

JERUSALEM COLLEGE OF ENGINEERING

(An Autonomous Institution)

Approved by AICTE & Affiliated to Anna University

Accredited by NAAC with 'A' Grade

Chennai – 600 100



DEPARTMENT OF BIOMEDICAL ENGINEERING

B.E. BIOMEDICAL ENGINEERING

CURRICULUM

REGULATION 2023
CHOICE BASED CREDIT SYSTEM



JERUSALEM COLLEGE OF ENGINEERING
(An Autonomous Institution)
(Approved by AICTE, Affiliated to Anna University,
Accredited by NBA and NAAC with 'A' Grade)
Velachery Main Road, Narayanapuram, Pallikaranai, Chennai – 600100

DEPARTMENT OF BIOMEDICAL ENGINEERING

VISION OF THE INSTITUTION

Jerusalem College of Engineering is committed in emerging as an international institution of excellence in imparting finest quality engineering, technology and management education rooted in ethical and societal values through various academic programmes, multi- disciplinary research, consultancy and entrepreneurship activities and hence to contribute towards social transformation and nation building.

MISSION OF THE INSTITUTION

- Generating abundant resources and making conducive policies, the management led by the Chairperson strives towards promoting globally competitive academic programmes augmented with value added courses, in-plant training activities, co- curricular activities and ambience that support intellectual growth and skill acquisition
- Promoting collaborative trans-border research programmes continuing education in synergy with academia, industries and research organizations leading to real time solutions and life-long learning
- Transforming young men and women into competent professionals and entrepreneurs motivated by a passion for professional excellence, driven by human values and proactively engage in the betterment of the society through innovative practices and academic excellence
- Facilitating effective interaction among faculty members and students and fostering network of alumni, industries, institutions and other stake-holders for successful career gain and placement

VISION OF THE DEPARTMENT

Department of Biomedical Engineering is committed to produce Biomedical Engineers with ethical and social considerations and to foster their intellectual growth in multi-disciplinary fields for improving human condition and healthy nation building.

MISSION OF THE DEPARTMENT

- Providing technical knowledge through skilled innovative practices and experiments in ethical learning environment.
- Creating new knowledge and enabling technologies in devising simple and low cost methods for diagnosis and therapy at different medical fields through research and developmental activities.
- Providing quality education and design activities in developing entrepreneurship qualities.

PROGRAMME OUTCOMES (POs):

The graduates will have the ability to

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8)

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7)

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PROGRAMME EDUCATIONAL OBJECTIVES

PEO 1: The Graduates will excel in application of mathematics, basic sciences, and Biosciences to multidisciplinary projects.

PEO 2: The Graduates will adapt to the contemporary technologies and support health care providers at various levels with effective communication and team work.

PEO 3: The Graduates will develop optimum Biomedical Engineering solution with ethical commitment.

PEO 4: The Graduates will excel themselves to work as an Entrepreneur in Biomedical field.

PROGRAMME SPECIFIC OUTCOMES

The graduates will have the ability to

PSO1: Development of innovative tools: An ability to design innovative tools to analyze and diagnose various pathological disorders.

PSO2: Medical Equipment maintenance and management: An ability to develop strategies to address the challenges of medical equipment maintenance and hospital management.

CREDIT SUMMARY

S.NO	CATEGORY	CREDITS AS PER SEMESTER								CREDIT TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1	HS	4	4	-	-	1	-	2	-	11
2	BS	10	9	3	3	-	-	-	-	25
3	ES	8	3	-	-	-	-	-	-	11
4	PC	-	5	16	12	16	12	2	10	73
5	PE	-	-	-	3	3	6	6	-	18
6	OE	-	-	-	3	3	3	3	-	12
7	EEC	-	2	-	3	2	3	6	-	16
TOTAL		22	23	19	24	25	24	19	10	166

JERUSALEM COLLEGE OF ENGINEERING
*(An Autonomous Institution, Affiliated to Anna University &
Accredited by NBA & NAAC 'A' Grade)*

B.E. - BIOMEDICAL ENGINEERING

CURRICULUM 2023 - (REGULATION 2023)

**CHOICE BASED CREDIT SYSTEM
I TO VIII SEMESTERS CURRICULUM AND SYLLABI**

SEMESTER 1

S.no	Course Code	Course Title	T/P/I	Category	Contact Period	L	T	P	C
1	JHS2121	English for Communicative Competence	I	HS	4	2	0	2	3
2	JMA2101	Matrices and Calculus	T	BS	4	2	2	0	3
3	JPH2101	Engineering Physics 1	T	BS	3	3	0	0	3
4	JCY2101	Engineering Chemistry	T	BS	3	3	0	0	3
5	JGE2101	Basic Engineering	T	ES	3	3	0	0	3
6	JCS2121	Programming in C	I	ES	5	3	0	2	4
7	JGE2102	Heritage of Tamils	T	HS	1	1	0	0	1
8	JPC2111	Engineering Physics and Chemistry Laboratory	P	BS	2	0	0	2	1
9	JGE2111	Basic Engineering Laboratory	P	ES	2	0	0	2	1
TOTAL					27	17	0	10	22

SEMESTER 2

S.no	Course Code	Course Title	T/P/I	Category	Contact Period	L	T	P	C
1	JHS2221	English for Science and Technology	I	HS	4	2	0	2	3
2	JMA2201	Statistics for Engineers	T	BS	4	2	2	0	3
3	JPH2201	Engineering Physics 2	T	BS	3	3	0	0	3
4	JGE2221	Engineering Graphics	I	ES	4	2	0	2	3
5	JEC2201	Electronic Devices and Circuit Analysis	T	PC	3	3	0	0	3
6	JCY2201	Environmental Science and Sustainability	T	BS	2	2	0	0	2
7	JGE2202	Tamils and Technology	T	HS	1	1	0	0	1
8	JPC2211	Engineering Physics and Environmental Science Laboratory	P	BS	2	0	0	2	1
9	JEC2211	Electronic Devices and Circuit Analysis Laboratory	P	PC	4	0	0	4	2
10	JGE2241	Gaming and Crafts Studio	P	EEC	4	0	0	4	2
TOTAL					31	15	0	16	23

SEMESTER 3

S.no	Course Code	Course Title	T/P/I	Category	Contact Period	L	T	P	C
1	JMA2301	Transforms and Partial Differential Equations	T	BS	4	2	2	0	3
2	JBM2321	Biosciences	I	PC	5	3	0	2	4
3	JEC2321	Signals and Systems	I	PC	5	3	0	2	4
4	JBM2301	Human Anatomy and Physiology	T	PC	3	3	0	0	3
5	JBM2302	Biosensors and Measurements	T	PC	3	3	0	0	3
6	JNC2361	Disaster Risk Reduction and Management	T	NCM	3	3	0	0	-
7	JBM2311	Biomedical Data Analysis Laboratory	P	PC	4	0	0	4	2
8	JPT2041	Soft Skills and Aptitude	P	EEC	2	0	0	2	*
TOTAL					29	17	2	10	19

** Only Internal Assessments will be conducted in the 3rd semester while the end semester examination will be conducted in the 4th semester.*

SEMESTER 4

S.no	Course Code	Course Title	T/P/I	Category	Contact Period	L	T	P	C
1	JMA2401	Applied Numerical Methods	T	BS	4	2	2	0	3
2	JBM2401	Biomaterials Engineering	T	PC	3	3	0	0	3
3	JBM2402	Biomedical Instrumentation	T	PC	3	3	0	0	3
4	JBM2421	Integrated Circuits	I	PC	5	3	0	2	4
5	-	Professional Elective 1	T	PE	3	3	0	0	3
6	-	Open Elective 1	T	OE	3	3	0	0	3
7	JBM2411	Biomedical Instrumentation Laboratory	P	PC	4	0	0	4	2
8	JGE2441	E-Protoshop	P	EEC	4	0	0	4	2
9	JPT2041	Soft Skills and Aptitude	P	EEC	2	0	0	2	1
TOTAL					31	17	2	12	24

SEMESTER 5

S.no	Course Code	Course Title	T/P/I	Category	Contact Period	L	T	P	C
1	JBM2501	Diagnostic and Therapeutic Equipment	T	PC	3	3	0	0	3
2	JBM2521	Biomedical Signal Processing	I	PC	5	3	0	2	4
3	JBM2502	Medical Physics	T	PC	3	3	0	0	3
4	JEC2521	Microprocessors and Microcontrollers	I	PC	5	3	0	2	4
5	-	Professional Elective 2	T	PE	3	3	0	0	3
6	-	Open Elective 2	T	OE	3	3	0	0	3
7	JHS2541	Professional Communication	P	HS	2	0	0	2	1
8	JBM2511	Diagnostic and Therapeutic Equipment Laboratory	P	PC	4	0	0	4	2
9	JGE2541	Industry 4.0 Laboratory	P	EEC	4	0	0	4	2
10	JPT2042	Technical Skills and Aptitude	P	EEC	2	0	0	2	*
TOTAL					34	18	0	16	25

