIGNAL PROCESSING	L	T	P	C
		2	0	2	3

UNIT I BIOMEDICAL SIGNAL AND SPECTRAL CHARACTERISTICS 6

Characteristics of biomedical signals, Stationary and Non stationary signals, Noises- random, structured and physiological noises, Spectral characteristics, Power spectrum estimation, Filtering for removal of artifacts- Time domain filters, Frequency domain filters, Optimal Filter- Wiener filter.

UNIT II ADAPTIVE FILTERS AND MODELING 6

Adaptive filter- Least Mean square filter, Recursive Least square filter, Applications- Removal of artifact in ECG and EEG signals, Elimination of Maternal ECG in Fetal ECG, Autoregressive Modeling, PCA, ICA.

UNIT III ANALYSIS OF BIOMEDICAL SIGNALS 6

QRS detection in ECG signal, Heart rate variability, Analysis of EEG signal- EEG Frequency band separation, Visual evoked potential, Synchronous Averaging, Event related potential, Analysis of EMG signals- Feature extraction.

UNIT IV WAVELET ANALYSIS 6

Time frequency Representation, Short time Fourier transform, Wavelets- Multiresolution analysis, Continuous wavelet transform, Discrete wavelet transform, Wavelet Packets, Wavelet denoising.

UNIT V APPLICATIONS 6

Denoising of Biosignals , Arrhythmia detection, Epileptic seizure detection, Emotion recognition, Case studies on applications of Biosignal processing.

PRACTICAL EXERCISES 30

1. Pre-processing of Biosignals
2. QRS detection using Pan-Tompkins algorithm in ECG signals.
3. Heart rate variability analysis in ECG signals.
4. Development of algorithm for ECG arrhythmia detection.
5. Band separation and spectrum of EEG signals
6. Autoregressive modelling of biosignals.
7. Feature extraction in EMG signals
8. Noise cancellation using Adaptive filters
9. .Wavelet denoising

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Pre-process the Biosignals.
CO2 Analyse biosignals in time domain & estimate the spectrum.
CO3 Apply Adaptive filters for denoising
CO4 Extract discriminant features from biosignals.
CO5 Apply wavelet transform techniques in the analysis of biosignals
CO6 Develop algorithms for Biosignal processing applications.

TEXT BOOKS:

1. Arnon Cohen, “Bio-Medical Signal Processing Vol I and Vol II”, CRC Press Inc., 2021.
2. Rangaraj M. Rangayyan, “Biomedical Signal Analysis-A case study approach”, Wiley, 2nd Edition, 2016.

REFERENCES:

1. Emmanuel C. Ifeachor, Barrie W.Jervis, “Digital Signal processing- A Practical Approach’’, Pearson education Ltd., 2004.
2. Raghuveer M. Rao and Ajith S.Bopardikar, “Wavelets transform – Introduction to theory and its applications”, Pearson Education, India, 2000.
3. John L.Semmlow, “Biosignal and Biomedical Image Processing Matlab Based applications’’, Taylor& Francis Inc, 2004.
4. Kayvan Najarian and Robert Splerstor, “Biomedical signals and Image processing’’, CRC – Taylor and Francis, New York, 2nd Edition, 2012.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			3				3	2		1		3	
CO2	3	3			3				3	2		1		3	
CO3	3	3			3				3	2		1		3	
CO4	3	3			3				3	2		1		3	
CO5	3	3	2		3				3	2		1		3	
CO6	3	3	2	2	3			1	3	2		1		3	
Avg	3	3	2	2	3			1	3	2		1		3	

BM23013	ARTIFICIAL INTELLIGENCE IN HEALTHCARE	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION **9**

Artificial Intelligence - The new age of healthcare, Precision medicine, Artificial intelligence and medical visualization, Intelligent personal health records, Robotics and artificial intelligence-powered devices , Ambient assisted living, Review of state of Artificial Intelligence in Healthcare, Ethical guidelines for Application of Artificial Intelligence in Healthcare.

UNIT II DISEASE DIAGNOSTICS AND TREATMENT DECISIONS USING ARTIFICIAL INTELLIGENCE **9**

Machine Learning and Deep learning for disease diagnosis and staging, Artificial intelligence to predict cancer treatment response and cancer recurrence and survival, Alzheimer disease detection, Monitoring of Dementia and Migraine, Neurodevelopmental disorders- ASD and ADHD Detection, Case studies

UNIT III ARTIFICIAL INTELLIGENCE FOR MEDICAL IMAGING **9**

Artificial Intelligence in Radiology, Data Augmentation, Transfer Learning, Clinical findings in Radiological Images using Deep learning- RadBot-CXR, Detection of osteoporosis using artificial intelligence, artificial intelligence in Ultrasound imaging and visualization of Arteries.

UNIT IV ARTIFICIAL INTELLIGENCE ASSISTED SURGERY **9**

Artificial Intelligence in Preoperative diagnosis, Preoperative staging, Intraoperative, Autonomous surgery, Computer vision, and Detection of post-operative complications, Case studies

UNIT V REMOTE PATIENT MONITORING USING ARTIFICIAL INTELLIGENCE **9**

Remote Patient Monitoring, Sensors, Smart phones, Apps and Devices, Natural language processing, Virtual reality, Augmented reality, Avathar, Chat bot and voice powered virtual assistants, Alzheimer disease detection, Monitoring of Dementia and Migraine, Cardiac monitoring, Diabetes prediction and monitoring.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 : Understand the potential of Artificial Intelligence in Healthcare applications.

CO2 : Apply Artificial Intelligence to diagnose and predict cancer treatment response.

CO3 : Apply Artificial Intelligence for medical imaging applications.

CO4 : Understand the concepts of Artificial Intelligence assisted surgery

CO5 : Develop Artificial Intelligence algorithms for remote patient monitoring

CO6 : Design and develop Artificial Intelligence algorithms for Healthcare applications

TEXT BOOKS:

1. Adam Bohr, Kaveh Memarzadeh, “Artificial Intelligence in Healthcare”, Elsevier,2020.
2. Bernard Nordlinger, Cedric Villani, Daniela Rus, “Healthcare and Artificial Intelligence”, Springer, 2020.

REFERENCES:

1. Tianhua Chen, Jenny Carter, Mufti Mahmud, Arjab Singh Khuman, “Artificial Intelligence in Healthcare Recent Applications and Developments”, Springer,2022.
2. Kayvan Najarian, Delaram Kahrobaei, Enrique Dominguez, Reza Soroushmehr, “Artificial Intelligence in Healthcare and Medicine”, CRC Press, 2022.
3. Chee Peng Lim, Ashlesh Vaidya, Kiran Jain, Virag U, Mahrokar, Lakhmi C Jain, “Handbook of Artificial Intelligence in Healthcare Vol 1- Advances and Applications, Springer, 2022.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2		1			3
CO2	3	3	3							2		1			3
CO3	3	3	3							2		1			3
CO4	3	3	3							2		1			3
CO5	3	3	3					1		2		1			3
CO6	3	3	3	1	2			1	1	2		1			3
Avg	3	3	3	1	2			1	1	2		1			3

BM23014 MEDICAL IMAGE ANALYSIS AND ITS APPLICATIONS

L	T	P	C
2	0	2	3

UNIT I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING 6

Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of morphological image processing

PRACTICAL

- Denoising of Medical Images

UNIT II SEGMENTATION OF MEDICAL IMAGES 6

Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour method-Level set method, Model based segmentation, Atlas based segmentation

PRACTICAL

- Segmentation of Medical Images

UNIT III FEATURE EXTRACTION IN MEDICAL IMAGES 6

Statistical Features, Shape features, Hough transform, Boundary descriptors, Texture features, Co-occurrence features, Runlength features, Fractal model based features, Gabor filter and wavelet features

PRACTICAL

- Feature Extraction and Analysis in Medical Images

UNIT IV REGISTRATION AND IMAGE FUSION 6

Registration- Preprocessing, Transformation functions-Similarity transformation and Affine Transformation. Resampling- Nearest Neighbour and Cubic Splines
Image Fusion-Overview of image fusion, pixel fusion, Multiresolution based fusion- discrete wavelet transform.

PRACTICAL

- Medical Image Registration
- Medical Image Fusion

UNIT V APPLICATIONS 6

Segmentation of Brain Tumor in MR Images, Detection of Malignancy in Mammogram Images, Classification of Abnormalities in Liver Ultrasound images, Detection of Diabetic Retinopathy in Fundus images.

PRACTICAL

- Classification of Abnormality in Medical Images

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Analyze and process the medical images.

CO2 Apply image processing techniques to enhance and denoise the medical images

CO3 Segment the region of interest in medical images

CO4 Extract the significant features in medical images.

CO5 Apply registration and fusion techniques in medical images

CO6 Design and implement algorithms for medical image processing application

TEXT BOOKS:

1. G.Dougherty, “Medical Image Processing: Techniques and Applications”, Springer,2013.
2. Mark Nixon, Alberto Aguado, “Feature Extraction and Image Processing”, Academic Press, 2008.
3. Ardeshir Goshtasby, “2D and 3D Image registration for Medical, Remote Sensing and Industrial Applications”, John Wiley and Sons,2005.
4. H.B.Mitchell, “Image Fusion Theories, Techniques and Applications”, Springer,2010.

REFERENCES:

1. Rafael C. Gonzalez, Richard E. Woods, ‘Digital Image Processing’, Pearson, Education, Inc., Second Edition, 2004.
2. John C.Russ, “The Image Processing Handbook”, CRC Press,2007.
3. Anil K. Jain, ‘Fundamentals of Digital Image Processing’, Pearson Education, Inc., 2002.
4. Rick S.Blum, Zheng Liu, “Multisensor image fusion and its Applications”, Taylor& Francis, 2006.
5. Milan Sonka, Vaclav Hlavac, Roger Boyle, “Image Processing, Analysis, and Machine Vision”, Thomson Brooks Cole Pub, Second Edition,2003

COURSE OUTCOMES	PROGRAMME OUTCOMES														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			3				3	2		1			3
CO2	3	3			3				3	2		1			3
CO3	3	3			3				3	2		1			3
CO4	3	3			3				3	2		1			3
CO5	3	3			3				3	2		1			3
CO6	3	3	1	1	3			1	3	2		1			3
Avg	3	3	1	1	3			1	3	2		1			3

BM23015	SOFT COMPUTING AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

UNIT I FUZZY SET THEORY 10

Introduction to Neuro-Fuzzy and Soft Computing - Fuzzy Sets - Basic Definition and Terminology - Set-theoretic Operations - Member Function Formulation and Parameterization - Fuzzy Rules and Fuzzy Reasoning - Extension Principle and Fuzzy Relations - Fuzzy If -Then Rules - Fuzzy Reasoning - Fuzzy Inference Systems - Mamdani Fuzzy Models - Sugeno Fuzzy Models - Tsukamoto Fuzzy Models.

UNIT II OPTIMIZATION 8

Derivative based Optimization - Descent Methods - The Method of Steepest Descent – Classical Newton‘s Method - Step Size Determination - Derivative free Optimization - Genetic Algorithm - Simulated Annealing - Random Search - Downhill Simplex Search.

UNIT III ROUGH SETS 9

Rough sets - Rough set theory - Set approximation - Rough membership - Attributes-Dependency of attributes - Rough equivalence - Reducts - Rough reducts based on SVM - Hybrid set systems - Fuzzy rough sets.

UNIT IV HYBRID TECHNIQUES 9

ANN concepts - Adaptive Neuro - Fuzzy Inference Systems - Architecture - Hybrid Learning Algorithm - Coactive Neuro Fuzzy Modeling - Neuro-Fuzzy Spectrum - Neuro- Fuzzy- GA systems and case studies.

UNIT V APPLICATIONS OF COMPUTATIONAL INTELLIGENCE 9

Neural networks for facial and emotion recognition - Detection of brain disorders - Study of cardiac conditions - Soft Computing for detection of Chest disorders.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Work on fuzzy logic and design inference systems

CO2 Apply various derivative and non-derivative optimization schemes

CO3 Understand concepts related to rough sets

CO4 Discuss hybrid soft computing with case studies

CO5 Develop different soft computing frame works for Engineering applications

TEXT BOOKS:

1. J.S.R.Jang, C.T.Sun and E.Mizutani, "Neuro Fuzzy and Soft Computing", Pearson Education, 2015.
2. N.P.Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press, 2005.