** Only Internal Assessments will be conducted in the 5th semester while the end semester examination will be conducted in the 6th semester.*

SEMESTER 6

S.no	Course Code	Course Title	T/P/I	Category	Contact Period	L	T	P	C
1	JBM2601	Artificial Intelligence and Pattern Recognition	T	PC	3	3	0	0	3
2	JBM2621	Medical Image Processing	I	PC	5	3	0	2	4
3	JBM2602	Radiological Equipment	T	PC	3	3	0	0	3
4	-	Professional Elective 3	T	PE	3	3	0	0	3
5	-	Professional Elective 4	T	PE	3	3	0	0	3
6	-	Open Elective 3	T	OE	3	3	0	0	3
7	JBM2611	Virtual Instrumentation Laboratory	P	PC	4	0	0	4	2
8	JGE2641	Product Development Laboratory	P	EEC	4	0	0	4	2
9	JPT2042	Technical Skills and Aptitude	P	EEC	2	0	0	2	1
TOTAL					30	18	0	12	24

SEMESTER 7

S.no	Course Code	Course Title	T/P/I	Category	Contact Period	L	T	P	C
1	-	Professional Elective 5	T	PE	3	3	0	0	3
2	-	Professional Elective 6	T	PE	3	3	0	0	3
3	-	Open Elective 4	T	OE	3	3	0	0	3
4	JNC2761	Industrial Safety	T	NCM	3	3	0	0	-
5	JHS2741	Universal Human Values	I	HS	3	1	0	2	2
6	JGE2751	Entrepreneurship Development	I	EEC	4	2	0	2	3
7	JBM2741	Comprehension and Technical Seminar	P	EEC	2	0	0	2	1
8	JBM2742	Hospital Training	P	PC	4	0	0	4	2
9	JBM2743	Internship	P	EEC	-	-	-	4**	2
TOTAL					20	12	0	8	19

*** Internship of 1 month must be undertaken in industry through semester 4,5 and 6 leading to 2 credits in semester 7*

SEMESTER 8

S.no	Course Code	Course Title	T/P/I	Category	Contact Period	L	T	P	C
1	JBM2831	Project Work	P	PC	20	0	0	20	10
TOTAL					20	0	0	20	10

Theory courses: 32

Integrated courses: 12

Practical courses: 21

TOTAL CREDITS: 166

JERUSALEM COLLEGE OF ENGINEERING
(An Autonomous Institution, affiliated to Anna University & Accredited by NBA & NAAC 'A' Grade)

DEPARTMENT OF BIOMEDICAL ENGINEERING

LIST OF PROFESSIONAL ELECTIVES AS VERTICALS

(REGULATION – 2023)

VERTICAL I HEALTHCARE INFORMATICS & MANAGEMENT	VERTICAL II BIOSIGNAL & IMAGE PROCESSING	VERTICAL III MEDICAL DEVICE INNOVATION & DEVELOPMENT	VERTICAL IV BIO- ENGINEERING	VERTICAL V COMMUNICATION SYSTEMS IN MEDICINE	VERTICAL VI MECHANICS & MODELLING
JBM2001 Hospital Planning and Management	JBM2008 Medical Imaging Systems	JBM2015 Biomedical Entrepreneurship	JBM2022 Genetic Engineering	JBM2029 Virtual Reality in Medicine	JBM2036 Medical Haptics
JBM2002 Computers in Medicine	JBM2009 Speech and Audio Signal Processing	JBM2016 Critical Care Equipment	JBM2023 Bioprinting	JBM2030 Body Area Networks	JBM2037 Neuromechanics of Human Movement
JBM2003 Clinical Engineering	JBM2010 Computer Vision in Healthcare	JBM2017 Medical Device Design	JBM2024 BioMEMS	JBM2031 Principles of Communication	JBM2038 Physiological Modelling
JBM2004 Quality Control for Medical Devices	JBM2011 Biometric Systems	JBM2018 Biophotonics	JBM2025 Nanotechnology and Applications	JBM2032 Telehealth Technology	JBM2039 Rehabilitation Engineering
JBM2005 Medical Informatics	JBM2012 Virtual Instrumentation for Biomedical Engineers	JBM2019 Regulatory Perspectives of Medical Devices	JBM2026 Medical Implants	JBM2033 Robotics in Medicine	JBM2040 Ergonomics
JBM2006 Medical Ethics	JBM2013 Soft Computing Techniques	JBM2020 Human Assist Devices	JBM2027 Artificial Organs	JBM2034 Wearable Systems	JBM2041 Biomechanics
JBM2007 Medical Waste Management	JBM2014 Brain Computer Interface Techniques	JBM2021 Patient Safety Standards	JBM2028 Neural Engineering	JBM2035 Neural Networks	JBM2042 Biofluids and Dynamics

JERUSALEM COLLEGE OF ENGINEERING
*(An Autonomous Institution, Affiliated to Anna University &
Accredited by NBA & NAAC 'A' Grade)*

B.E. - BIOMEDICAL ENGINEERING

OPEN ELECTIVES LIST

(REGULATION - 2023)

S.no	Course Code	Course Title	Category	Contact Period	L	T	P	C
IV Semester								
1	JBM9201	Food & Nutrition	OE	3	3	0	0	3
2	JBM9202	Medical Instrumentation	OE	3	3	0	0	3
3	JBM9203	Biosensors Technology	OE	3	3	0	0	3
V Semester								
4	JBM9204	Introduction to Biometric Systems	OE	3	3	0	0	3
5	JBM9205	Applications of Telemedicine	OE	3	3	0	0	3
6	JBM9206	IoT in Healthcare	OE	3	3	0	0	3
VI Semester								
7	JBM9207	Wearable Technology	OE	3	3	0	0	3
8	JBM9208	Basics of Image Processing	OE	3	3	0	0	3
9	JBM9209	Artificial Intelligence in Healthcare	OE	3	3	0	0	3
VII Semester								
10	JBM9210	Assistive Technology	OE	3	3	0	0	3
11	JBM9211	Basics of Neural Networks	OE	3	3	0	0	3
12	JBM9212	Advancements in Healthcare	OE	3	3	0	0	3

SEMESTER 1

JHS2121	ENGLISH FOR COMMUNICATIVE COMPETENCE	L	T	P	C
		2	0	2	3

Course Objectives:

- To enable the students of Engineering to develop their reading and other language skills
- To facilitate the learners to reflect and share their ideas effortlessly
- To develop their skills to communicate thoughts effectively in social contexts
- To expose them to different genres to develop their understanding and expression
- To train the students to improve their writing skills for efficient communication

UNIT I Analytical Grammar and Information Sharing 12

Parts of speech – Functional units – Tenses – Affixes; Reading comprehension: short general passages for skimming and scanning

Language Practice

Reading: Biographical essays, short stories; **Speaking:** Self-introduction, peer introduction;

Listening: Inspiring speeches, newscasts; **Writing:** Journal writing

UNIT II Foundational Grammar and Expressing Thoughts 12

Framing questions – Prepositions – Compound nouns – Contextual meaning; Letter writing (informal letters)

Language Practice

Reading: Travelogues; **Speaking:** Small talks, Just A Minute (JAM); **Listening:** Anecdotes, stories, podcasts; **Writing:** Fill in the blanks in short dialogues

UNIT III Functional Grammar and Social Communication 12

Articles – Subject-verb agreement – Synonyms and antonyms – Email etiquette; Dialogue writing

Language Practice

Reading: Adverts; **Speaking:** Role play, storytelling / completion; **Listening:** Messages from social network; **Writing:** Writing messages for social network / emails

UNIT IV Structural Grammar and Visual Communication 12

Modal verbs – Simple, complex and compound sentences – Discourse markers – Correction of errors; Interpretation of posters on social issues

Language Practice

Reading: Excerpts from literature; **Speaking:** Asking for / giving directions - Picture description;

Listening: Talks on English and language skills; **Writing:** Reporting on events / incidents

UNIT V - Transformational Grammar and Written Communication 12

Degrees of comparison – Reported speech – Connotations – One-word substitutes (general); Essay writing: narrative / descriptive / expository / argumentative

Language Practice

Reading: Newspaper articles, social media messages (educational contexts); **Speaking:** Group discussions (general topics); **Listening:** Formal and informal talks, Ted talks; **Writing:** Writing short stories / poems (guided)

TOTAL: 60 PERIODS

Course Outcomes:**At the end of the course, students will be able:**

- To comprehend reading passages and express themselves
- To communicate their thoughts confidently and skillfully
- To participate in activities of daily life using appropriate communicative strategies
- To be creative and critical in expressing themselves
- To write effectively and persuasively and produce different types of writing

Text Books:

1. Department of English, Anna University, English for Engineers & Technologists, Volume 2, Orient Black Swan Private Limited, Chennai, 2022.
2. Dhanavel, SP. English and Communication Skills for Students of Science and Engineering. Orient Black Swan Private Limited, Chennai, 2011.
3. Interact English: Lab Manual for Undergraduate Students. Orient Black Swan Private Limited, Chennai, 2017.