REFERENCES:

1. Timothy J.Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, 3ed., 2011.

2. Davis E.Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning, Addison Wesley, N.Y., 1989.
3. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2013.
4. R.Eberhart, P. Simpson and R. Dobbins, "Computational Intelligence - PC Tools", Academic Press Professional, Boston, 1996.
5. Dr.S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India, 3rd Edition, 2018.
6. Vladik Kreinovich and Nguyen Hoang Phuong , “Soft Computing for Biomedical Applications and Related Topics”, Springer, 2021.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	3	3	-	-	1				1	1			3	3
CO2	3	3	-	3	-	1				1	1			3	3
CO3	-	3	3	-	-	1					1			3	3
CO4	3	3	3	3	-	1				1	1			3	3
CO5	3	-	3	3	1	1		1		1	1	1		3	3
Avg	3	3	3	3	1	1		1		1	1	1		3	3

BM23016	BRAIN COMPUTER INTERFACE AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO BCI 9

Brain Computer Interface system, Classification of BCI- Dependent, Independent, Hybrid BCI, Invasive, Non-invasive and Partially invasive BCI, Synchronous and Asynchronous BCI, Neuronal Activity in brain cortex.

UNIT II SOURCES FOR BCI 9

EEG signal acquisition – Signal Preprocessing – Artifacts removal, MEG, Signals reflecting brain metabolic activity- PET, fNIRS, fMRI. EEG-Event related potential- P300, Mu band ,Sensory Motor Rhythm- Event Related Desynchronization, Event related synchronization, Motor Imagery signals, Visual Evoked potential, Steady state Visual Evoked potential, Slow cortical potential.

UNIT III FEATURE EXTRACTION 9

Power spectral density, Band power, Wavelet features, Spatial filters- Common Average Reference Filter, Laplacian filter, Common Spatial Pattern, PCA and ICA.

UNIT IV CLASSIFICATION 9

Linear Discriminant Analysis, k Nearest Neighbor classifier, Support Vector Machine, Regression, Deep Neural networks- Transfer learning, Convolution Neural Network.

UNIT V APPLICATIONS OF BCI 9

Speller based on P300, Speller based on SSVEP, SSVEP based wheelchair control, Motor imagery based control of Exoskeleton, Neurorehabilitation, Gaming, Neuromarketing, Case studies on Applications of BCI.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Acquire and analyse the brain signal from different regions of brain cortex for specific BCI Application
- **CO2** Apply suitable preprocessing technique to the brain signal
- **CO3** Analyze the event related potentials
- **CO4** Extract discriminant features from brain signals
- **CO5** Classify and derive the control signals for BCI applications
- **CO6** Design a BCI system for various applications

TEXT BOOKS:

1. Jonathan Wolpaw, Elizabeth Winter Wolpaw, “Brain Computer Interfaces: Principles and Practice”, Oxford University Press,2012.
2. R. Spehlmann, “EEG Primer”, Elsevier Biomedical Press, 1999.
3. Bernhard Graimann, Brendan Allison, GertPfurtscheller, “Brain-Computer Interfaces: Revolutionizing Human - Computer Interaction”, Springer, 2010.

REFERENCES:

1. Arnon Cohen," Biomedical signal processing Vol 1 Time and Frequency Domain Analysis", CRC Press, 1986.
2. Arnon Cohen, "Biomedical Signal Processing Vol 2: Compression and automatic recognition",CRC Press Inc., 2021.
3. Bishop C.M., "Neural Networks for Pattern Recognition", Oxford, Clarendon Press, 1995.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3								2				3	3
CO2	3	3								2				3	3
CO3	3	3		1						2		1		3	3
CO4	3	3		1						2		1		3	3
CO5	3	3	3							2		1		3	3
CO6	3	3	3	1				1		2		1		3	3
Avg	3	3	3	1				1		2		1		3	3

VERTICAL III: BIOMEDICAL DEVICE DEVELOPMENT

EC23C22	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - System Design & Modeling - Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL – Obsolescence Management – Configuration Management - EoL Disposal

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Define, formulate, and analyze a problem.

CO2 Solve specific problems independently or as part of a team.
CO3 Gain knowledge of the Innovation & Product Development process in the Business Context.
CO4 Work independently as well as in teams.
CO5 Manage a project from start to finish.

TEXT BOOKS:

1. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGrawHill, Fifth Edition, 2011.
2. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

REFERENCES:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3								2		1	3		
CO2	3	3	3						2	2		1	3		
CO3	3	3								2		1	3		
CO4	-	-	-					1	3	2		1	3		
CO5	3	3	3					1		2	2	1	3		
Avg	3	3	3					1	3	2	2	1	3		

BM23017 BIOMEDICAL DEVICE DESIGN AND DEVELOPMENT

L	T	P	C
3	0	0	3

UNIT I PRODUCT DESIGN **9**

Product Development process, Market Survey, Design lifecycle, Classification of medical Devices, Design process-Product specification, Design Evaluation, Risk Assessment, Product Life cycle, Design History File, Case studies: ECG System design

UNIT II PRODUCT DEVELOPMENT **9**

Process to Design Realization, Computer Aided Design- Rapid prototyping, 3D Visualization, Prototype Development, Risk Analysis and Management, Clinical Validation, Medical Device Calibration, Scalability, Commercialization, Case studies on development of ECG system.

UNIT III SIGNAL PROCESSING **9**

Discrete Representation of Analog systems, Discrete Fourier Transform, Spectrum, Power spectral density function, Signal Denoising using Filtering, Case studies on signal denoising

UNIT IV MEDICAL DEVICE STANDARDS AND REGULATIONS **9**

Medical Device Quality Management System- ISO 13485, Technical Standards for Medical Devices, Safety requirement of Medical Devices, Electromagnetic Compatibility test- IEC 60601-1, IEC 60601-2, Medical Device Regulations, Medical Device Certification, Case studies on Medical Device Standards.

UNIT V MEDICAL SOFTWARE **9**

Guidelines on Software design, Software development process, Standards for Medical Software, Risk management in Software, Cloud Computing Model, Case studies on Medical Software.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the design and development of biomedical products and processes at the systems level

CO2 Understand the processes to ensure quality, testing, and approval of biomedical products.

CO3 Implement signal processing techniques required for product development

CO4 Possess knowledge in medical device standards and regulations

CO5 Possess knowledge in Software development process

CO6 Design and develop a Biomedical product complying to the standards

TEXT BOOKS:

1. Peter J.Ogrodnik, “Medical Device Design Innovation from Concept to Market”, Elsevier, Academic Press, 2013.
2. Claudio Becchetti, Alessandro Neri, “Medical Instrument Design and Development from Requirements to Market Placements”, Wiley, 2013.

REFERENCES:

1. Jones, J.C. “Design Methods”, John Wiley, 2nd Edition, 1992.
2. Cross N, “Engineering Design Methods”, John Wiley, 4th Edition, 2008.
3. Michael E.McGrath, “Product Strategy for High-Technology Companies”, 2nd Edition,

McGrawHill, 2000
4. Ulrich, K.T., and Eppinger, S.D., “Product Design and Development”, McGraw Hill, 7th Edition,2020
5. Paul H king, Richard C. Fries, Arthur T. Johnson, “Design of Biomedical Devices and Systems”, 3rd Edition, CRC Press, 2014

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3							2				3	
CO2	3	3								2				3	
CO3	3	3	3							2		1		3	
CO4	3	3								2		1		3	
CO5	3	3								2		1		3	
CO6	3	3	3					1		2		1		3	
Avg	3	3	3					1		2		1		3	

BM23018	WEARABLE SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I SENSORS **9**

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS –Based Biosensors, E-Textiles, Bio compatibility

UNIT II SIGNAL PROCESSING **9**

Wearability issues -physical shape and placement of sensor, technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Datamining.

UNIT III ENERGY HARVESTING FOR WEARABLE DEVICES **9**

Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT IV WIRELESS HEALTH SYSTEMS **9**

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication techniques.

UNIT V APPLICATIONS OF WEARABLE SYSTEMS **9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Choose the appropriate sensor for specific wearable application.
- **CO2** Develop signal processing techniques for wearable systems
- **CO3** Assess the energy requirement for a wearable system and choose the appropriate energy harvesting technique for wearable systems
- **CO4** Understand the need for BAN and the challenges involved in the design of BAN
- **CO5** Analyze applications of Wearable systems.
- **CO6** Design wearable systems for medical applications.

TEXT BOOKS:

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer,2011.
2. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata subramanian, "Body AreaNetworks Safety, Security, and Sustainability", Cambridge University Press, 2013.

REFERENCES:

1. Hang,Yuan-Ting, "Wearable medical sensors andsystems",Springer-2013.

2. Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore,2012.
3. Guang-Zhong Yang (Ed.), "Body Sensor Networks", Springer, 2006.
4. Andreas Lymberis, Danilo de Rossi, 'Wearable eHealth systems for Personalized Health Management - State of the art and future challenges' IOS press, Netherlands, 2004.

COURSE	PROGRAMME OUTCOMES												PSO		
OUTCOMES	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3								2		1		3	3
CO2	3	3								2		1		3	3
CO3	3	3								2		1		3	3
CO4	3	3								2		1		3	3
CO5	3	3	2							2		1		3	3
CO6	3	3	2	1				1		2		1		3	3
Avg	3	3	2	1				1		2		1		3	3

BM23C01	BODY AREA NETWORK	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION **9**

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BAN Architecture – Introduction.

UNIT II HARDWARE FOR BAN **9**

Processor-Low Power MCUs, Mobile Computing MCUs, Integrated processor with radio transceiver, Memory ,Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

UNIT III WIRELESS COMMUNICATION AND NETWORK **9**

RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1, IEEE P802.15.13, IEEE 802.15.14, Zigbee.

UNIT IV COEXISTENCE ISSUES WITH BAN **9**

Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self-protection-Bacterial attacks, Virus infection, Secured protocols, Self-protection.

UNIT V APPLICATIONS OF BAN **9**

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrythmia monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Understand the BAN Architecture and the technical challenges
- **CO2** Select the suitable hardware for BAN
- **CO3** Assess the efficiency of communication and the security parameters.
- **CO4** Understand the need for medical device regulation and regulations followed in various regions.
- **CO5** Analyze various BAN Applications
- **CO6** Design a BAN for appropriate application in medicine.

TEXT BOOKS:

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, “Body Area Networks Safety, Security, and Sustainability’’, Cambridge University Press, 2013.

REFERENCES:

1. Zhang, Yuan-Ting, “Wearable Medical Sensors and Systems’’, Springer, 2023.

2. Guang-Zhong Yang (Ed.), “Body Sensor Networks’’, Springer, 2014.
3. Mehmet R. Yuce, Jamil Y.Khan, “Wireless Body Area Networks Technology, Implementation, and Applications”, Pan Stanford Publishing Pte. Ltd., Singapore, 2012.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3								2		1		3	
CO2	3	3								2		1		3	
CO3	3	3								2		1		3	
CO4	3	3								2		1		3	
CO5	3	3								2		1		3	
CO6	3	3	1					1		2		1		3	
Avg	3	3	1					1		2		1		3	

BM23019	SMART HEALTHCARE TECHNOLOGIES AND SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I AI AND INTELLIGENT HEALTHCARE 9

Introduction, The Role of AI in Establishing a Smart Sensor Network, Role of Nanotechnology and IoMT in Healthcare, AI-Supported Cardiac Monitoring, Role of AI in Surgery, Role of AI in Diabetes Mellitus and Cancer Management, Challenge and Future Prospects. Case study: Internet of Medical Things (IoMT) as a strategic IT-based innovation to achieve Smart Hospitals.

UNIT II IOMT AND SMART HEALTHCARE SYSTEM BUILDING BLOCKS 9

Introduction, IoMT Devices-On-Body Devices, In Home Devices, Community Devices, In-Clinic Devices, In Hospital Devices, IoMT System Architecture - Data Collection Layer, Data Management Layer, Medical Server Layer; Design Methodology.

UNIT III ENABLING SMART HEALTHCARE TECHNOLOGIES 9

E-Health Industrial applications in IoMT - Body centric IoMT - Skin disorder IoMT detection - Layer management in IoMT - Sensor management - Network management - Internet management - Service management; Data acquisition in IoMT -Enabling biosensors - Cancer cell detection - Smart beds - Human activity detection - Skin care wearable - Smart pillbox; Software defined IoMT - Augmented reality for IoMT; Wearable sensor network; E-health cloud for medical of things.

UNIT IV IOMT SECURITY THREATS AND CHALLENGES 9

Secured architecture for loT enabled Personalized Healthcare Systems; IoMT Attack Types, Challenges in IoMT Security Schemes, Current Security Plans for IoMT, Potential Solutions for Security Vulnerabilities. A case study on the application of Block Chain concepts on Securing IoMT.

UNIT V SMART HEALTHCARE SYSTEM APPLICATIONS 9

A Novel Framework for Healthcare Monitoring System Through Cyber-Physical System; Secured Architecture for Internet of Things-Enabled Personalized Healthcare Systems; Healthcare Application Development in Mobile and Cloud Environments; Internet of Medical Things (IoMT) Applications, Architectures and Challenges in Smart Healthcare Systems

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Comprehend the essentials of Intelligent and Smart Healthcare Systems

CO2 Understand the building blocks and enabling technologies of Smart healthcare systems.

CO3 Analyze the building blocks and enabling technologies of Smart healthcare systems.

CO4 Design IoT-based systems for real-world problems and Bio-Medical Applications.

CO5 Mitigate and manage Security threats and challenges of Smart Healthcare systems

CO6 Design and develop smart healthcare applications

TEXT BOOKS:

1. Potential of Internet of Medical Things (IoMT) applications in building a smart healthcare system: A systematic review, Ruby Dwivedi,a Divya Mehrotra,b,∗ and Shaleen Chandra, J Oral Biol Craniofac Res. 2022 Mar-Apr; 12(2): 302–318.
2. Internet of Medical Things (IoMT) as a strategic IT-based innovation to achieve Smart Hospitals– Case Study "Mayo Clinic & Charité – Universitätmedizin Berlin.", Erika Santos and etal., 2023.
3. A Survey of Internet of Medical Things (IoMT) Applications, Architectures and Challenges in Smart Healthcare Systems, Sindhuja R and etal., ITM Web of Conferences **56**, 05013 (2023) https://doi.org/10.1051/itmconf/20235605013 *ICDSAC 2023*
4. Artificial Intelligence (AI) and Internet of Medical Things (IoMT) Assisted Biomedical Systems for Intelligent Healthcare, Pandiyaraj Manickam and etal., Biosensors, 2022,
5. 12, 562, https://doi.org/10.3390/bios12080562 and https://www.mdpi.com/journal/biosensors
6. Internet of medical things and trending converged technologies: - A comprehensive review on real-time applications, Journal of King Saud University – Computer and Information Sciences 34 (2022) 9228–9251
7. Venkata Krishna, Sasikumar Gurumoorthy, Mohammad S. Obaidat, “Internet of Things and Personalized Healthcare Systems”, Springer Briefs in Applied Sciences, and Technology, Forensic and Medical Bioinformatics, 2019.
8. Medtech and the Internet of Medical Things - How connected medical devices are transforming health care, Deloitte Centre for Health Solutions July 2018
9. IoMT at the heart of Digital Healthcare, Andy Brown, OMDIA, Silicon labs, 2022
10. IoMT, Thematic Report, Dr.Yogesh Shelke, Arpit Sharma, Technology Intelligence & IP Research. 2016

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3								2		1		3	
CO2	3	3								2		1		3	
CO3	3	3	3							2		1		3	
CO4	3	3	3							2		1		3	
CO5	3	3								2		1		3	
CO6	3	3	3							2		1		3	
Avg	3	3	3							2		1		3	

BM23020	MEMS AND ITS BIOMEDICAL APPLICATIONS	L	T	P	C
		3	0	0	3

UNIT I MEMS MATERIALS AND FABRICATION 9

Typical MEMs and Microsystems, materials for MEMS - active substrate materials-Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers. Micromachining- photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA.

UNIT II MECHANICAL AND THERMAL - SENSORS AND ACTUATORS 9

Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermo mechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever – microplates, strain, pressure and flow measurements, Thermal sensors and actuators- actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys- Inertia sensor, flow sensor.

UNIT III ELECTROSTATIC, PIEZOELECTRIC SENSORS AND ACTUATORS 9

Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

UNIT IV MICROFLUIDIC SYSTEMS 9

Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in microconduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel. Fluid actuation methods- electro wetting, thermocapillary effect, electro osmosis, dielectrophoresis. Microfluid dispenser, microneedle, micro pumps- continuous flow system, micromixers.

UNIT V APPLICATIONS OF BIOMEMS 9

CAD for MEMs, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR), DNA sensor, MEMS based drug delivery, electronic nose, Biosensors- sensors for glucose, uric acid, urea and triglyceride sensor. Introduction to 3D printing, Introduction to COMSOL Multiphysics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Discuss various MEMS fabrication techniques.
- **CO2** Explain different types of sensors and actuators and their principles of operation at the microscale level.
- **CO3** Comprehend the characteristics of fluid flow and actuation through micro channels.
- **CO4** Explain the need and use of simulation for MEMS design.
- **CO5** Design MEMS devices for different medical applications.

TEXT BOOKS:

1. Chang Liu, " Foundations of MEMS", Pearson Education International, New Jersey, USA, 2nd Edition, 2011.
2. Tai Ran Hsu, "MEMS and Microsystems design and manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002

REFERENCES:

1. Wanjun Wang, Stephen A.Soper, "BioMEMS: Technologies and applications", CRC Press, New York, 2007
2. Marc J. Madou, "Fundamentals of Microfabrication: the science of miniaturization'', CRC Press, 2002.
3. Nadim Maluf, Kirt Williams, "An Introduction to Micro electro mechanical Systems Engineering", Second Edition, Artech House Inc, MA, 2004.
4. Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007.
5. Koushik Guha, Gorachand Dutta, Arindam Biswas,K. Srinivasa Rao, "MEMS and Microfluidics in Healthcare Devices and Applications Perspectives", Springer, 2023.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3											3	
CO2	3	3	3									1		3	
CO3		3				3			3	2				3	
CO4		3		3	3							1		3	
CO5			3	3					3		2	1		3	
Avg	3	3	3	3	3	3			3	2	2	1		3	

BM23021	BIO MICROFLUIDIC DEVICES	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO MICROFLUIDICS 9

Fluids and nonfluids, properties of fluids, classification of fluids, Electrokinetic phenomena- Electric double layer, debye length, coupling species transport and fluid mechanics, Micro channel Resistance, Shear stress, capillary flow, flow through porous media, Diffusion, surface tension, contact angle and Wetting. Introduction to surface, surface charge, surface energy, Thermodynamics of surfaces, The Navier Strokes equation, Boundary and Initial conditions problems.

UNIT II FABRICATION TECHNIQUES OF MICROFLUIDIC DEVICES 9

Materials, Clean room, Silicon crystallography, Miller indices. Patterning, Photolithography, Micromachining, Micromolding, Soft lithography, PDMS properties, Fabrication of microfludics channels. Hot embossing, Fluid interconnections. Fabrication of lab-on-a-paper - Lab-on-a-chip.

UNIT III COMPONENTS OF MICROFLUIDIC DEVICES 9

Design considerations and applications – Micromixers, Microvalves, Micropumps, Microchannels, Microflow sensors, Droplet generators. Microreactors - Liquid phase reactors, PCR reactors. Microparticle separator - Principles of separation and sorting of microparticles. Mathematical modeling of microfluidic devices and systems, Practical aspects of testing flow through microfluidic channels, Digital Microfluidics.

UNIT IV MICROFLUIDICS BIOCHIP 9

Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment. Bioreactors on Microchips- Enzyme assay and inhibition, Chemical synthesis in microreactors, Sequential reaction and Parallel reaction in micro reactors, chemical separation, liquid chromatography. Immunosensors - Nucleic acid sensors, DNA amplification platforms.

UNIT V APPLICATIONS OF MICROFLUIDIC DEVICES IN HEALTHCARE 9

Diagnostic applications - In vitro diagnostics, point of care diagnostics, Controlled drug delivery using microfluidic devices. Microneedles for drug delivery and monitoring. Microfluidic devices for cell manipulation. Microfluidic devices for stem cell analysis and genetic analysis, Immunosensing. Microfluidic devices for radio chemical synthesis. paper-based microfluidic biomedical devices.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Describe the fundamental principles and concepts of microfluidics.
- **CO2** Explain the different types of materials and fabrication techniques used in developing microfluidic devices.
- **CO3** Elaborate the design considerations of various microfluidic devices.
- **CO4** Illustrate the bioanalytical applications of microfluidic devices.

CO5 Elucidate the diagnostic and therapeutic applications of microfluidic devices.

TEXT BOOKS:

1. Tabeling,P., Introduction to microfluidics, Oxford University Press Inc., 2005.
2. Oosterbroek and van den Berg, Lab-on-a-chip: Miniaturized Systems for (Bio) Chemical Analysis and Synthesis. Elsevier, 2003.

REFERENCES:

1. Gescheke et al, Microsystems Engineering of Lab-on-a-Chip Devices. Wiley, 2004.
2. Nguyen, N. T., Werely, S. T., Fundamentals and Applications of Microfluidics, Artech house Inc., 2002.
3. Bruus, H., Theoretical Microfluidics, Oxford University Press Inc., 2008.
4. Madou, M. J., Manufacturing Techniques for Microfabrication and Nanotechnology (Vol. 2), CRC Press, Boca Raton, FL, 2011.
5. Kirby, B. J., Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices, Cambridge University Press, 2010.
6. Colin, S., Microfluidics, John Wiley & Sons, 2009.
7. Chakraborty, S., Microfluidics and microfabrication, Springer, New York, NY, 2010.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	-	-	-			-	2	-	1		3	
CO2	3	3	3	-	-	-			-	2	-	1		3	
CO3	-	3	-	-	-	1			3	2	-	1		3	
CO4	-	3	-	3	3	-			-	2	-	1		3	
CO5	-	-	3	3	-	-			3	2	1	1		3	
Avg	3	3	3	3	3	1			3	2	1	1		3	

BM23022	MEDICAL OPTICS	L	T	P	C
		3	0	0	3

UNIT I INSTRUMENTATION IN PHOTONICS 9

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

UNIT II OPTICAL PROPERTIES OF THE TISSUES 9

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

UNIT III SURGICAL APPLICATIONS OF LASERS 9

Lasers in ophthalmology- Dermatology –Dentistry-Urology-Otolaryngology, Neurology-Tissue welding.

UNIT IV DIAGNOSTIC APPLICATIONS 9

Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)-Imaging, Raman Spectroscopy and Imaging, FLIM-Applications, Holographic- Applications, NIRS-Application, speckle application of lasers in biology and medicine.

UNIT V THERAPEUTIC APPLICATIONS 9

Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and non- oncological applications of PDT - Biostimulation effect – applications, LLT-Low level Laser therapy.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Comprehend the concepts in the field of photonics and describe the photonic instruments.

CO2 Demonstrate knowledge of the fundamentals of optical properties of tissues and understand procedures underlying laser safety.

CO3 Describe surgical applications of laser.

CO4 Acquire knowledge on various diagnostic applications using light.

CO5 Describe various therapeutics applications using light.

TEXT BOOKS:

1. Markolf H.Niemz, “Laser-Tissue Interaction Fundamentals and Applications”, Springer, 2007.
2. Paras N. Prasad, “Introduction to Bio photonics”, A. John Wiley and sons, Inc. Publications,2003.

REFERENCES:

1. Tuan Vo Dinh, “Biomedical photonics – Handbook”, CRC Press LLC, 2003.
2. Mark E. Brezinski, “Optical Coherence Tomography: Principles and Applications”,

AcademicPress, 2006.
3. R. Splinter and B.A. Hooper, “An Introduction to Biomedical Optics”, Taylor and Francis, 2007. 4.Helena Jelinkova, “Lasers for Medical Applications: Diagnostics, Therapy and Surgery’’, Woodhead Publishing, 1st Edition, 2013.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2		1	3		
CO2			2	3		3				2		1	3		
CO3	3		2	3		3				2		1	3		
CO4			2	3						2		1	3		
CO5	3									2		1	3		
Avg	3		2	3		3				2		1	3		

VERTICAL IV: REHABILITATION ENGINEERING

BM23023	REHABILITATION ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 9

Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation team members and their functions. Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.

UNIT II ENGINEERING CONCEPTS IN SENSORY REHABILITATION 9

Sensory augmentation and substitution- Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system- Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution. Tactual system-Tactual augmentation, Tactual substitution, Computerized wheel chairs

UNIT III ENGINEERING CONCEPTS IN MOTOR REHABILITATION 9

Prosthesis and orthoses, Artificial limbs- body powered, externally powered and controlled orthotics and prosthetics, Myoelectric hand and arm prosthetics. Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

UNIT IV VIRTUAL REALITY IN REHABILITATION 9

Introduction to virtual reality, Virtual reality-based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.

UNIT V REHABILITATION MEDICINE AND ADVOCACY 9

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal rights of persons with disabilities- The PWD Act 2016, Provisions available in education, employment, and in day-to-day life.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Understand the key terminologies used by the rehabilitation team.
- **CO2** Apply knowledge to design and develop different sensory assist devices.
- **CO3** Analyse the functionality of orthotics and prosthetics for rehabilitation applications.
- **CO4** Understand the need of virtual reality tools for different aids.
- **CO5** Appreciate the necessity of rehabilitation medicine and acquire knowledge on legislations available for PWD.