Reference Books:

1. Chellammal, V. Learning to Communicate. Allied Publishing House, New Delhi, 2004.
2. Raman, Meenakshi & Sangeetha Sharma. Technical Communication: Principles and Practices. Oxford University Press, New Delhi. 2015.
3. Regional Institute of English. English for Engineers. Cambridge University Press, New Delhi. 2008.
4. Rizvi M, Ashraf. Effective Technical Communication, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017.

Web Links:

1. www.esl-lab.com
2. www.englishgrammar.org
3. www.englishclub.com
4. www.usingenglish.com
5. www.esl.about.com
6. www.bbc.co.uk/learningenglish/
7. <https://esl-bits.net/>
8. <https://elt.oup.com/>
9. <https://learnenglish.britishcouncil.org>
10. <https://quizizz.com/>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	1	-	1	1	1	3	-	1	-	-
CO2	-	-	-	1	-	1	1	1	3	-	1	-	-
CO3	-	-	-	1	-	1	1	1	3	-	1	-	-
CO4	-	-	-	1	-	1	1	1	3	-	1	-	-
CO5	-	-	-	1	-	1	1	1	3	-	1	-	-
AVG	-	-	-	1	-	1	1	1	3	-	1	-	-

JMA2101	MATRICES AND CALCULUS	L	T	P	C
		2	2	0	3

COURSE OBJECTIVES:

- To equip students with the knowledge of matrices required for applications in engineering.
- To enable students understand the concepts of multivariable calculus.
- To introduce concepts of integral calculus as tools required for applications in engineering.
- To familiarize students in the concepts of vector calculus and its applications.
- To help students understand theory of analytic functions and provide knowledge of Cauchy Residue theorem and its applications.

UNIT I - MATRICES

9+3

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Reduction of a quadratic form to canonical form – Nature of quadratic forms.

UNIT II - FUNCTIONS OF SEVERAL VARIABLES

9+3

Jacobians – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT III - APPLICATIONS OF INTEGRAL CALCULUS

9+3

Double integrals in Cartesian coordinates – Change of order of integration – Area enclosed by plane curves – Triple integrals – Volume of solids.

UNIT IV - VECTOR CALCULUS

9+3

Gradient and directional derivative – Divergence and curl – Irrotational and Solenoidal vector fields. Green's theorem, Gauss' divergence theorem, Stoke's theorem – Verification and evaluation in simple problems.

UNIT V - COMPLEX ANALYSIS

9+3

Analytic functions – Cauchy-Riemann equations – Milne-Thomson rule (given real or imaginary part) – Bilinear transformation. Residues – Application of Cauchy's Residue theorem for evaluation of real integrals (Circular contour and semi-circular contour only).

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able

- To apply matrix method in reducing quadratic form to canonical form.
- To solve simple optimization problems through differential calculus.
- To evaluate multiple integrals required for solving area and volume problems.
- To apply vector calculus for verifying Green's, Gauss' and Stoke's theorems.
- To solve problems arising in analytic functions and solve real integrals through Cauchy Residue theorem.

TEXT BOOKS:

1. Grewal B S, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2018.
2. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, New Delhi, 10th Edition, 2016.
3. Anuradha.P and Sudhakar.V, "Matrices and Calculus", Scitech Publications, 1st Edition, Chennai, 2019.

REFERENCES:

1. Anton H, Bivens I and Davis S, "Calculus", Wiley, 10th Edition, 2016.
2. Jain R K and Iyengar S R K, "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 8th Edition, 2022.
3. Srimantha Pal and Bhunia S C, "Engineering Mathematics" Oxford University Press, 1st Edition, 2015.
4. Weir, M D and Joel Hass, "Thomas Calculus", 15th Edition, Pearson India, 2022.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/111107112>
2. <https://nptel.ac.in/courses/111108157>
3. <https://nptel.ac.in/courses/111107108>
4. <https://nptel.ac.in/courses/111106141>
5. <https://nptel.ac.in/courses/111103070>

CO-PO & PSO MAPPING

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

JPH2101	ENGINEERING PHYSICS 1	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the students to understand the basics of Properties of Matter
- To expand their knowledge about thermal properties of materials
- To enhance their understanding of Photonics
- To familiarize the students with the principles of quantum mechanics
- To enrich their knowledge on Solid State of Materials

UNIT I - PROPERTIES OF MATTER

9

Elasticity – Stress-strain diagram and its uses - factors affecting elastic moduli and tensile strength - Torsion pendulum: theory and experiment - Bending of beams - stress due to bending in beams - bending moment – Cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment.

UNIT II - THERMAL PHYSICS

9

Fundamentals of thermal energy - expansion joints – Bimetallic strips - Thermal conductivity, conduction in solids, Differential equation of one dimensional heat flow – Forbes's and Lee's disc method - Conduction through compound media- Solar heater

UNIT III - LASERS AND FIBER OPTICS

9

Spontaneous and stimulated emission-Population inversion -Einstein's A and B coefficients derivation – Laser Principle – Nd:YAG and Semiconductor lasers (homojunction & heterojunction) Principle and propagation of light in optical fiber, Derivation of Numerical aperture and Acceptance angle – Fiber optical communication (Block diagram) – Active and passive sensors – Medical endoscope.

UNIT IV - BASIC QUANTUM PHYSICS

9

Black body radiation –Planck's theory (derivation) –Deduction of Wien's displacement law and Rayleigh –Jeans' Law from Planck's theory –Compton effect-theory –Properties of Matter waves - Schrödinger's wave equation –Time independent and time dependent equations –Physical significance of wave function –Particle in a one dimensional box –Scanning Transmission electron microscope.

UNIT V - SOLID STATE PHYSICS

9

Single crystal, Polycrystalline and Amorphous materials – Single Crystals: Unit cell, Crystal systems, Bravais lattices, Directions and Planes in a crystal, Miller indices – Inter planar distances – Coordination number and Packing factor for SC, BCC, FCC, HCP and Diamond structures - Crystal imperfections: Point defects, Line defects – Burgers vector, Surface defects and Volume defects.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able

- To apply their knowledge in analyzing the elastic property of any materials
- To assess the thermal properties of materials
- To use modern optical fiber communication systems and tools in real life situations
- To compute problems in Quantum Physics
- To comprehend the structure of solid materials

TEXT BOOKS:

1. Dr. Beula Shanthi John, Dr.P.Mani, “Engineering Physics-I”, Dhanam Publications, First Edition, 2019.
2. Bhattacharya, D.K. & Poonam, T. “Engineering Physics- I”. Oxford University Press, 2015.
3. Gaur, R.K. & Gupta, S.L. “Engineering Physics”. Dhanpat Rai Publishers, 2012.
4. S. O. Pillai, “Solid State Physics”, New Age International Publications, Revised Edition.
5. Pandey, B.K. & Chaturvedi, S. “Engineering Physics”. Cengage Learning India, 2012.
6. Kittel, C. —Introduction to Solid State Physics. Wiley, 2005.

REFERENCES:

1. Halliday, D., Resnick, R. & Walker, J. “Principles of Physics”. Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. “Physics for Scientists and Engineers”. Cengage Learning, 2010.
3. Tipler, P.A. & Mosca, G. “Physics for Scientists and Engineers with Modern Physics”.
4. Rajendran V, "Engineering Physics", Tata McGraw Hill, 2009.
5. Arumugam M, "Materials Science", Anuradha Publications, 2015.
6. William F Smith, “Material Science and Engineering”, Tata McGraw - Hill Publications, 2008.
7. John D. Cutnell, “Cutnell and Johnson Physics”, Wiley Publications, 2018.

Website References

1. <https://archive.nptel.ac.in/courses/115/104/115104109/>
2. <https://archive.nptel.ac.in/courses/105/105/105105177/>
3. <https://archive.nptel.ac.in/courses/102/105/102105090/>
4. <https://archive.nptel.ac.in/courses/115/104/115104096/>
5. <https://archive.nptel.ac.in/courses/108/104/108104113/>

CO-PO & PSO MAPPING

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

JCY2101	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To inculcate the significance of water quality parameters and water treatment techniques.
- To acquaint the properties and applications of industrial polymers.
- To acquire knowledge in corrosion of material and its prevention.
- To import knowledge over energy conversion methods and of energy storage devices.
- To acquire knowledge on the basics of nanomaterials and its preparatory methods.

UNIT I - WATER AND ITS TREATMENT

9

Water quality parameters (pH, TDS, DO, BOD, COD) - Hardness - Types and estimation (EDTA method). Alkalinity – Types and estimation. Water softening methods- Limesoda Process (Cold and Hot methods) -Zeolite Process - Ion exchange process. Desalination of brackish water – reverse osmosis. Municipal water treatment- Primary treatment and Disinfection (UV, Ozonation, Chlorination) - Break point chlorination.