REFERENCES:

1. Joseph D Bronzino, “The Biomedical Engineering Handbook”. 2nd edition, CRC Press,2000.
2. Robinson C.J, “Rehabilitation Engineering”, CRC Press, 2006.
3. Sashi S Kommu, “Rehabilitation Robotics”, 1st edition, CRC Press, 2007.
4. Sunder, “Textbooks of Rehabilitation”, Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.
5. Horia- Nocholai Teodorecu, L.C.Jain, “Intelligent systems and technologies in rehabilitation Engineering”, CRC; December 2000.
6. Warren E. Finn, Peter G. Lopressor, “Handbook of Neuroprosthetic Methods”, CRC, 2002.
7. Rory A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), “An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering” CRC Press, 2006.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2		1		3	
CO2	3	3								2		1		3	3
CO3	3	3	3					1		2		1		3	3
CO4	3	3	3							2		1		3	
CO5	3					1	1	1		2		1		3	
Avg	3	3	3			1	1	1		2		1		3	3

BM23024	ASSISTIVE TECHNOLOGY	L	T	P	C
		3	0	0	3

UNIT I ASSISTIVE TECHNOLOGY FOR CARDIAC IMPAIRMENT 9

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

UNIT II ASSISTIVE TECHNOLOGY FOR VISUAL IMPAIRMENT 9

Types of visual impairment, color blindness, corrective lenses, haptic as a substitute for vision, Mobility: canes- types, Guided Dog, Navigation- GPS

UNIT III ASSISTIVE TECHNOLOGY FOR HEARING IMPAIRMENT 9

Technology for non-aided users, Technology for aided users, telephone accessories, music accessories, assistive listening system, Alerting devices, TTY relay services.

UNIT IV ASSISTIVE TECHNOLOGY FOR PHYSICAL IMPAIRMENT 9

Alternative input devises to access computers, Eye gaze system, head tracking system, foot control system, Technology for daily living – wheel chairs types.

UNIT V RECENT ADVANCEMENT 9

Human cognitive- assistive technology for learning disabilities, intellectual disability, speech and language disorders.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Acquire knowledge, skills and application of existing technology.
- **CO2** Design innovative and indigenous technologies to enhance the quality of life.
- **CO3** Build knowledge on Assistive devices and assistive technologies
- **CO4** Develop Software applications for persons with special needs
- **CO5** Understanding how ICT can be a potential solution for people with special needs

TEXT BOOKS:

1. Cook, A., Polgar, J. M., & Encarnação, P. (2019). Assistive Technologies- E-Book (5th ed.). Elsevier Health Sciences. Retrieved from https://www.perlego.com/book/2938145/assistive-technologies-ebook-principles-and-practice-pdf (Original work published 2019
2. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 12-May-2010
3. Suzanne Robitaille - The Illustrated Guide to Assistive Technology and Devices_ Tools and Gadgets for Living Independently (2010)
4. Soonhwa Seok - Handbook of Research on Human Cognition and Assistive Technology_ Design, Accessibility and Transdisciplinary Perspectives (Handbook of

Research On...)-Medical Information Science Refer.
5. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st Fedition,2010.

REFERENCES:

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3								2		1		3	
CO2	3	3	3					1		2		1		3	3
CO3	3	3	3					1		2		1		3	
CO4	3	3	3		3			1		2		1		3	3
CO5	3	3	3		3					2		1		3	
Avg	3	3	3		3			1		2		1		3	3

BM23025	ERGONOMICS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO ERGONOMICS 9

Human factors and ergonomics and its domain, human system and interface technology, macro ergonomics, Ergonomic design and methods.

UNIT II ANTHROPOMETRY 9

Human posture and body mechanics, estimating body dimension, anthropometric relations and its use in ergonomics, Anthropometric principles in workspace and equipment design. Design for standing and seated workers

UNIT III OCCUPATIONAL ERGONOMICS 9

Health disorders caused by occupational exposure to vibration, chemical, noise, light and heat transfer, work-related musculoskeltal disorders, upper limb and lower limb disorders, Disorders of the neck, Carpal tunnel syndrome, Tennis elbow (epicondylitis), Disorders of the shoulder, Ergonomic interventions, Prevention of manual handling injuries in the workplace.

UNIT IV HUMAN INFORMATION PROCESSING 9

Information processing model of the user, Displays, controls and virtual environments, Human–computer interaction, human error and safety, Prevention of error in human–machine interaction, Systems design methods for ergonomics.

UNIT V ERGONOMICS AND ITS APPLICATION 9

Occupational safety and health care, Opportunities and Challenges in the Pursuit of Patient Safety, Social and Economic Impact of the System, Human Factors and Ergonomics in Intensive Care Units., Pediatrics, Home Care and Infection Prevention

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Understand the human factors and Anthropometric principles
- **CO2** Reduces the risks of problems that can get the employees sick and injured
- **CO3** Analyze the human errors and provide preventive measures
- **CO4** Develop system design for ergonomics
- **CO5** Apply the design concept for medical applications

TEXT BOOKS:

1. R.S. Bridger - introduction to Ergonomics-Routledge, Taylor & Francis (2003)
2. Pascale Carayon, “Handbook of Human Factors and Engineering”, Second Edition, CRC Press, 2011
3. Martin Helander, “Guide to Human Factors and Ergonomics”, Second Edition, CRC Press,2005
4. Benjamin W.Niebel, “Motion and Time Study”, Richard, D. Irwin Inc., Seventh Edition, 2002

REFERENCES:

1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press2007.
2. George Kanawaty, "Introduction to work study", ILO, 3rd edition, Oxford & IBH publishing, 2001
3. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, 2005.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2		1		3	
CO2	3	3								2		1		3	
CO3	3	3								2		1		3	
CO4	3	3								2		1		3	
CO5	3	3						1		2		1		3	
Avg	3	3						1		2		1		3	

BM23026 SPORTS ENGINEERING AND TECHNOLOGY

L	T	P	C
3	0	0	3

UNIT I INTRODUCTION TO SPORTS ENGINEERING AND TECHNOLOGY 9

Meaning of sports engineering, human motion detection and recording, human performance, assessment, equipment and facility designing and sports related instrumentation and measurement; Historic overview of sports equipment Sports Technology - Meaning, purpose and advantages of sports technology - Application of technology in modern sports. Purpose of instrumentation in sports.

UNIT II MECHANICS OF ENGINEERING IN SPORTS 9

Concept of internal force, axial force, shear force, bending movement, torsion, energy method to find displacement of structure, strain energy. Biomechanics of daily and common activities –Gait, Posture, Body levers, ergonomics; Mechanical principles in movements – as lifting, walking, running, throwing, jumping, pulling, pushing etc. A report on the impact of 3D Prosthetics in sports

UNIT III MATERIALS AND PERFORMANCE ANALYSIS OF SPORTS 9

Measurement of surface performance, materials used in sports, Running shoe materials-construction and stress analysis; Playfields; Modern surface of playfields and its advantages. Types of materials of different play fields; - Synthetic, Wooden, polyurethane and Astroturf. Types, Modern sports equipment, types, Materials and Advantages of modern sports equipment (Ball, Bat, Racquets in different events) Significance of footwear in individual events. Clothing; - Types, Materials and advantages of clothing in different events. Modern measuring equipment in sports; - Running, Throwing and Jumping. Types, Materials and Advantages of different Protective Equipment in sports

UNIT IV MEASUREMENT, TRAINING AND ASSESSMENT IN SPORTS 9

Motion analysis using video : Analysis Software - Data Collection Procedure - Two Dimensional Video Re – recording - Three Dimensional Video Recording - Processing Analysis and Presenting Data; Sports Specific Instrumentation and software i.e. Athletic etc. Training Gadgets; Concept and use of modern training gadgets (Basketball- Ball Feeder, Cricket - Bowling Machine, Tennis - Serving Machine, Volleyball - Serving Machine, Table Tennis - Serving Machine; Use of Computer and Software in Match Analysis and Coaching. A case study on the role AI, IoT and Data Analytics in Cricket.

UNIT V IoT AND ASSISTIVE TECHNOLOGY IN SPORTS 9

Rehabilitation and Reintegration; IoT in Sports Analytics; Sports and Disability - Disabled Sports Equipment/Assistive Technology - Technology and disabled sports – wheelchairs – prosthetics - sportswear - sports for children with disabilities; Wearable Sensors in Sports for Persons with Disability; Immersive Technologies in Physical Education for Students with Learning Disabilities; 3D printing, Assistive Technology and parasports; IoT in smart footwear, smart apparel, smart equipment , real time trackers; Facility Management – Realtime IoT applications – Athos, 3L labs, Glassup; Sports Injury Prevention and Rehabilitation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Define the importance of engineering and Technology in the sports

CO2 Exhibit competency in the choice of materials that can augment performance
CO3 Understand role of engineering biomechanics in sports
CO4 Analyze the material concept of shoe, sports goods and instrumentation in Sports
CO5 Apply the knowledge of Engineering and Technology in Sports Disability
CO6 Articulate the use of IoT platforms in Sports

REFERENCES:

1. Franz K. F. et. al., Editor,Routledge Handbook of Sports Technology and Engineering(Routledge, 2013)
2. Steve Hake, Editor, The Engineering of Sport (CRC Press, 1996)
3. Franz K. F. et. al., Editor The Impact of Technology on Sports II (CRC Press, 2007)
4. Helge N., Sports Aerodynamics (Springer Science & Business Media, 2009)
5. Youlin Hong, Editor Routledge Handbook of Ergonomics in Sport and Exercise (Routledge, 2013)
6. Jenkins M., Editor Materials in Sports Equipment, Volume I (Elsevier, 2003)
7. Colin White, Projectile Dynamics in Sport: Principles and Applications
8. Eric C. et al., Editor Sports Facility Operations Management (Routledge, 2010)
9. https://www2.deloitte.com/us/en/pages/consumer-business/articles/internet-of-things-sports-bringing-iot-to-sports-analytics.html
10. https://www.intuz.com/blog/iot-applications-in-sports

COURSE OUTCOMES	PROGRAMME OUTCOMES														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3									2				3	
CO2	3	3	2							2		1		3	
CO3	3	3								2		1		3	
CO4		3								2		1		3	
CO5		3	2			2		1		2		1		3	
CO6			2			2				2		1		3	
Avg	3	3	2			2		1		2		1		3	

BM23027	MEDICAL ROBOTICS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO ROBOT MODELING 9

Position Kinematics: Transformations, Rigid Motions, Forward Kinematics: Denavit-Hartenberg Convention, Inverse Kinematics. Velocity Kinematics – The Jacobian: Angular and Linear Velocity: Singularities, Accelerations.

UNIT II ROBOT DYNAMICS 9

Equations of Motion, Kinetic and Potential Energy, Euler-Lagrange Equations, Recursive Newton-Euler Formulation

UNIT III ROBOT MOTION PLANNING 9

Path and Trajectory Planning: Path vs. Trajectory, The Configuration Space, Path Planning in Configuration Space, Probabilistic Roadmap Planner, Potential Fields, RRTs, Trajectory Planning, Point To Point Motion, Paths Specified by Via Points.

UNIT IV ROBOT CONTROL 9

Linear Control: Feedback and closed-loop control, second-order linear systems, control of second-order systems, Control-law partitioning, trajectory-following control, disturbance rejection, Continuous vs. Discrete time control, modelling and control of a single joint, architecture of an industrial-robot controller.

Nonlinear control: Nonlinear and time-varying systems, multi-input, multi-output control systems, control of manipulators, practical considerations, Lyapunov stability analysis, cartesian-based control systems, adaptive control

Force Control: Interaction with Environment, Force Control, Hybrid Force/Motion control.

UNIT V ROBOT APPLICATIONS IN MEDICAL DOMAIN 9

SURGICAL ROBOTS: Da Vinci Surgical System, Nanorobotics. REHABILITATION AND ASSISTIVE ROBOTS: Robotic Therapy for the Upper Extremity and Walking, Clinical-Based Gait Rehabilitation Robots, Robotic Exoskeletons – Design considerations, Hybrid assistive limb.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the applications of robots and the concept of grippers and actuators.

CO2 Comprehend the functions of manipulators and basic kinematics.

CO3 Analyze different robotic control mechanism

CO4 Design and analyze the robotic systems for rehabilitation

CO5 Design the wearable robots.

REFERENCES:

1. Saha S. K., Introduction to robotics. Tata McGraw-Hill Education
2. Spong M. W., Hutchinson, S., and Vidyasagar, M., Robot modeling and control. New York: Wiley.
3. O'Kane J. M., A Gentle Introduction to ROS, ISBN 978-1492143239
4. Craig J. J, Introduction to robotics: mechanics and control. Pearson/Prentice Hall.
5. Jacob Rosen, Blake Hannaford & Richard M Satava, “Surgical Robotics: System 46 Applications & Visions”, Springer, 2011
6. Jocelyn Troccaz, Medical Robotics, Wiley, 2012
7. Achim Schweikard, Floris Ernst, Medical Robotics, Springer, 2015

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3								2				3	
CO2	3	3								2				3	
CO3	3	3	3							2		1		3	
CO4	3	3	3	3				1		2		1		3	
CO5	3	3	3					1		2		1		3	
Avg	3	3	3	3				1		2		1		3	

BM23028	HAPTICS	L	T	P	C
		3	0	0	3

UNIT I HUMAN HAPTICS **9**

Human senses- vision, audition and touch, Human haptic system, Multimedia haptics-audio visual multimedia system

UNIT II HAPTICS DEVICES **9**

Sensors and actuators, Computer aided design, touch haptic devices, PHANTOM device, Haptic feedback force feedback, vibrotactile feedback, Electro tactile feedback, ultrasonic tactile feedback, thermal feedback – its applications.

UNIT III COMPUTATIONAL HAPTICS **9**

Haptic Rendering; Rigid bodies, Deformable bodies, Stability Rendering effects, Human performance and evaluation; collision detection effects.

UNIT IV HAPTICS IN VIRTUAL REALITY **9**

Virtual reality system, virtual environment representation and rendering, display technologies, input device to virtual reality system, interaction with virtual environment, virtual fixtures.

UNIT V HAPTICS FOR MEDICAL APPLICATIONS **9**

Surgical Simulations, Stroke-Based Rehabilitation, Support to the Visually Impaired, Tele-Robotics, Tele-Operation and Tele-Surgery.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the basic principles, theories, and concepts of haptics
CO2 Comprehend human touch perception
CO3 Build a haptic technology for medical applications
CO4 Learn how to develop immersive user interfaces with haptic feedback
CO5 Understand the causes of instability in virtual reality and teleoperation systems

TEXT BOOKS:

1. Mark Paterson, The Senses of Touch: Haptics, Affects and Technologies, Bloomsbury, 2007
2. M. Tavakoli - Haptics for teleoperated surgical robotic Systems-World Scientific,2008
3. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics Technologies-Bringing Touch to Multimedia -Springer-Verlag Berlin Hei , 2011

REFERENCES:

1. A.El Saddik, Haptics Rendering and Applications, Intech, 2011
2. Femke Elise van Bee, Making Sense of Haptics: Fundamentals of Perception and Implications for Device Design, Springer International Publishing,2017

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													3	
CO2	3													3	
CO3	3	3	3					1		2		1		3	
CO4	3	3								2		1		3	
CO5	3	3										1		3	
Avg	3	3	3					1		2		1		3	

BM23029	PHYSIOLOGICAL MODELLING	L	T	P	C
		2	0	2	3

UNIT I SYSTEM CONCEPT 9

Introduction to Physiological control systems, Purpose of physiological modeling and signal analysis, Illustration- example of a physiological control system. Difference between engineering and physiological control systems. System variables and properties- Resistance – both static and dynamic, Compliance and combination of resistance and compliance. Resistance and compliance models - respiratory system, aortic segments, lumped model of physiological thermal system, and step response of resistance-compliance system – dye dilution study of circulation

UNIT II SYSTEM ANALYSIS 9

Review of transfer function, transfer function of coupled system. Impedance based transfer function - flexible tube feeding a single port compliant model, development of a lung model. Periodic signals: sinusoidal analysis of second order system, analysis of respiratory system based on sinusoidal excitation, pendelluft.

UNIT III TRANSIENTAND FEEDBACK 9

Review of transient and stability analysis. Homeostasis, representation, finger tracking. Characterization of Physiological Feedback systems- Hypophysis adrenal systems. Nonlinear systems and linearization - transfer function analysis of pupillary control system as a closed loop and method of opening the closed loop, pupillary hippus.

UNIT IV MODELING OF CARDIOPULMONARY SYSTEM 9

Model of cardiac output regulation - Starling‘s law, Physical Significance of under damped responses of post systolic operations in aortic arch, model of circadian rhythms, chemical regulation of ventilation, Cheyne-Stoke breathing, biot breathing.

UNIT V OTHER PHYSIOLOGICAL MODELS AND SIMULATION 9

Steady state analysis of regulation of glucose, Hodgin-Huxley model, Thermal system – model and simulation, modeling of eye movement- types of eye movement, saccade model, model of occulomotor control. Introduction to digital control system.

PRACTICAL EXERCISES 15

1. Modelling of Musculoskeletal model
2. Modelling of Thermal system
3. Modelling of Respiratory system
4. Modelling of feedback systems- Pupillary control system
5. Modelling of Cardiac output regulation

TOTAL: 60 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Develop an application of Physiological models.
CO2 Model dynamically varying physiological system.
CO3 Analyze and synthesize dynamic models of physiological system.

CO4 Develop differential equations to describe the dynamic models, simulate and visualize.

CO5 Implement physiological models using software to get dynamic responses.

TEXT BOOKS:

1. Michel C Khoo, Physiological Control Systems Analysis, simulation and estimation, Prentice Hall of India, 2001.
2. Vasilis Z. Marmarelis, Nonlinear Dynamic Modelling of Physiological Systems, Wiley IEEE Press, 2004.
3. Benjamin C Kuo, Automatic control systems,10thEdition, McGraw-Hill Education, 2017.

REFERENCES:

1. David T. Westwick, Robert E. Kearney, Identification of Nonlinear Physiological Systems, Wiley-IEEE Press, 2003.
2. Marmarelis V.Z, Advanced methods of physiological modelling, Springer, 1989.
3. Stark L, Neurological Control System, Plenum Press, 1968.
4. John H Milsum, Biological control systems, McGraw Hill, 1966.
5. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su, Advanced Computational Methods in Life System Modelling and Simulation, Springer,2017.
6. Douglas S.Rigg, “Control Theory and Physiological Feedback Mechanism”, The Wilkliam and Wilkins Co. Baltimore, 1970.
7. ChristofKoch, “Biophysics of Computation”, Oxford University Press, 2004.
8. F.C. Hoppensteadt and C.S.Peskin, "Modeling and Simulation in Medicine and the Life Sciences" Springer, 2nd Edition, 2002.

COURSE OUTCOMES	**PROGRAMME OUTCOMES**												**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	2	**3**	**3**					2	2		1		3	
CO2	**3**	2	**3**	**3**	**2**				2	2		1		3	
CO3	**3**	2	**3**	**3**	**2**				2	2		1		3	
CO4	**3**	2	**3**	**3**	**2**	**2**		1	2	2		1		3	
CO5	**3**	2	**3**	**3**	**2**	**2**			**2**	2		1		3	
Avg	**3**	2	**3**	**3**	**2**	**2**		1	**2**	2		1		3	

BM23030	FINITE ELEMENT METHODS FOR BIOMEDICAL ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I GENERAL INTRODUCTION 9

Historical Background of Engineering Modeling- Governing Equations for Field Problems-Discrete and Continuous Models-Boundary, Initial, and Eigenvalue Problems- Variational Formulation of Boundary Value Problems-Ritz Technique for Approximation-Natural and Essential Boundary Conditions.

UNIT II INTRODUCTION TO FINITE ELEMENT METHOD 9

Basic Concepts of Finite Element Method-Solving One-Dimensional Second Order Equations-Discretization and Different Element Types-Linear and Higher Order Elements-Deriving Shape Functions, Stiffness Matrices, and Force Vectors-Assembly of Matrices-Application in Solid Mechanics and Biomechanics-Analysis of Structures, Stress, and Strain

UNIT III BEAM ELEMENTS AND SCALAR PROBLEMS IN 2D 9

Beam Equations and Transverse Deflections-Determining Natural Frequencies and Longitudinal Vibration of Beams-Second Order 2D Equations with Scalar Variables-Formulating Variational and Finite Element Methods-Triangular Elements and Shape Functions-Applications in Biomechanics-Introduction to Quadrilateral Elements.

UNIT IV ISOPARAMETRIC FORMULATION AND MISCELLANEOUS TOPICS 9

Introduction to Elasticity Equations and Stress-Strain Relations-Plane Problems of Elasticity and Element Equations-Plane Stress, Plane Strain, and Axisymmetric Problems-Modeling Soft Connective Tissue Components-Analyzing Musculoskeletal Systems-Stress Calculations and Introduction to Plate and Shell Elements-Basics of Fluid Mechanics and Flow Problems

UNIT V NON-LINEAR ANALYSIS 9

Introduction to Non-Linear Problems and Solution Methods-Computational Procedure for Non-Linear Analysis-Considerations for Material Nonlinearity and Contact Interfaces-Exploring Geometric Nonlinearity-Impact Analysis and Modeling Considerations-Mechanical Properties of Materials-Finite Element Analysis in Biomechanical Research: Applications and Limitations

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understands the concept of Finite Element Method and realize its limitations
CO2 Evaluate the global matrix to understand the material properties.
CO3 Identify mathematical model for biomedical engineering problems.
CO4 Analyse the model with different material property
CO5 Use the finite element software to design implants for biological system.

TEXT BOOKS:

1. Zhangxin Chen. "Finite element methods and their applications" Springer,2005

REFERENCES:

1. Seshu. P. Textbook of Finite Element Analysis" Prentice Hall of India, 2003
2. J.N. Reddy, Finite Element Method" Tata McGraw Hill, 2003.
3. S.S. Rao, "The Finite Element Method in Engineering", Butter worth heinemann, 2001.
4. Reddy, J.N, "An Introduction to the Finite element Method", McGraw-Hill, 1985.

COURSE OUTCOMES	PROGRAMME OUTCOMES														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2		1		3	
CO2	3	3								2		1		3	
CO3	3	3								2		1		3	
CO4	3	3	3							2		1		3	
CO5	3	3	3		2					2		1		3	
Avg	3	3	3		2					2		1		3	

BM23031	HEALTH CARE INFORMATION SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION TO HEALTH INFORMATICS 9

Historical highlights and Evolution of Health informatics, Hospital Information System — its characteristics and functional online and offline modules, Health Informatics, Bioinformatics, Medical Informatics, Clinical Informatics, imaging Informatics, Nursing Informatics, Public Health Informatics and Consumer Health Informatics.

UNIT II BIOINFORMATICS AND TECHNOLOGIES 9

Bio-information technologies, Semantic web and Bioinformatics, Genome projects - Nano technology in Healthcare - CNT based Nano sensor, BioCom chip, Medical Nanorobo – Bioinformatics software tools.

UNIT III IMAGING INFORMATICS 9

Imaging Informatics Technology, Standard protocols in Imaging Informatics, key technologies – PACS, DICOM – Architectures - EHR with image distribution, Image aided detection and diagnosis;

UNIT IV NURSING AND CONSUMER INFORMATICS 9

Nursing Informatics – Definition – Components – Perspectives, Competencies, Applications - Roles and responsibilities, Data, Information and Knowledge – Support Decision making – Metastructures, Concepts and tools. Consumer Informatics – Bringing medical knowledge to consumers – EHR accessible to patients, Decision aids to support consumer choices.

UNIT V CLINICAL AND PUBLIC HEALTH INFORMATICS 9

History of Clinical and Public Health Informatics, Clinical information system applications in health care, Outcomes relevant to the clinical goals and quality measures, Legal and regulatory issues, patient management systems, clinical data mining. Public Health Informatics – Context, Science, key and Public Health Information Systems – Surveillance, Information Network, Geographic Information System (GIS), Challenges and Emerging solutions.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 : Develop knowledge about problems and challenges that health informatics with its sub clauses addresses

CO2 : Demonstrate basic skills and knowledge in health informatics for application in future health-related careers

CO3 : Demonstrate ability to identify and understand Bioinformation Technologies and their applications

CO4 : Analyze the key technologies that improved health care delivery and diversity issues in health informatics

CO5 : Understand the various Standard Operating Protocols in the process of developing and implementing Health Informatics.

CO6 : Acquire a conceptual and theoretical framework of the design, development, and implementation of healthcare information systems.

REFERENCES:

1. Hoyt, RE and Yoshihashi, A, Eds., Health Informatics: Practical Guide for Healthcare and Information Technology Professionals, Sixth Edition. Pensacola, FL, Lulu.com, 2014
2. Ramachandra Lele, Computers in Medicine Progress in Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005
3. Mohan Bansal M S, Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005.
4. Yi-Ping Phoebe, Bioinformatics Technologies, Springer International, New Delhi, 2007.
5. Arpita Bosu, Bioinformatics – Databases, Tools and Algorithms, Oxford University Press, 2007.
6. H M Dietel, Internet and World Wide Web, AB Goldberg publishers, New Delhi, 2007
7. Herbert Schildt, The Complete Reference – JAVA, Tata McGraw Hill Publishing Company, New Delhi, 2005

COURSE OUTCOMES	**PROGRAMME OUTCOMES**												**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3									**2**			**3**		
CO2	3	3				2				**2**			**3**		
CO3	3	3	3		2					**2**			**3**		
CO4		3	3					**1**		**2**			**3**		
CO5		3	3							**2**		**1**	**3**		
CO6			3							**2**		**1**	**3**		
Av	**3**	**3**	**3**		**2**	**2**		**1**		**2**		**1**	**3**		

BM23032	HOSPITAL MANAGEMENT	L	T	P	C
		3	0	0	3

UNIT I OVERVIEW OF HOSPITAL ADMINISTRATION 7

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

UNIT II HUMAN RESOURCE MANAGEMENT IN HOSPITAL 9

Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer.