UNIT II - POLYMER AND COMPOSITES

9

Classification of polymers – Functionality – Types of polymerisation (addition & condensation) – Mechanism of addition polymerisation (free radical, cationic, anionic) - Degree of polymerization - Thermoplastic and Thermosetting. Bio degradable polymer- Polylactic acid, Polyvinyl acetate-Preparation – Properties – applications. Conducting polymer – types – Mechanism – application - Polymer composites – types – properties and application.

UNIT III - CORROSION AND ITS PREVENTION

9

Corrosion - chemical, electrochemical corrosion, galvanic corrosion and differential aeration corrosion. Factors influencing the rate of corrosion. Corrosion control - material selection, design aspects, cathodic protection, Corrosion inhibitors - Electroplating (copper) and electroless plating (nickel) – Organic coating(Paints – Constituents and function).

UNIT IV - ENERGY SOURCES AND STORAGE DEVICES

9

Nuclear energy- critical mass light water nuclear power plant and Breeder reactor. Principle, working and applications of solar energy and wind energy. Primary battery (dry cell and alkaline battery). Secondary battery (lead acid, nickel-cadmium and lithium-ion-battery). H₂-O₂ fuel cell.

UNIT V NANOCHEMISTRY

9

Distinction between molecules, nanomaterials and bulk materials - Size-dependent properties - Types of nanomaterials - Nanoparticle, nanocluster, nanorod, nanowire and nanotube. Synthesis of nanomaterials solvothermal, laser ablation, chemical vapour deposition and electrochemical deposition – General applications of nanomaterial.

TOTAL: 45 PERIODS

COURSE OUTCOMES

- To identify water quality and propose suitable methods to treat water.
- To analyze the compatibility of polymeric materials for biomedical and electronic applications.
- To recognize the nature of corrosive environment and implement preventive methods of corrosion.
- To design different forms of energy sources for suitable applications.
- To identify suitable synthetic method of nanomaterials for specific applications.

TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008. S.S. Dara, "A Text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.
3. A.Ravikrishnan, "Engineering Chemistry" Sri Krishna Hitech Publishing Company Pvt.Ltd., 22nd edition, 2023

REFERENCES:

1. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
2. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
3. B.R.Puri, L.R.Sharma, Madan S.Pathana, Principle of physical chemistry, 47th edition, Vishal publishing Co, 2017.
4. S. Ananda Kumar (Editor)"Eco-friendly Nano-hybrid materials for Advanced Engineering Applications" CRC Press, USA. (2016)
5. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
6. Dara S.S, Umare S.S, "Engineering Chemistry", S. Chand & Company Ltd., New Delhi 2013.

Website reference:

1. <https://nptel.ac.in/courses/113/101/113101098/>
2. <https://nptel.ac.in/courses/113/106/113106093/>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	2	3	1	3	2	1	1	-	1	-	-
CO2	1	1	1	2	1	3	1	-	1	-	1	-	-
CO3	1	1	2	2	1	2	-	-	1	-	1	-	-
CO4	1	1	2	2	1	2	1	1	1	-	1	-	-
CO5	1	1	1	2	1	-	-	-	1	-	1	-	-
AVG	1	1	1.6	2.2	1	2.5	1.33	1	1	-	1	-	-

JGE2101	BASIC ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide students with illustrations about mechanical engineering to satisfy societal needs
- To provide them knowledge on refrigeration, air-conditioning and power plants
- To help students acquire knowledge in the basics of surveying and building materials
- To impart knowledge on the electric circuits and working principles of Electrical Machines.
- To provide the knowledge on the Principles and characteristics of various electronic devices and measuring instruments.

UNIT I – BASICS OF MECHANICAL ENGINEERING 9

Introduction to the concepts of Mechanization and Automation, Robotics - Manufacturing methods - casting, machining, forming operations. Introduction to IC Engine - Working principles of four stroke petrol and diesel engines. Electric vehicle Technology- Layout, components and control.

UNIT II-REFRIGERATION, AIR CONDITIONING SYSTEM AND POWER PLANT 9

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system–Layout of typical domestic refrigerator–Window and Split type room Air conditioner. Classification of power plant and working principle of Thermal and Hydel powerplant.

UNIT III - BASICS OF CIVIL ENGINEERING 9

Introduction to Civil Engineering, Types of buildings, Components of a residential building, Building Materials. Surveying: Objects – Classification – Principles – Measurements of Distances and angles. Rain Water Harvesting, Solid Waste Management

UNIT IV ELECTRIC CIRCUITS AND ELECTRICAL MACHINES 9

Basic circuit components - Ohms Law - Kirchhoff's Law – Introduction to AC circuits - Power and power factor –Construction, Principle of operation and characteristics of DC machines, Transformers and Induction machines.

UNIT V ELECTRONIC DEVICES & INSTRUMENTATION 9

Types of Materials - N type and P type materials - Principle of operation and Characteristics: PN Junction diode , Zener Diode, BJT, MOSFET. Elements of generalized measurement system — Operating forces– Principle of operation of moving coil and moving iron instruments -Errors in measurement - Standards of Measurement.

TOTAL PERIODS: 45

COURSE OUTCOMES:

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

- To be acquainted with the concepts in mechanical engineering and vehicle concept.
- To understand the fundamentals of refrigeration, air-conditioning and power plant.
- To summarize the surveying, planning of building, infrastructure and building materials.
- Apply the basic concepts of electric circuits and working principles of electrical machines.
- Gain knowledge on the basics of electronics and choose appropriate instruments for electrical measurement for a specific application.

TEXT BOOKS:

1. G Shanmugam, M S Palanichamy, Basic Civil and Mechanical Engineering, McGraw Hill Education; First edition, 2018.
2. Palanikumar, K. Basic Mechanical Engineering, ARS Publications, 2018.
3. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", Mc Graw Hill, 2015.
4. D P Kothari and I.J Nagarath, "Electrical Machines - Basic Electrical and Electronics Engineering" , Third Reprint , Mc Graw Hill Education (India) Private Limited, , 2016.
5. A.K.Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Co, 2010.
6. S Salivahanan , N Suresh Kumar, "Electronic Devices And Circuits ", fifth Edition, Mc Graw Hill, 2022.

REFERENCE BOOKS:

1. Ramamrutham S., “Basic Civil Engineering”, Dhanpat Rai Publishing Co.(P) Ltd, 2013.
2. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, First edition 2017.
3. Thereja. B.L., “Fundament also f Electrical Engineering and Electronics” , S. Chand & Co.Ltd., 2008.
4. H.S.Kalsi, “Electronic Instrumentation “ , Tata Mc Graw-Hill, 2010.

WEB SITE REFERENCE:

1. <https://archive.nptel.ac.in/courses/112/103/112103262/>
2. <https://archive.nptel.ac.in/courses/112/105/112105129/>
3. <https://archive.nptel.ac.in/courses/105/106/105106201/>
4. <https://archive.nptel.ac.in/courses/105/106/105106201/>
5. https://youtu.be/LPcQYXjPdIQ?list=PLp6ek2hDcoNCANsWM2mw3qi0387Bhf_LyV
6. https://www.youtube.com/playlist?list=PLMYtBmvT7X7QaLu0b0Jn1QQD4EO_uT_CA
7. <https://youtu.be/5ZNeDxfgYAE><https://youtu.be/36j6hCtLOE>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	1	-	-	-	-	-	-	-	1
CO2	1	1	1	1	1	-	-	-	-	-	-	-	3
CO3	1	1	1	1	1	-	-	-	-	-	-	-	-
CO4	1	1	1	1	1	-	-	-	-	-	-	2	3
CO5	1	1	1	1	1	-	-	-	-	-	-	3	3
AVG	1	1	1	1	1	-	-	-	-	-	-	2.5	2.5

JCS2121	PROGRAMMING IN C	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES

- To understand the concepts of C Language.
- To implement programs using basic constructs of C
- To develop C programs using Arrays and Strings
- To develop modular applications in C using functions and Pointers.
- To be able to use File operations and Structures in C.

UNIT I - INTRODUCTION TO C PROGRAMMING

9

Introduction to programming paradigms - Simple model of Computer - Algorithms and Flowcharts - Structure of C program - Applications of C Language - Data Types – Constants - Enumeration - Keywords – Number System.

UNIT II - OPERATOR AND EXPRESSIONS

9

Data Input and Output statements – Operators: Arithmetic Operators, Relational Operators, Logical Operators, Increment and Decrement Operators, Bitwise Operators, Assignment Operators and Expressions, Precedence and Order of Evaluation – Decision Making and Branching – Looping statements.

UNIT III - ARRAYS AND STRINGS

9

Arrays – Initialization – Declaration – One dimensional array – Two dimensional arrays - String - String operations: length, compare, concatenate, copy – Arrays of strings - Simple programs: Sorting, Searching and Matrix operations.

UNIT IV - FUNCTIONS AND POINTERS

9

Function – Definition of function – Function Prototypes - Pass by value - Pass by reference - Recursion. Pointers: Definition- Initialization -Pointer Arithmetic- Pointers and Arrays.

UNIT V - STRUCTURES, UNION AND FILES

9

Structure - Structure Definition - Structure Declaration - Nested structures - Array of structures - Union - Storage Classes - Files - Types of file processing: Sequential access, Random access - Sequential access file - Random access file - Command line arguments.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. Usage of Basic Linux commands.
2. C Programming using Simple I/O Statements, operators and expressions.
3. C Programming using decision making and looping.
4. Simple programming for one dimensional and two dimensional arrays.
5. Solving problems using Strings.
6. C Programming using user defined functions (Pass by value and Pass by reference).
7. C Programming using Recursion.
8. C Programming using Pointers and Array of Pointers.
9. C Programming using structures and union.

10. C Programming using storage classes.
11. C Programming using Files.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

- Develop efficient algorithms for solving a problem.
- Develop simple applications using various operators in C.
- Design and Implement applications using Array and Strings.
- Develop applications using Functions and Pointers.
- Design and Develop applications using Structures and Files.

TEXT BOOKS

1. Paul J. Deitel, Harvey M. Deitel, “C: How to Program”, 9th Edition, Prentice Hall.
2. Reema Thareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
3. E. Balaguruswamy, “Programming in ANSI C”, 8th Edition, 2019, McGraw Hill Education.
4. Yashavant P. Kanetkar. “Let Us C”, BPB Publications, 16th edition 2017.

REFERENCE BOOKS

1. Pradip Dey, Manas Ghosh, “Programming in C”, 2nd Edition, 2018, Oxford University Press, ISBN: 978-01-9949-147-6.
2. Kernighan B.W and Dennis M. Ritchie, “The C Programming Language”, 2nd Edition, 2015, Pearson Education India, ISBN: 978-93-3254-944-9.
3. Jacqueline A Jones and Keith Harrow, “Problem Solving with C”, Pearson Education. ISBN: 978-93-325-3800-9.
4. Pradip Dey, Manas Ghosh, “Programming in C - As per the latest AICTE syllabus”, First Edition, Oxford University Press, 2018.
5. Byron S Gottfried, “Programming with C”, Schaum’s Outlines, Third Edition, McGraw-Hill, 2010.

WEBSITE REFERENCES

1. <http://elearning.vtu.ac.in/econtent/courses/video/BS/14CPL16.html>
2. <https://nptel.ac.in/courses/106/105/106105171/>
3. <https://www.w3resource.com/c-programming-exercises/>
4. <https://www.programiz.com/c-programming/c-structures-pointers>
5. <https://www.sitesbay.com/cprogramming/c-applications>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	2	-	-	3	2	2	-	2	-	-
CO2	3	3	3	3	-	-	3	3	3	-	3	-	-
CO3	3	3	3	3	-	-	3	3	3	-	3	-	-
CO4	3	3	3	3	-	-	3	3	3	-	3	-	-
CO5	3	3	3	3	-	-	3	3	3	-	3	-	-
AVG	2.8	2.8	2.8	2.8	-	-	3	2.8	2.8	-	2.8	-	-

JGE2102	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

COURSE OUTCOMES:

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

- Understand the evolution of Tamil language, classical literature, and contributions of major Tamil scholars.
- Appreciate Tamil art and architecture from rock art to modern sculpture and traditional crafts.
- Explore Tamil folk and martial arts and their cultural significance.
- Explain the Thinaï concept, socio-cultural life, trade, and education of the Sangam Age.
- Evaluate Tamil contributions to Indian freedom, culture, medicine, and print heritage.

TEXT BOOKS:

1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL — (in print)
2. Social Life of the Tamils - The Classical Period (Dr.S.SingaraveIu) (Published by: International Institute of Tamil Studies.
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Publish by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M.VaIarmathi) (Published by:International Institute of Tamil Studies.)
5. Keeladi - ‘Sangam City C ivilization on the banks of river Vaigai’ (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) — Reference Book.

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	-	-	-	3	3	2	2	-	2	-	-
CO2	2	2	-	-	-	3	3	2	2	-	2	-	-
CO3	2	2	-	-	-	3	3	3	2	-	2	-	-
CO4	2	2	-	-	-	3	3	3	3	-	2	-	-
CO5	2	2	-	-	-	3	3	3	3	-	3	-	-
AVG	2	2	-	-	-	3	3	2.6	2.4	-	2.2	-	-

JPC2111	ENGINEERING PHYSICS AND CHEMISTRY LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES:

To provide students the firsthand experience of verifying various concepts learnt in theory courses.

LIST OF EXPERIMENTS

1. Determination of Young's Modulus for the given Uniform bar by Uniform Bending method
2. Determination of Moment of Inertia of the given Circular disc and Rigidity Modulus of thin metal wire using Torsional Pendulum
3. Determination of Planck's constant using different color filters
4. Determine the Wavelength of Mercury Spectrum using Spectrometer.
5. Determine the Thermal conductivity of a Bad conductor using Lee's Disc
6. Determination of Wavelength of the Diode Laser and hence determine the Size of the coated powder particle
7. Estimation of Alkalinity of Water Sample.
8. Estimation of Total, Temporary and Permanent Hardness of Water by EDTA method.
9. Determination of Molecular Weight of a Polymer by Viscosity Average method
10. Estimation of Amount of an Acid by Conductometric Titration
11. Estimation of Ferrous ions by Potentiometric Titration
12. Estimation of Amount of Hydrochloric Acid using pH Meter.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able

1. To evaluate elasticity of a linear body.
2. To discriminate different wavelengths of optical spectrum and the behavior of particles and waves at the atomic scale.
3. To identify the materials which are utilized for thermal insulation.
4. To estimate and analyse the amount of hardness and alkalinity in water for domestic consumption.
5. To apply the principles of conductivity and viscosity of substances in aqueous solutions for quantitative analysis using analytical instruments.

REFERENCES:

1. D. Bailey and E. Wright, Practical Fiber Optics, 2003.
2. Jerrad H.G. and Mc Neil D.B. Theoretical and Experimental Physics.
3. Fretter W.B. Introduction to Experimental Physics.
4. J. Mendham, RC Denney, JD Barnes, MJK Thomas, Text book of quantitative chemical analysis, Vogel's, 2008.

WEBSITE REFERENCES

1. <https://www.jhotpotinfo.com/2020/02/determination-of-youngs-modulus-of-bar.html>
2. <https://vlab.amrita.edu/index.php?sub=1&brch=280&sim=1518&cnt=1>
3. <https://vlab.amrita.edu/?sub=1&brch=281&sim=851&cnt=2>
4. http://sites.iiserpune.ac.in/~bhasbapat/phy221_files/Lee%27s%20Method.pdf
5. [https://edisciplinas.usp.br/pluginfile.php/4212400/mod_resource/content/0/Dunniv ant%2021.pdf](https://edisciplinas.usp.br/pluginfile.php/4212400/mod_resource/content/0/Dunniv%20ant%2021.pdf)

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	2	1	1	-	2	1	-	1	-	-
CO2	1	1	1	2	1	1	-	2	1	-	1	-	-
CO3	1	1	1	2	1	1	-	2	1	-	1	-	-
CO4	1	1	1	2	1	1	-	2	1	-	1	-	-
CO5	1	1	1	2	1	1	-	2	1	-	1	-	-
AVG	1	1	1	2	1	1	-	2	1	-	1	-	-

JGE2111	BASIC ENGINEERING LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES

- To provide an exposure to students with hands-on experience on various basic engineering practices in Civil, Mechanical Engineering
- To impart knowledge on creativity, ideation and realize the importance of team working
- To gain knowledge through experience in handling of engineering aggregates.
- To appreciate the use of various mechanisms involved in engineering products like vehicles.
- To provide exposure to the students with hands-on experience on various basic engineering practices in Electrical and Electronics Engineering
- To kindle your own creativity, ideation and realize the importance of team working.
- To gain knowledge through experience in handling of engineering aggregates.

GROUP A

I CIVIL ENGINEERING PRACTICE BUILDINGS:

(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

PLUMBING WORKS:

- Study of pipe line joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
- Hands-on-exercise: Basic pipe connections - Mixed pipe material connection Pipe connections with different joining components.

II MECHANICAL ENGINEERING PRACTICE WELDING AND DRILLING

- Preparation of butt joints, lap joints and T-joints by Shielded metal arc welding.
- Drilling Practice

TWO WHEELER DISMANTLING AND DIAGNOSIS

- Brake Adjustment and Replacing
- Chain Adjustment and lubrication
- Air Filter and Spark plug Cleaning
- Engine oil Replacement and Carburetor Tuning

STUDY AND DEMONSTRATION ON:

- Study of Lathe Machine, tools and components, Safety aspects
- Study of Sheet Metal work, tools and components, Safety aspects

GROUP B

I ELECTRICAL ENGINEERING PRACTICE

8

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Staircase wiring
4. Measurement of electrical quantities -voltage, current, power & powerfactor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of electrical equipment.