UNIT III MARKETING RESEARCH & CONSUMER BEHAVIOUR 10

Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations - Consumer Markets & Consumer Buyer behaviour - Model of consumer behaviour - Types of buying decision behaviour - The buyer decision process - Model of business buyer behaviour - Major types of
buying situations - global marketing in the medical sector - WTO and its implications.

UNIT IV HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES 10

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

UNIT V QUALITY AND SAFETY ASPECTS IN HOSPITAL 9

Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – ISO 13485, Environment Management Systems. NABA, JCI, NABL, NABH. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care - Medical Audit – Hazard and Safety in a hospital Setup.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 : Explain the principles, practices and areas of application in Hospital Management.

CO2 : Understand the biomedical waste disposal concept.

CO3 : Explain the importance of supportive services.

CO4 : Comprehend the quality aspect specified by the international standards.

CO5 : Knowledge on Hospital safety.

TEXT BOOKS:

1. R.C.Goyal, “Hospital Administration and Human Resource Management”, PHI–4 th Edition,2006.
1. G.D.Kunders, “Hospitals – Facilities Planning and Management”, TMH, New Delhi – 5 th edition Reprint 2007.

REFERENCES:

1. Cesar A.Caceres and Albert Zara, “The Practice of Clinical Engineering”, Academic Press, New York,1977.
2. Norman Metzger , “Handbook of Health Care Human Resources Management”, Aspen Publication Inc. Rockville, Maryland, USA, 2nd Edition 1990.
3. Peter Berman, “Health Sector Reform in Developing Countries”, Harvard University Press, 1995.
4. William A.Reinke, “Health Planning For Effective Management”, Oxford University Press, 1988.
5. Blane, David, Brunner, Eric , “Health and Social organization: Towards a health policy for the 21st century”, Calrendon Press, 1994.
6. Arnold D. Kalcizony & Stephen M.Shortell, “Health Care Management”, 6 th Edition, 2011.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3						2	2				1	3		
CO2	3						2	2				1	3		
CO3	3						2	2				1	3		
CO4	3						2	2				1	3		
CO5	3						2	2				1	3		
Av	3						2	2				1	3		

VERTICAL V: AI IN HEALTH CARE SYSTEMS

		L	T	P	C
BM23033	**HEALTH CARE DATA ANALYTICS**	**3**	**0**	**0**	**3**

UNIT I INTRODUCTION TO BIG DATA ANALYTICS IN HEALTHCARE 9

Introduction - Data analytics in Healthcare – its life cycle - Big data tools in healthcare Characteristics of Big Data – Global strategies for Healthcare Classification of medical big data - Types of data - Accountancy of big data analytics in health care domains - Open source tools - cloud resources for health care management; Privacy security risks of big data processing in healthcare - Opportunities and challenges in healthcare with the management of big biomedical data and the role of machine learning.

UNIT II BIG DATA ARCHITECTURAL FRAMEWORK 9

Data aggregation, Data Processing and Data Visualization; Key elements of big data analysis - Big data analytical tools used in healthcare; Big data analytics in precision medicine - Machine learning techniques for big data analytics - Applications Biological data capturing, processing, Interpretating and data management for digital therapeutics - Big data analytical techniques, datasets, life cycles, managements, and applications for diagnosis and treatment; Recent applications of data mining in medical Visualization, diagnosis and prediction.

UNIT III DATA ANALYTICS TOOL IN HEALTHCARE 9

Big medical data analytics tools/algorithms - Data Integration Tools, Searching and Processing Tools, Machine Learning Tools, Real-Time and Streaming Data Processing Tools and Visual Data Analytical Tools; Machine learning medical diagnosis model based on patients' complaints - A machine learning approach tp disease diagnosis - Use of artificial intelligence in the prediction of malignant potential of gastric gastrointestinal stromal tumours; Big medical data, cloud computing, and artificial intelligence for improving diagnosis in healthcare.

UNIT IV DATA ANALYTICS TECHNIQUES IN HEALTHCARE 9

Collecting patient data into cloud-based big data repositories - Using artificial intelligence techniques for improving diagnosis; Prediction: Big data analytical techniques, datasets, life cycles, managements, and applications for prediction; Use of artificial intelligence for predicting infectious disease - Mathematical modeling of infectious diseases and their development Predicting infectious diseases using artificial intelligence; Predictions on diabetic patient datasets using big data analytics and machine learning techniques; Skin cancer prediction using big data analytics and AI techniques.

UNIT V APPLICATIONS OF DATA ANALYTICS IN HEALTHCARE 9

Case studies of big data in healthcare arena orthopedics: Roles and applications of epidemiological big data in current orthopedics research; Roles and applications of molecular big data in current orthopedics research; Roles and applications of big data generated by imaging techniques and wearable technologies/smart sensors in current orthopedics research; Big medical data mining system (BigMed) for the detection and classification of COVID-19 misinformation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 : Describe different types of data generated in health care and how the public health information infrastructure is used to collect, process, maintain, and disseminate data

CO2 : Discuss the value and approaches of machine learning and AI would enable use of information technology to access, evaluate, and interpret public health data

CO3 : Conduct basic data analysis for a specified purpose

CO4 : Explore the applications of data analytics in clinical and patient-oriented settings with few case studies using informatics methods and resources as strategic tools to promote public health

CO5 : Apply the principles of usability to data capture, analysis, and usage.

CO6 : Identify methods for receiving, organizing, storing, mining, and formatting data Business Intelligence and Clinical Intelligent

REFERENCES:

1. Pantea Keikhosrokiani, Big Data Analytics for Healthcare, Datasets, Techniques, Life Cycles, Management, and Applications, 1st Edition, 2022.

2. Chandan K. Reddy, Charu C. Aggarwal, Healthcare Data Analytics, Chapman & Hall/CRC Data Mining and Knowledge Discovery Series Book 36, 1st Edition, CRC Press, Taylor & Francis Group.2015.

3. Nilanjan Dey, Himansu Das, Bighnaraj Naik, H Behera, Big Data Analytics for Intelligent Healthcare Management, by Academic Press, 2019,ISBN: 9780128181478.
4. Trevor L. Strome, Healthcare Analytics for Quality andPerformance Improvement. John Wiley & Sons, Inc. 2013.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3									2			3		
CO2	3	3	2							2			3		
CO3	3	3						1		2		1	3		
CO4		3								2		1	3		
CO5		3	2			2				2		1	3		
CO6			2			2				2		1	3		
Avg	3	3	2			2		1		2		1	3		

BM23034	VIRTUAL, AUGMENTED MIXED REALITY IN MEDICINE	L	T	P	C
		3	0	0	3

UNIT I INTRODUCTION 9

Introduction to Virtual Reality (VR) – Types – current VR Technologies – Hardware and Software; Introduction to Augmented Reality (AR) – Types – Technologies – Hardware and Software – Developmental Tools; The three I‘s of virtual reality and the five classic components of a VR system; Motion tracking, navigation and controllers - Position and Motion Trackers - Inside Out/Outside In..

UNIT II THE HUMAN BEHIND THE LENSES 9

Human Perception and Cognition -The Human Visual System - The Human Auditory System - The Human Vestibular System; Physiology, Psychology and the Human Experience - Adaptation and Artefacts -Ergonomics - Ethics - Scientific Concerns; VR - Health and Safety Issues - Effects of VR Simulations on Users- Cybersickness, before and now - Guidelines for Proper VR Usage; User Centered Design, User Experience and an Ethical Code of Conduct.

UNIT III MODELING 9

Navigation and Manipulation Interfaces; Tracker Based Navigation/Manipulation Interfaces - Three-Dimensional Probes and Controllers - Data Gloves and Gesture Interfaces; Reality, Virtuality and Immersion - VR, AR, MR, xR: similarities and Differences, Current trends and state of the art in immersive technologies, developing platforms and consumer devices - Camera tracking and 3D Rendering for Immersive Environments; Modeling the Physical world - Geometric Modeling - Kinematics Modeling - Physical Modeling - Behavior Modeling - Model Management..

UNIT IV AR AND MR 9

Definition; Tracking for Augmented Reality - Augmented Reality Interaction - Collaborative Augmented Reality - Heterogeneous user interfaces - Mobile Augmented Reality - Software Technologies, Augmented Reality Methods, 3D User Interface Input Hardware, Visualization Techniques.

UNIT V xR AND HEALTHCARE APPLICATIONS 9

Virtual and Augmented Surgery - Virtual Anatomy - Post-Traumatic Stress Disorder (PTSD) with VR, VR for Disabled People, Pain Treatment with VR, Experiential Treatment with VR, Experiential Personal Development with VR; ; 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; Behavioral Therapy - Exposure Therapy and PTSD – Training – Rehabilitation - Triage and Diagnostics .

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 : Knowledge of working principles in AR/VR based training simulators, Navigation and tracking in AR/VR.

CO2 : Understanding of the fundamentals related to AR/VR technologies, content creation, hardware design for AR/VR applications.

CO3 : Acquire knowledge in VR and AR technologies in terms of used devices, building of the virtual environment and modalities of interaction and modelling.

CO4 : Articulation of Health and safety issues.

CO5 : Developing awareness about recent trends in AR/VR systems

CO6 : Demonstrate competency in VR and AR applications in medicine

TEXT BOOKS:

1. C. Burdea& Philippe Coiffet, “Virtual Reality Technology”, Second Edition, Gregory, John Wiley & Sons, Inc.,2008.
2. Kelly S. Hale (Editor), Kay M. Stanney (Editor), Handbook of Virtual Environments: Design,Implementation, and Applications, Second Edition (Human Factors and Ergonomics)ISBN-13: 978-1466511842. Amazon, 2014
3. Virtual and Augmented Reality:An Educational Handbook, Zeynep Tacgin, Cambridge Scholars Publishing, Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK, 2020
4. Jason Jerald, The VR Book, Human-Centered Design for Virtual Reality, Jason Jerald, NextGen Interactions, 2016
5. Pensieri Claudio & Pennacchini Maddalena, Overview: Virtual Reality in Medicine, Journal of Virtual Worlds Research, Volume 7, Number 1, Lantern (1), January, 2014.
6. Mythreye Venkatesan & etal, Review: Virtual and augmented reality for biomedical applications, CellPress, Cell Reports Medicine 2, 100348, July 20, 2021.

REFERENCES:

1. John Vince, “Introduction to Virtual Reality”, Springer-Verlag Ltd., 2004.
2. William R.Sherman, Alan B.Craig, “Understanding Virtual Reality – Interface, Application, Design”, The Morgan Kaufmann Series, 2003.
3. Gonca Telli Yamamoto, Deniz Altun, Virtual reality technology in healthcare, Pearson journal of social sciences & humanities, 2021; DOI Number: http://dx.doi.org/10.46872/pj.282.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				3					2				3	3
CO2	3	1	3							2				3	3
CO3			3		3					2				3	3
CO4						1				2				3	3
CO5						1				2		1		3	3
CO6			3	1	3					2				3	3
Avg	3	1	3	1	3	1				2		1		3	3

BM23035	DEEP LEARNING	L	T	P	C
		3	0	0	3

UNIT I BASICS OF MACHINE LEARNING 9

Biological Neuron, Artificial Neural Network, Supervised, Unsupervised and Reinforcement learning, Basic machine learning algorithm, Linear separability, Linear perceptron, Multilayer Perceptron, Backpropagation algorithm, Radial Basis function network, SVM, classification & clustering problems in Health care applications

UNIT II INTRODUCTION TO DEEP LEARNING 9

Concepts in Deep Learning, Gradient-Based Learning, Vanishing Gradient Problem, Overfitting and Underfitting, Activation Functions: RELU, LRELU, ERELU, Regularization, Optimization methods for neural networks- Adagrad, Adadelta, RMSprop, ADAM

UNIT III CONVOLUTIONAL NEURAL NETWORKS 9

Overview of Convolutional Neural Networks Architecture-Motivation, Layers, Kernels, Convolution operation, Padding, Stride, Pooling, Non-linear layer, Stacking Layers, Transfer Learning Strategies, Variants of CNN: DenseNet, ResNet, GoogleNet, Inception, Xception, VGG Net

UNIT IV DEEP RECURRENT NEURAL NETWORK 9

Recurrent Neural Networks, Bidirectional RNNs, Encoder-decoder sequence to sequence architectures, Deep Recurrent Networks, Recursive Neural Networks, Long Short-Term Memory Networks

UNIT V AUTOENCODERS AND DEEP GENERATIVE MODELS 9

Auto encoders- types, Boltzmann Machines, Restricted Boltzmann Machines, Deep Belief networks, Deep Boltzmann Machine, Generative Adversarial Networks, Applications in Health care domain

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1	**:**	Understand the characteristics and applications of Machine learning models
CO2	**:**	Explore the terminologies and familiarize with different optimizers involved in deep neural network
CO3	**:**	Understand and analyze different deep learning models and develop the transfer learning models
CO4	**:**	Identify and apply suitable deep learning approaches for a given application
CO5	**:**	Apply Auto encoders and Recurrent Neural Networks for different types of data processing
CO6	**:**	Develop and use deep learning algorithms in health care applications

TEXT BOOKS:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2017

2. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017

REFERENCES:

1. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
2. Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.
3. Francois Chollet, “Deep Learning with Python”, Manning Publications, 2018.
4. Navin Kumar Manaswi, “Deep Learning with Applications Using Python”, Apress, 2018.
5. Joshua F. Wiley, “R Deep Learning Essentials”, PACKT Publications, 2016

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3		2					1		1		3	3
CO2	3	3	3		2					1		1		3	3
CO3	3	3	3		2					1		1		3	3
CO4	3	3	3		2					1		1		3	3
CO5	3	3	3		2					1		1		3	3
CO6	3	3	3		2					1		1		3	3
Avg	3	3	3		2					1		1		3	3

BM23036	TELEMEDICINE TECHNOLOGY	L	T	P	C
		3	0	0	3

UNIT I TELEMEDICINE AND TELEHEALTH 9

History and Evolution of telemedicine, Purposes and its organization, Biomedical Telemetry, Teleconsultation, Tele health, Components, Delivery modes of Telemedicine, Global and Indian scenario;

UNIT II TELEMEDICAL TECHNOLOGY 9

Transmission of data, image, video, audio; Bandwidth considerations; Tele consultancy and its hardware and software design requirements and standards; Telemedicine Workstation and interfacing; Telecommunication Technologies.