II ELECTRONICS ENGINEERING PRACTICE

7

1. Study of Electronic components and equipment's - Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CRO.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

COURSE OUTCOMES:

At the end of the course, students will be able

- To fabricate carpentry components and pipe connections including plumbing works.
- To weld various joints in steel plates using arc welding work.
- To understand various mechanism involved in automobiles.
- To illustrate on lathe machine and sheet metal work.
- Carry out basic home electrical works and appliances.
- Measure the electrical quantities.
- Elaborate on the components, gates, soldering practices.

WEBSITE REFERENCE:

1. <https://nptel.ac.in/courses/107106088>
2. www.vikaspublishing.com/engineering-practices-lab
3. <https://archive.org/mechanicalengineeringworkshoplaboratory>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	1	-	-	-	-	-	1	-	2
CO2	1	1	1	1	1	-	-	-	-	-	2	-	2
CO3	1	1	1	1	1	-	-	-	-	-	1	-	1
CO4	1	1	1	1	1	-	-	-	-	-	1	-	2
CO5	1	1	1	1	1	-	-	-	-	-	-	-	2
AVG	1	1	1	1	1	-	-	-	-	-	1.25	-`	1.8

SEMESTER 2

JHS2221	ENGLISH FOR SCIENCE AND TECHNOLOGY	L	T	P	C
		2	0	2	3

Course Objectives:

- To enable the students of Engineering to comprehend technical texts
- To improve their technical writing skill for better transmission of messages
- To help them acquire language skills required in academic and workplace contexts
- To facilitate them to hone their skills to prepare effective reports
- To equip them with effective communicative skills to meet their future needs

UNIT I Communicating Technical Information

12

Definitions – Conditional clauses – Technical vocabulary; Comprehension of short technical passage and note-making

Language Practice

Reading: Short technical texts / excerpts; **Speaking:** Interviewing on social or global issues; **Listening:** Talks on science, engineering, medicine / interviews of achievers; **Writing:** Sentence Completion, gap filling, verbal aptitude: sentence correction

UNIT II Graphical Analysis and Interpretation

12

Purpose statements – Numerical adjectives – Collocation; Process Description - Interpretation of Graphs and Charts

Language Practice

Reading: Emails, invitations; **Speaking:** Describing charts and tables; **Listening:** Process descriptions; **Writing:** Paraphrasing – Developing outlines

UNIT III Persuasive Writing and Information Dissemination

12

Cause and effect – Voice (active, personal and impersonal passive) – Words used as nouns and verbs; Instructions – Recommendations

Language Practice

Reading: User manuals, gadget reviews; **Speaking:** Presentation on social / technical topics; **Listening:** Announcements, instructions; **Writing:** Instructions – Recommendations

UNIT IV Report Writing and Group Interaction

12

Determiners – Editing - Initialisms and acronyms; Report writing: survey, accident – Minutes of meeting

Language Practice

Reading: Notices, reviews; **Speaking:** Group discussions (technical topics) and debates; **Listening:** IELTS and TOEFL; **Writing:** Writing profiles of personalities and industries

UNIT V Career and Business Communication

12

Adverbials – Misspelt words – Formal and informal English; Letter writing – Job application and resume by mail and email – Inviting and sending quotations and placing orders

Language Practice

Reading: Email invitations to job interviews; **Speaking:** About future / career; **Listening:** Talks by entrepreneurs; **Writing:** Career objective, short-term and long-term goals, tagline

TOTAL: 60 PERIODS

Course Outcomes:

At the end of the course, students will be able

- To read and understand different types of technical texts
- To write procedural texts logically and sequentially in English
- To communicate effectively in academic and professional contexts
- To prepare effective reports and participate in group activities
- To use language precisely and accurately in business relations

Text Books:

1. Department of English, Anna University, Fluency in English, Orient Black Swan Private Limited, Chennai, 2018.
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering, Orient Black Swan Private Limited, Chennai, 2011.
3. Interact English: Lab Manual for Undergraduate Students, Orient Black Swan Private Limited. Chennai, 2017.

Reference Books:

1. Chellammal, V. Learning to Communicate, Allied Publishing House, New Delhi, 2004.
2. Raman, Meenakshi & Sangeetha Sharma, Technical Communication: Principles and Practices, Oxford University Press, New Delhi, 2015.
3. Regional Institute of English. English for Engineers, Cambridge University Press, New Delhi, 2008.
4. Rizvi M, Ashraf. Effective Technical Communication, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2017.

Web Links:

1. www.esl-lab.com
2. www.englishgrammar.org
3. www.englishclub.com
4. www.usingenglish.com
5. www.esl.about.com
6. www.bbc.co.uk/learningenglish/
7. <https://esl-bits.net/>
8. <https://elt.oup.com/>
9. <https://learnenglish.britishcouncil.org>
10. <https://quizizz.com/>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	1	-	1	1	1	3	-	1	-	-
CO2	-	-	-	1	-	1	1	1	3	-	1	-	-
CO3	-	-	-	1	-	1	1	1	3	-	1	-	-
CO4	-	-	-	1	-	1	1	1	3	-	1	-	-
CO5	-	-	-	1	-	1	1	1	3	-	1	-	-
AVG	-	-	-	1	-	1	1	1	3	-	1	-	-

JMA2201	STATISTICS FOR ENGINEERS	L	T	P	C
		2	2	0	3

COURSE OBJECTIVES:

- To provide basic concepts of discrete, continuous random variables and moments.
- To acquaint students in the concepts and problems of standard distributions.
- To familiarize students in problems of correlation and regression.
- To provide students knowledge of testing of hypothesis and its applications.
- To introduce Design of Experiments for practical problem solving.

UNIT I RANDOM VARIABLES 12

Discrete and continuous random variables – Moments – Moment generating functions.

UNIT II STANDARD DISTRIBUTIONS 12

Discrete distributions: Binomial distribution – Poisson distribution – Geometric distribution.
Continuous distributions: Uniform distribution – Exponential distribution – Normal distribution.

UNIT III STATISTICAL CORRELATION AND REGRESSION 12

Correlation coefficient – Rank correlation – Correlation for bivariate data – Regression coefficients – Lines of regression.

UNIT IV TESTING OF HYPOTHESIS 12

Normal tests for mean and difference of means – t tests for mean and difference of means – Chi-square test for goodness of fit – Chi-square test for independence of attributes.

UNIT V DESIGN OF EXPERIMENTS 12

ANOVA classification – Completely Randomized Design – Randomized Block Design – Latin Square Design.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able

- To solve problems of discrete and continuous type random variables for finding mean and variance.
- To apply standard probability distributions in solving real time problems.
- To solve correlation problems and to use regression analysis for predicting values of variables.
- To apply hypothesis testing for making statistical inferences in large and small sample real life problems.
- To compare and contrast various design of experiments methods and use them in problems.

TEXT BOOKS:

1. Gupta S C and Kapoor V K, “Fundamentals of Mathematical Statistics”, Sultan Chand and Sons, 12th Edition, 2020.
2. Ibe O C, "Fundamentals of Applied Probability and Random Processes", Elsevier, 2nd Edition, 2014.
3. Johnson R A, “Miller & Freund’s Probability and Statistics for Engineers”, Pearson Education, Asia, 9th Edition, 2018.

REFERENCES:

1. Hwei Hsu, "Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, NewDelhi, 3rd Edition 2014.
2. Trivedi K S, "Probability and Statistics with Reliability, Queueing and Computer Science Applications", John Wiley and Sons, 2nd Edition, 2016.

WEB REFERENCES:

1. <https://nptel.ac.in/courses/117105085>
2. <https://nptel.ac.in/courses/111105041>
3. <https://nptel.ac.in/courses/102101056>
4. <https://nptel.ac.in/courses/102106051>

CO-PO & PSO MAPPING

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

JPH2201	ENGINEERING PHYSICS 2	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enlighten the students on the principles of semiconductor materials and Electron transport properties
- To acquaint them with the applications of magnetic materials To impart knowledge on superconducting materials
- To help them acquire a basic understanding of dielectric materials To introduce the basic principles in nano electronic devices

UNIT I SEMICONDUCTING MATERIALS

9

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Hall Effect- Hall Coefficient in N-type and P-type semiconductors.

UNIT II MAGNETIC MATERIALS

9

Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism Domain theory – Hysteresis – Soft and Hard magnetic materials– Ferrites and its applications – Memory devices-ROMs and RAMs(R/W)

UNIT III SUPERCONDUCTING MATERIALS

9

Properties of Superconductors – Josephson junction - Type I and Type II superconductors – BCS theory of superconductivity (Qualitative) – High T_c superconductors - Applications – SQUIDS. Cryotron and Maglev train.

UNIT IV DIELECTRIC MATERIALS

9

Polarization mechanisms in dielectrics– dielectric loss – internal field – Clausius- Mosotti relation- dielectric loss and dielectric breakdown – high-k dielectrics – Types of dielectrics – Applications in transformers and capacitors.