UNIT III NETWORKING IN TELEMEDICINE 9

Network configuration, management, communication and implementation; Wireless Technologies – Types, Evolution, Transmission media, antenna for in-body and on-body applications and EMI; mHealth technologies, WBAN, WPAN and WSN using 5G;

UNIT IV TELEHOME CARE AND PERSONAL HEALTH MONITORS 9

Homecare and telehealth – Categories, Homecare technologies. Requirements and Management; Personal Healthcare Monitors, Wearable Monitors;

UNIT V e-HEALTH AND LEGAL ISSUES 9

Internet, eHealth and cyber Medicine; Videoconferencing – Components, categories, considerations; Videoconferencing standards and selection; Applications, Telepathology, Tele dermatology, Teleradiology, Telecardiology, Telesurgery; Ethical, privacy, Security and legal issues in Telemedicine;

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course the student will be able to:

CO1 : Solve healthcare delivery process

CO2 : Evaluate how events in the technology space can impact the broader healthcare industry

CO3 : Analyze and translate large datasets into actionable information for decision making

CO4 : Propose strategies to improve access, quality or affordability through Technology

CO5 : Apply advanced design principles when utilizing communication networks.

CO6 : Able to identify and address a range of sociotechnical factors that influence the success or failure of implementation projects and be able to apply principles and methods of evaluation to telehealth projects

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1		3	3							**2**				**3**	
CO2		3				3				**2**				**3**	
CO3		3								**2**				**3**	
CO4			3			3				**2**				**3**	
CO5			3	2				1		**2**		**1**		**3**	
CO6		3		2		3		1		**2**		**1**		**3**	
Avg		**3**	**3**	**2**		**3**		**1**		**2**		**1**		**3**	

VERTICAL MINOR-BIOMEDICAL TECHNOLOGY

BM23037	MEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

UNIT I BIOPOTENTIAL ELECTRODES AND AMPLIFIERS 9

Cell potential- Resting and Action potential, Electrode Electrolyte Interface, Types of electrodes, Bio signal characteristics– frequency and amplitude ranges, Bioamplifier, isolation amplifiers – transformer and optical isolation, Artifacts and removal.

UNIT II BIOPOTENTIAL MEASUREMENT 9

ECG – Einthoven ‘s triangle, standard 12 lead system, block diagram. Measurement of heart sounds - PCG. EEG – 10-20 electrode system, unipolar, bipolar and average mode, Functional block diagram. EMG – unipolar and bipolar mode, block diagram, EOG and ERG.

UNIT III PHYSIOLOGICAL PARAMETER MEASUREMENT 9

Temperature, Respiration rate and pulse rate measurements, Plethysmography, Pulse oximetry, Blood Pressure measurement-direct and indirect method. Blood flow - Ultrasound blood flow measurement. Cardiac output measurement- Indicator dilution, dye dilution and thermodilution method, GSR Measurement, Patient Monitoring system.

UNIT IV BIOCHEMICAL MEASUREMENT 9

Blood gas Analyzer, Blood Glucose measurement, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyser.

UNIT V RECENT TRENDS 9

Point of care devices, Endoscopy unit, Radio pill, laproscopy, Applications of Laser in medicine, cryogenic application. Biotelemetry, Telemedicine, m-health.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

- **CO1** Understand the electrode behavior
- **CO2** Comprehend the fundamentals of Bio potential recording.
- **CO3** Design various bio amplifiers
- **CO4** Measure various electrical and non-electrical physiological parameters.
- **CO5** Understand different monitoring system

TEXT BOOKS:

1. Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”,Pearson Education, 4th Edition, 2014.
2. John G.Webster, “Medical Instrumentation Application and Design”, John Wiley and Sons,New York, 4th Edition, 2009.

REFERENCES:

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi,3rd Edition, 2014.
2. Richard Aston, “Principles of Biomedical Instrumentation and Measurement” Merril PublishingCompany, 1990.
3. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, 3rd Edition,John Wiley and Sons, Reprint 2008.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**3**								2			3		
CO2	**3**	**3**								2		1	3		
CO3	**3**	**3**	**3**					1		2		1	3		
CO4	**3**	**3**						1		2		1	3		
CO5	**3**	**3**								2		1	3		
Avg	**3**	**3**	**3**					1		2		1	3		

BM23038	BIOMEDICAL EQUIPMENT	L	T	P	C
		3	0	0	3

UNIT I CARDIAC EQUIPMENT 8

Cardiac Pacemaker- Internal and External Pacemaker, types, Batteries. AC and DC Defibrillator- Internal and External, types.

UNIT II RESPIRATORY AND SENSORY EQUIPMENT 8

Lung volume measurement, Spirometer, Ventilator. Audiometer- Air conduction and Bone conduction, Auto refractometer, Muscle stimulators, Nerve stimulators, TENS.

UNIT III EXTRA CORPOREAL DEVICES AND DIATHERMY 9

Heart lung machine, Hemodialyser unit, Peritoneal dialyser unit, Wearable artificial kidney. Lithotripsy, Short wave diathermy, ultrasonic diathermy, Microwave diathermy. Electro surgery machine

UNIT IV IMAGING EQUIPMENT 12

X ray, Computed tomography, Magnetic resonance imaging, Nuclear imaging, Principles of SPECT and PET, Ultrasound imaging, Thermography.

UNIT V PATIENT SAFETY 9

Physiological effects of electricity –Macro shock, Micro shock hazards, GFI units Earthing Schemes. Electrical safety codes and standards, Basic Approaches to protection against shock, Radiation safety, Protection equipment design,Electrical safety analyser – Testing the Electrical safety of medical equipment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understands the concept of cardiac and neurological equipment
CO2 Understand the concepts of Radiological equipment.
CO3 Analyze different types of diathermy units
CO4 Comprehend the need of extra corporeal devices.
CO5 Identify the electrical hazards and Implement methods of patient safety.

TEXT BOOKS:

1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, “Biomedical Instrumentation and Measurements”, Pearson Education India; 2nd Edition, 2015.
2. Joseph J. Carr and John M. Brown, “Introduction to Biomedical equipment technology”,Pearson Education, 4th Edition, 2014.
3. Leon Goldman, “The Biomedical Laser: Technology and Clinical applications”, Springer –Verlag Newyork Inc., 2013.

REFERENCES:

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi,3rd Edition, 2014.
2. Richard Aston, “Principles of Biomedical Instrumentation and Measurement” Merril PublishingCompany, 1990.
3. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical

Instrumentation", 3rd Edition,John Wiley and Sons, Reprint 2008.
4. John G.Webster, "Medical Instrumentation Application and Design", John Wiley and Sons,New York, 4th edition, 2009.
5. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design" – McGraw-HillPublisher, 2003.
6. Antony Y.K.Chan, "Biomedical Device technology, Principles and design'', Charles ThomasPublisher Ltd, Illinois, USA, 2008.

COURSE OUTCOMES	**PROGRAMME OUTCOMES**												**PSO**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	1				2	2	1		1	3		
CO2	3	3	2	2				2	2	1		1	3		
CO3	3	3	3	3				2	2	1		1	3		
CO4	3	3	3	3				2	2	1		1	3		
CO5	3	3	2	2				2	2	1		1	3		
CO6	3	3	2	2				2	2	1		1	3		
Avg	3	3	2	2				2	2	1		1	3		

BM23E01 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING L T P C
2 0 2 3

UNIT I INTRODUCTION TO ARTIFICIAL INTELLIGENCE 6+3

Foundations of AI: Importance of AI, Evolution of AI, Applications of AI, Classification of AI systems with respect to environment – Intelligent Agents – Structure of Agents, Multi Agents and Collaboration systems - Heuristic search strategies - Optimization problems.

Practical:

Developing algorithms for basic mathematical expressions using search techniques

UNIT II SEARCH PROCESS AND GAMES 6+3

AI and search process - Min-max Search, Heuristic Alpha-Bata Tree Search, Cutting of Search, Monte Carlo Tree Search - Optimal Decisions in Games: Alpha-Beta Pruning, Stochastic Games, Partially Observable Games - Card Game.

Practical:

Developing algorithms for basic mathematical expressions using simple game program

UNIT III INTRODUCTION TO MACHINE LEARNING AND SUPERVISED LEARNING 6+3

Introduction and Basic Concepts of Machine Learning - Probability Theory - Eigen values - Eigen vectors - Decision Theory - Types of Machine Learning - Linear Regression models - Basic Neural Networks – Back propagation Networks - Radial Basis Function Networks - Random Forest model - Support Vector Machines - Decision trees - Reinforcement Learning

Practical:

Implement a linear regression method, Implement SVM algorithm for a given data set

UNIT IV UNSUPERVISED LEARNING 6+3

Clustering Algorithms - K-means - Mean-shift Clustering algorithm - Expectation-Maximization Algorithm - Competitive networks - Dimensionality Reduction- Principal Component analysis - Independent component analysis

Practical:

Implement a program to implement k- means clustering algorithm, Implement PCA for a given dataset

UNIT V DEEP LEARNING NETWORKS 6+3

Introduction to Deep neural networks - Convolution neural networks - Deep Belief Networks - Recurrent neural networks - Generative Models - Case studies based on Biomedical applications

Practical:

Implement a CNN model for a Biomedical Application, Implement Image augmentation using GANs

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Apply basic principles of AI in solutions that require problem solving

CO2 Demonstrate the ability to solve problems using searching process

CO3 Understand different machine learning models for classification and regression problems

CO4 Implement typical dimensionality reduction and clustering algorithms

CO5 Apply deep generative models for various biomedical applications

CO6 To design and implement neural networks and deep learning models for biomedical applications

TEXT BOOKS:

1. Russell, S. and Norvig, P. 2020. Artificial Intelligence - A Modern Approach, 4th edition, Prentice Hall.
2. Ric, E., Knight, K and Shankar, B. 2017. Artificial Intelligence, 3rd edition, Tata McGraw Hill
3. Ethem Alpaydm, "Introduction to Machine Learning", The MIT Press, Cambridge, Fourth Edition, 2020.
4. Tom Mitchell, Machine Learning, McGraw Hill, 3rd Edition, 2017.

REFERENCES:

1. Luger, G.F, “Artificial Intelligence -Structures and Strategies for Complex Problem Solving, 6th edition, Pearson, 2008.
2. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2016
3. Josh Patterson and Adam Gibson, "Deep Learning - A Practitioner's Approach", O'Reilly Media, Inc, 1st edition, 2017.
4. Kevin P. Murphy, "Machine Learning - A Probabilistic Perspective", The MIT Press, Cambridge, 2012.
5. Charu C. Aggarwal, Data Classification Algorithms and Applications, CRC Press, 2014.
6. R.O. Duda, P.E. Hart and D.G. Stork, "Pattern Classification" John Wiley, 2nd Edition, 2012.
7. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3			2					3		2			3
CO2	3	3			2					3		2			3
CO3	3	3			2					3		2			3
CO4	3	3			2					3		2			3
CO5	3	3			2					3		2			3
Avg	3	3			2					3		2			3

BM23E02 INTERNET OF MEDICAL THINGS L T P C

3 0 0 3

UNIT I IoT AND ITS ARCHITECTURE 9

Introduction to IoT - Evolution of Internet of Things, Genesis of IoT, IoT and Digitization, IoT impact, Convergence of IT and OT; IoT Network Architecture and Design - Drivers, Comparing IoT architectures, oneM2M, IoT World Forum (IoTWF) and Alternative IoT models; Power awareness of IoT, Core IoT Enabling Technologies – IoT Architectures, Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT.

UNIT II ENGINEERING IoT ARCHITECTURE 9

Smart objects The "THINGS' in IoT – Sensors, Actuators and Smart objects, Sensor Networks; IoT Networking - Basic IoT Components, Interdependencies, Service Oriented Architecture; IoT Data Protocols - MQTT, SMQTT, CoAP, XMPP, AMQP; IoT Communication Protocols and their applications - IEEE 802.15.4, ZigBee6LoWPAN, Wireless HART, Z-Wave, ISA 100, Bluetooth, and Bluetooth low energy (BLE), NFC,RFID, WiFi for IoT communications; Cloud-Centric IoT - Architecture, Open Challenges, Energy efficiency, QoS, QoE; Cloud services - SaaS, PaaS, IaaS, Study of IOT Cloud platforms, ThingSpeak API and MQTT.

UNIT III INTERNET OF MEDICAL THINGS (IOMT) 9

Introduction: Prototype of an IoMT system, its organization clue; Architectures: Environment, Gateway, cloud service and function layers; Domains: On-body, In-hospital, In-home and Outdoor IoMT; Technologies: Sensors, Communication, Parallel computing, Information security and AI; Applications: Remote health monitoring, Intelligent diagnosis of diseases, Infectious disease tracing, Smart hospital, Security and privacy, Patient-Centric IoMT, IoMT in the context of patient data and integration with EHR; Healthcare IoMT strategies, architecture health domains, e-healthcare and AI applications, 5G in healthcare; Internet of medical things: Internet of things in Health: Requirements, issues, and gaps; Internet of Medical Things (IoMT): Emerging Technologies, and Case Studies.

UNIT IV DATA ANALYTICS AND SUPPORTING SERVICES 9

Web server- introduction, installation, configuration, Interfacing ESP8266 with Web services; Posting sensor(s) data to web server; An Introduction to Data Analytics - Structured Vs Unstructured Data and Data in Motion Vs Data in Rest; Role of Machine Learning – Supervised and Unsupervised learning, Neural Networks, Getting intelligence from Big Data, Predictive Analysis; Big Data Analytics tools – Parallel processing databases, No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark; Edge Streaming Analytics and Network Analytics; Securing IoT.

UNIT V IOT AND PUBLIC SAFETY 9

Smart city IoT Architecture; An IoT architecture for Transportation; Public safety – Emergency response for IoT Architecture, IoT Public safety and Information processing; Smart Healthcare System IoT Architecture, Surveillance, Mitigation and Management of Pandemics and Epidemics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Understand the evolution and underlying principles of IoT and IoMT

CO2 Identify and analyze the architectures of IoT and IoMT

CO3 Develop applications using IoMT architectures

CO4 Identify and analyze the domains, technologies and strategies used in IoT and IoMT

CO5 Do IoT and IoMT deployment, data analytics and use cloud as a resource

CO6 Implement secured IoT and IoMT and analyze its design and development for surveillance and public safety

TEXTBOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.
2. Misra, S., Mukherjee, A. and Roy, A. *Introduction to IoT*. Cambridge University Press, 2021.
3. Internet of Things - A Hands-on Approach, Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
4. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, by Eethurum Raj and Anupama C. Raman (CRC Press).
5. Multirole of the internet of medical things (IoMT) in biomedical systems for managing smart healthcare systems: An overview of current and future innovative trends, Darin Mansor Mathkor and etal., Journal of Infection and Public Health 17 (2024) 559–572
6. Internet of medical things: A systematic review, Chenxi Huang and etal., Journal of Neurocomputing 557 (2023) 126719.
7. Internet of things in health: Requirements, issues, and gaps, Jorge Calvillo-Arbizu, Computer Methods and Programs in Biomedicine 208 (2021) 106231
8. Internet of Medical Things (IoMT): Overview, Emerging Technologies, and Case Studies, Sahshanu Razdan & Sachin Sharma (2021): Internet of Medical Things (IoMT): Overview, Emerging Technologies, and Case Studies, IETE Technical Review, DOI:10.1080/02564602.2021.1927863, Taylor & Francis Group. To link to this article: https://doi.org/10.1080/02564602.2021.1927863.

REFERENCES:

1. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
2. AdrianMcEwen, HakimCassimally, Designing the Internet of Things,Wiley,Nov 2013, (1st edition)
3. Martin Charlier, Alfred Lui, Claire Rowland, Elizabeth Goodman, Ann Light, Designing Connected Products, May 2015, O'Reilly Media.santos
4. Serpanos, D. and Wolf, M. *Internet-of-things (IoT) systems: architectures, algorithms,*

methodologies. Springer, 2017.

5. Xiao, P. *Designing Embedded Systems and the Internet of Things (IoT) with the ARM mbed*. John Wiley & Sons, 2018.
6. Internet of Medical Things, Technology Intelligence & IP Research, Thematic Report by Dr.Yogesh Shelke and Arpit Sharma, Aranca, 2016

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														3
CO2	3	3													3
CO3		3	3	2											3
CO4	3	3													3
CO5		3	3												3
CO6		3	3	2											3
Avg	3	3	3	2											3

BM23E03 BIOSENSORS L T P C

3 0 0 3

UNIT I INTRODUCTION TO BIOSENSOR 9

Biosensors- Advantages and limitations, various components of biosensors, Classification of Biosensors Based on Type of Transduction - Electrochemical, Optical, Acoustic, Calorimetric. Classification of Biosensors Based on Biological Element - Enzyme Sensor, Immunosensors, Cell-based Sensors.

UNIT II DESIGN OF BIOSENSOR 9

Introduction, Assay format, Immobilisation-Ligand Activity, Regeneration, Analysis of regeneration data, Signal correction, Buffer scouting, Extracting kinetic affinity constant, Extracting kinetic rate constant, Sensor Surfaces and Receptor Depth, Molecular Interaction.

UNIT III OPTICAL AND BIOCHEMICAL BIOSENSORS 9

Principles of Optical biosensing, Immobilization of bio-recognition elements, Types of optical biosensor: Fiber optic, planar waveguide, Evanescent, Interferometric, and Surface plasmon resonance-biosensor- Applications. Chemical and other sensors - Biocatalysis based biosensors, Bio affinity based biosensors & Microorganisms based biosensors, Biologically active material and
analyte. Types of membranes used in biosensor constructions.

UNIT IV IMMUNOSENSOR 9

Introduction to Immuno biosensor- Enzyme Biosensor, Bio Affinity Biosensor, Labelled Immuno sensors, Non-Labelled Immuno sensors. Transducer Aspects of Immuno sensor- Optical Immunosensor, Piezoelectric Crystal Immunosensors, Electrochemical Immunosensors. Biological Aspects of biosensor- Antibody Development, Immunosensor-based Assay Development.

UNIT V DIAGNOSTIC APPLICATION OF BIOSENSORS 9

Preparation of Doped Sol-Gel Glasses, Application of Sol-Gel Glasses in Biosensors- Glucose Biosensor, Urea Biosensor, Cholesterol Biosensor, Lactate Biosensor. Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors in healthcare.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of this course, the student will be able to

CO1 Apply principles and concepts of biology and engineering to design biosensors

CO2 Apply principles and concepts of electronics and electrochemistry to design electrochemical biosensors

CO3 Recognize different types of transducers, and their application in biosensor design

CO4 Apply principles and concepts of sensing and engineering to design biosensors for detection of markers in biofluids

CO5 Apply engineering tools to evaluate parameters needed for point-of-care devices

TEXT BOOKS:

1. Bansi D Malhotra, Anthony, Advances in Biosensors, Volume 5, 2003, Elsevier, Oxford.
2. Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996.
3. Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, First edition, Marcel Dekker,Inc, 1991.
4. Donald G. Buerk - Biosensors Theory and Applications, First Edition Technomic Publishing. Co, Inc, 1993.

REFERENCES:

1. Elizabeth A Hall - Biosensors, First Edition, Open University, Milton Keynes, 1990.
2. Graham Ramsay - Commercial Biosensors, First edition, John Wiley & Sons, Inc. 1998.
3. Tran Minh Canh - Sensor Physics & Technology – Biosensors, First Edition, Champan & Hall, 1993.
4. Mathew A.Cooper, Label free Biosensors Techniques and Applications, Cambridge, 2009.

COURSE OUTCOMES	PROGRAMME OUTCOMES												PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3					1		2		1		3	
CO2	3	3	3					1		2		1		3	
CO3		3				1			2	2				3	
CO4		3		3	1			1		2		1		3	
CO5			3	3				1	2	2				3	
Avg	3	3	3	3	1	1		1	2	2		1		3	

BM23E04 EMBEDDED SYSTEM DESIGN L T P C
2 0 2 3

UNIT 1 INTRODUCTION TO EMBEDDED COMPUTING AND INSTRUCTION SET 8

Embedded system design process- requirement, specification, architecture design, design of hardware and software components, system integration, System design – structural description & behavioural description, Model train controller. Arm processor, TiC55xDsp processor – processor & memory organization, addressing modes, data and flow of control, C – Coding guidelines.

UNIT 2 CPU'S AND BUS BASED COMPUTERS SYSTEM 8+2

Programming input & output devices – Busy – wait input & output, interpret, Supervisor mode, exceptions and traps. Coprocessors, Memory system mechanism, CPU performance & power consumptions – Design example – Data compressor. CPU bus – Bus protocols, DMA, AMBA, System bus configuration, Memory device, Input -output devices – timers & counters, A/D convertor, D/A convertor, LED displays, computer interfacing, development and debugging, system level performance analysis.

Practicals:

Design example – Alaram clock for Patients Medicine reminder

UNIT 3 PROGRAM DESIGN WITH ANALYSIS 10

Components and Models of programs, Assembly, linking and loading, basic compilation technique, program level and software level performance optimization, program level energy and power analysis optimization, program validation and testing.

UNIT 4 PROCESSORS AND MULTIPROCESSORS OPERATING SYSTEMS 8+8

Processors-Multiple Tasks and Multiple Processes., Priority-Based Scheduling., Interprocess Communication Mechanisms., Evaluating Operating System Performance, Power Management and Optimization for Processes.

PRACTICALS:

- Design Example: Telephone Answering Machine.
- Multiprocessor Performance Analysis.
- Design Example: Heart rate Monitor, Pulse rate monitor, Biosignal acquisition-ECG

UNIT 5 DISTRIBUTED EMBEDDED NETWORKS & SYSTEM DESIGN TECHNIQUES 8+8

Distributed Embedded Architectures, Networks for Embedded Systems, Network-Based Design, Review of ADC, DAC, Timers / Counters, LED, Switches, LCD, Interrupt Controllers, Networks for Embedded systems- USB, PCI, PCI Express, UART, SPI, I2C, CAN, Wireless Applications - Bluetooth, Zigbee, Wi-Fi., Evolution of Internet of things (IOT). Internet-Enabled Systems., Sensor network.

Practicals:

- Design Examples-Elevator controller. System design Methodologies, System Analysis and Architecture Design., Quality Assurance.
- Mobile application – m- Health platform – ECG and EMG signals.

Total: 60 hrs

TEXT BOOKS:

1. Wayne Wolf “Computers as components: Principles of Embedded Computing System Design”, The Morgan Kaufmann Series in Computer Architecture and Design, 2013.
2. Computers as Components Principles of Embedded Computing System Design, Second Edition Wayne Wolf, 2008.

REFERENCE BOOKS:

1. Lyla B. Das," Embedded Systems an Integrated Approach", Pearson Education, 2013.
2. Raj Kamal, “Embedded systems Architecture, Programming and Design”, Tata McGrawHill, 2011.
3. Shibu K V," Introduction to Embedded Systems", McGraw Hill Education(India) Private Limited, 2014
4. Sriram V Iyer, Pankaj Gupta " Embedded Real Time Systems Programming", Tata McGraw- Hill, 2012
5. Steve Heath, “Embedded Systems Design”, EDN Series, 2013
6. Embedded System Design: A Unified Hardware/Software Approach Frank Vahid and Tony Givargis Department of Computer Science and Engineering University of California Riverside, CA 92521 vahid@cs.ucr.edu http://www.cs.ucr.edu/~vahid Draft version, Fall 1999

COURSE OUTCOMES:

At the end the course the students will be able to

1. Comprehend Embedded Processor and its software
2. Design an Embedded system with different modeling techniques.
3. Build a process for an Embedded system.
4. Design an Embedded system using processors, memory I/O devices and communication network within realistic constraints for Biomedical applications.
5. Incorporate operating system in an Embedded system for Biomedical applications.
6. Comprehend the operation of multitasking in an Embedded System and implementation for Biomedical applications.

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3				2							3			3
CO2	3	3	2		2							3			3
CO3	3				2							3			3
CO4	3	3	2		2					3		3			3
CO5	3	3			2							3			3
CO6	3	3	2		2							3			3
AVG	3	3	2		2					3		3			3