UNIT V NANOELECTRONIC MATERIALS

9

Size dependence of Fermi energy– quantum confinement – quantum structures - Density of states in quantum well, quantum wire and quantum dot structures - Single electron phenomena and Single Electron Transistor.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able

- To be familiar with the functioning of semiconductors
- To assess the magnetic properties of materials
- To make use of superconductors in real life situations
- To understand the nuances of advanced solid state physics
- To recognize the uses of Nano electronic materials

TEXT BOOKS:

1. Dr.P.Mani, "Engineering Physics – II", Dhanam Publications, First Edition, 2019.
2. Dr.G.Senthil Kumar "Engineering Physics – II", VRB Publications, Revised Edition 2018.
3. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012.
4. S.O.Pillai, "Solid State Physics", New Age International Publications, Revised Edition.
5. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2015.
6. Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012.

REFERENCES:

1. R. Murugesan, "Modern Physics", Sultan chand & sons, 2021.
2. Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2020.
3. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2017.
4. Tipler, P.A. & Mosca, G. "Physics for Scientists and Engineers with Modern Physics".
5. William F Smith, "Material Science and Engineering", Tata McGraw -Hill Publications, 4th Edition.

WEBSITE REFERENCES:

1. <https://archive.nptel.ac.in/courses/108/108/108108122/>
2. <https://archive.nptel.ac.in/courses/115/103/115103038/>
3. <https://archive.nptel.ac.in/courses/115/103/115103108/>
4. https://www.brainkart.com/article/Dielectric-Materials_6827/
5. <https://archive.nptel.ac.in/courses/117/108/117108047/>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	1	-	1	-	-	1	-	-
CO2	3	2	1	-	-	2	-	-	-	-	1	-	-
CO3	3	2	1	-	-	-	-	-	-	-	1	-	-
CO4	3	2	1	-	-	-	-	-	-	-	1	-	-
CO5	3	2	1	-	-	1	-	-	-	-	1	-	-
AVG	3	2	1	-	-	1.33	-	1	-	-	1	-	-

JGE2221	ENGINEERING GRAPHICS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES

- To acquaint students with the importance of graphics in engineering
- To develop their skills in the preparation of basic drawing
- To improve their technical communication skill in the form of communicative drawing
- To impart knowledge about standard principle of orthographic projection of objects
- To improve their visualization skills for developing new products

UNIT I CONIC SECTIONS AND SPECIAL CURVES

12

Conics - Construction of ellipse, Parabola and hyperbola by eccentricity method, Rectangle method- Drawing of tangents and normal to the above curves.

Special curves: Cycloid-Involute-Drawing of tangents and normal to the curves.

UNIT II PROJECTION PLANE SURFACES AND ORTHOGRAPHIC PROJECTIONS

12

Introduction to Points, Lines (Only theory not for Exam Practice) – Projection of Plane Surfaces- Projection of polygonal surface and circular lamina inclined to both reference planes. Representation of Three Dimensional objects - General principles of orthographic projection– Need for importance of multiple views and their placement - First angle projection - layout views - Developing visualization skills through free hand sketching of multiple views from pictorial views of objects.

UNIT III PROJECTION OF SOLIDS

12

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

UNIT IV DEVELOPMENT OF SURFACES

12

Introduction to Section of Solids (Only theory not for Exam Practice), Development of lateral surfaces of simple and truncated solids - Prisms, pyramids, cylinders and cones.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS

12

Principles of isometric projection – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones. Conversion of orthographic views into Isometric Drawing (Simple Objects) - Perspective projection of prisms and pyramids by visual ray method.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- To be familiar with the fundamental and standards of engineering graphics.
- To perform free hand sketching of basic geometrical constructions and multiple views of object.
- To project orthographic projections of lines and plane surfaces.
- To draw projection of solids and development of surfaces.
- To interpret isometric and perspective view of objects.

JEC2201	ELECTRONIC DEVICES AND CIRCUIT ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To help students understand the basic methods to analyze circuits and concepts of network theorems
- To acquaint the students with in-depth knowledge of the characteristics of electronic diodes.
- To familiarize the working, characteristics and applications of BJT
- To make students understand the characteristics and different operating modes of FET, MOSFET.
- To familiarize students with working of special electronic devices such as UJT, Tunnel diode and power devices such as SCR, TRIAC etc.

UNIT I - CIRCUIT ANALYSIS FUNDAMENTALS

9

Passive and Active elements, Source transformation rules, Star-Delta conversion, Kirchhoff's laws, Mesh Analysis and Nodal Analysis, Quantitative Analysis of Network Theorems - Thevenin's and Norton Theorems, Super position Theorem, Maximum power transfer theorem, Fundamental of Resonance circuits, Basics of coupled circuits.

UNIT II - DIODE AND APPLICATIONS

9

PN junction diode – Biasing, energy band diagram, V-I Characteristics, Drift and Diffusion currents, Space charge width, Capacitances associated with PN junction diode, Varactor diode, Breakdown diodes – Zener and Avalanche mechanism, Zener diode as regulator, Design of power supply, Clipper and Clamper.

UNIT III - BIPOLAR JUNCTION TRANSISTOR

9

Types, current components. CB, CE, CC configurations – current gain and relations, input and output characteristics, h-parameter model of BJT, Quantitative analysis of current gain, voltage gain, input impedance and output admittance of transistor configurations, Applications- BJT as transistors.

UNIT IV - FIELD EFFECT TRANSISTORS

9

Classifications of FET, JFETs – Types, construction and operation, Channel length modulation, characteristics. JFET parameters, Quantitative measure of drain current and Pinch off voltage, MOSFET- Characteristics of MOSFET, JFET Vs MOSFET, MOSFET as switch.

UNIT V - SPECIAL SEMICONDUCTOR DEVICES & POWER DEVICES

9

Unijunction Transistor and applications, Thyristor - Schottky barrier diode, SCR, TRIAC, DIAC, Applications- Tunnel diode, Photo diode, Phototransistor, Opto Coupler, Photo Voltaic Cells, CCD, Case study on Solar energy.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Apply and analyze circuits using network theorems
- Explain the characteristics of semiconductor diodes
- Explain the working, characteristics and applications of BJT
- Explain the characteristics of FET, MOSFET
- Comprehend the characteristics of various electronic components and power devices

TEXTBOOKS:

1. Jacob Millman, Christos C. Halkias and Satyabrata Jit, Millmans Electronic Devices and Circuits, Fourth edition, McGraw Hill, 2015
2. William H. Hayt, Jack Kemmerly and Steven M. Durbin, Engineering Circuit Analysis, McGraw Hill, 2013.

REFERENCES:

1. Albert Paul Malvino, "Electronic Principles", 7th Edition, Mcgraw Hill Publication, 2017
2. Salivahanan. S and Suresh Kumar S. N, Electronic Devices and circuit, Fourth Edition, Tata McGraw- Hill, 2016.
3. R. S. Sedha, A Textbook of Electronic Devices and Circuits, Second Edition, S.Chand Publishing, 2008.
4. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", McGraw Hill, 2015.

WEBSITE REFERENCES:

- 1 <https://archive.nptel.ac.in/courses/108/105/108105112/>
- 2 <https://nptel.ac.in/courses/108/102/108102042/>
- 3 <https://nptel.ac.in/courses/117/103/117103063/>
- 4 <https://archive.nptel.ac.in/courses/117/107/117107095/>
- 5 <https://www.elprocus.com/semiconductor-devices-types-and-applications/>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1	2	-	-	-	3	3	2	3
CO2	3	3	3	3	2	2	-	-	-	3	3	2	2
CO3	3	3	3	3	2	1	-	-	-	3	3	2	3
CO4	3	3	3	3	2	2	-	-	-	2	3	2	3
CO5	3	3	3	3	2	2	-	-	-	3	3	3	3
AVG	3	3	3	3	1.8	1.8	-	-	-	2.8	3	2.2	2.8

JCY2201	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY	L	T	P	C
		3	0	0	2

COURSE OBJECTIVES:

- To study the inter-relationship between living organisms and environment.
- To learn causes, effects and preventive methods of environmental pollution.
- To import knowledge on the needs of renewable and new energy sources.
- To acquire broad knowledge on sustainable development and its values on society.
- To expertise sustainability practices of sustainable habitat, sustainable energy and green engineering.

UNIT I ENVIRONMENT AND BIODIVERSITY

6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow–ecological succession. Biodiversity – Types and values. India as mega-diversity nation–hot-spots of biodiversity – endangered and endemic species of India – threats to biodiversity –conservation of biodiversity – In-situ and ex-situ – Field visit

UNIT II ENVIRONMENTAL POLLUTION

6

Causes, Effects and preventive measures of water, air, soil and thermal pollution. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHSMS). Environmental protection acts – Field visit

UNIT III RENEWABLE SOURCES OF ENERGY

6

Energy management and conservation – Need of new energy sources- Applications of- Hydrogen energy – Ocean energy resources – Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABLE DEVELOPMENT

6

Sustainability- concept, needs and challenges- economic and social aspects of sustainability – millennium development goals and protocols- Sustainable Development Goals – targets, indicators and intervention areas. Climate change
- Global, Regional and local environmental issues and possible solutions – case studies. Concept of carbon credit and carbon footprint.

UNIT V SUSTAINABILITY PRACTICES

6

Zero waste and 3R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency and sustainable transports. Sustainable energy: Energy Cycles – carbon cycle, emission and sequestration. Green Engineering: Sustainable urbanization – Socio-economic and technological change.

TOTAL: 30 PERIODS

COURSE OUTCOMES

At the end of course completion, students will be able

- To recognize the function of ecosystem and contribute to conservation of biodiversity.
- To identify the causes and effects of environmental pollution and practice the preventive measures.
- To recognize various types of new renewable sources of energy and their potential applications.
- To apply the sustainable development goals for technological advancement and societal development.
- To adopt sustainability practices for energy efficiency and sustainable urbanization.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers, 2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Sanjay K Sharma, Green Corrosion Chemistry and Engineering: Opportunities and challenges, Wiley-VCH Verlag GmbH & Co., Germany (2011).
4. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

REFERENCES:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. Edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

Website references:

1. <https://www.hzu.edu.in/bed/E%20V%20S.pdf>
2. <https://catalogimages.wiley.com/images/db/pdf/9781119582052.excerpt.pdf>
3. <https://ncert.nic.in/textbook/pdf/keec109.pdf>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	2	-	-	3	2	-	1	-	1	-	-
CO2	1	1	1	-	-	3	3	-	1	-	1	-	-
CO3	1	1	2	-	-	3	2	-	1	-	1	-	-
CO4	1	1	2	-	-	3	3	-	1	-	1	-	-
CO5	1	1	1	-	-	3	3	-	1	-	1	-	-
AVG	1	1	1.6	-	-	3	2.6	-	1	-	1	-	-

JGE2202	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 beads - Archeological evidences - Gem stone types described in Silappathikaram

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

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

COURSE OUTCOMES

At the end of course completion, students will be able

- Understand the development of weaving and ceramic technologies during the sangam age.
- Analyze ancient Tamil design and construction technologies in temples, monuments, and architecture.
- Explain manufacturing technologies including metallurgy, shipbuilding and bread-making industries.
- Describe agricultural, irrigation, and marine technologies practiced by ancient Tamils.
- Explore the growth of Scientific Tamil, Tamil computing, and digital initiatives for language preservation.

TEXT BOOKS:

1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL (in print)
2. Social Life of the Tamils - The Classical Period (Dr.S.SingaraveIu) (Published by: International Institute of Tamil Studies).
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Publish by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M.VaIarmathi) (Published by :International Institute of Tamil Studies.)
5. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department ofArchaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8. Journey of Civilization Indus to Vaigai (R.BaIakrishnan) (Published by: RMRL) — Reference Book.

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	-	-	2	3	3	2	2	-	2	-	-
CO2	2	2	-	-	2	3	3	3	2	-	2	-	-
CO3	2	2	-	-	2	3	3	3	2	-	2	-	-
CO4	2	2	-	-	2	3	3	3	2	-	2	-	-
CO5	2	2	-	-	3	3	3	3	3	-	3	-	-
AVG	2	2	-	-	2.2	3	3	2.8	2.2	-	2.2	-	-

JPC2211	ENGINEERING PHYSICS AND ENVIRONMENTAL SCIENCE LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

To provide students the first hand experience of verifying various concepts learnt in theory courses.

LIST OF EXPERIMENTS:

1. Determination of Numerical Aperture of the given Fiber and Estimate the Linearity of the Laser Source.
2. Determine the Dispersive power of a given Prism using Spectrometer
3. Determination of Thickness of the given thin Wire by forming Interference fringes using air-wedge setup
4. Analysis of I-V Characterization of Solar cell
5. Determination of Energy gap of the given Semiconductor Diode by plotting the graph between current and temperature.
6. Determination of Young's Modulus for the given bar by Nonuniform Bending method.
7. Determination of Dissolved oxygen by Winkler's method
8. Estimation of amount of chloride in water.
9. Estimation of the amount of mixture of acids in water
10. Estimation of Iron content in water by Spectrophotometric method
11. Estimation of acetic acid adsorbed on charcoal.
12. Determination of per capita energy consumption and carbon footprint.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

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

1. To lucid the effective communication system and to scrutiny the required wavelength.
2. To quantify micro sized linear objects and to ascertain band gap of semiconducting materials.
3. To configure solar power system as close as possible to its maximum peak power point.
4. To quantify the degree of pollution of water samples by measuring water quality parameters.
5. To carry out energy audit and practice energy conservation methods.

REFERENCES:

1. D. Bailey and E. Wright, Practical Fiber Optics, Newnes publications, 2003.
2. Fretter W.B. -Introduction to Experimental Physics UCL Press, 2005
3. Gurdeep R. Chatwal, Sham K. Anand, Instrumental methods of chemical analysis, Himalaya Publishing House, 2007.

WEBSITE REFERENCES:

1. <https://vlab.amrita.edu/?sub=1&brch=281&sim=851&cnt=2>
2. <https://anilpangantiwar.tripod.com/expt10.htm>
3. <https://praxilabs.com/en/3d-simulations/i-v-characteristics-of-solar-cell-i-physics-simulation>
4. <https://vlab.amrita.edu/?sub=2&brch=193&sim=575&cnt=1>
5. <https://jigyasa-csir.in/neeri/n32-t1-a2/>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	1	1	-	2	1	-	1	-	-
CO2	1	1	1	1	1	1	-	2	1	-	1	-	-
CO3	1	1	1	1	1	1	-	2	1	-	1	-	-
CO4	1	1	1	1	1	2	-	2	1	-	1	-	-
CO5	1	1	1	1	1	2	-	2	1	-	1	-	-
AVG	1	1	1	1	1	1.4	-	2	1	-	1	-	-

JEC2211	ELECTRONIC DEVICES AND CIRCUIT ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To verify the characteristics of diodes
- To verify the characteristics of BJT, FET, UJT, SCR
- To demonstrate the use of KVL & KCL
- To verify various Network Theorems in Circuit analysis.
- To demonstrate the frequency response and transient behavior of RL, RC and RLC circuits

LIST OF EXPERIMENTS

1. Demonstrate of characteristics of PN Junction Diode and its application: clipper, clamper and Full Wave Rectifier
2. Investigate and plot the characteristics of Zener diode and its application as voltage regulator
3. Investigate and plot input-output characteristics of BJT in Common Emitter Common Base Configuration
4. Investigate the Characteristics of FET
5. Investigate the Characteristics of UJT
6. Demonstrate the characteristics of SCR
7. Verification of KVL & KCL
8. Verification of Thevenin & Norton theorems
9. Verification of Super Position Theorem
10. Verification of maximum power transfer & reciprocity theorems
11. Determination of resonant frequency of series & parallel RLC Circuits

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Verify the characteristics of diodes
- Verify the characteristics of BJT, FET, UJT, SCR
- Demonstrate the use of KVL & KCL
- Verify various Network Theorems in Circuit analysis.
- Demonstrate the frequency response and transient behavior of RL, RC and RLC circuits

LABORATORY REQUIREMENTS:

1. BC 107, BC 148, 2N2646, BFW10 - 25 each
2. 1N4007, Zener diodes - 25 each
3. Resistors, Capacitors, Inductors - sufficient quantities
4. Bread Boards - 15 Nos
5. CRO (30MHz) – 10 Nos.
6. Function Generators (3MHz) – 10 Nos.
7. Dual Regulated Power Supplies (0 – 30V) – 10 Nos.

WEBSITE REFERENCES:

1. <https://www.youtube.com/watch?v=csxkMy0PYWg>
2. <https://www.youtube.com/watch?v=RPI4AcILfeY>
3. <https://circuitdigest.com/tutorial/rc-rl-and-rlc-circuits>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2	2	-	-	-	2	3	1	2
CO2	3	3	3	3	2	2	-	-	-	2	3	1	3
CO3	3	3	3	3	2	2	-	-	-	2	3	-	2
CO4	3	3	3	3	2	2	-	-	-	2	3	1	2
CO5	3	3	3	3	2	2	-	-	-	2	3	-	3
AVG	3	3	3	3	2	2	-	-	-	2	3	1	2.4

JGE2241	GAMING AND CRAFTS STUDIO	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Understand the fundamental principles of game development and the Unity interface.
- Analyse various game design principles to enhance gameplay experience.
- Evaluate and integrate audio and visual assets to create immersive game environments.
- Create a complete game project that incorporates learned techniques and personalized creative elements.
- Reflect on the game development process and critique peer projects to foster a collaborative learning environment.

Module 1: The World of Game Development and Gaming Fundamentals

- Introduction to Game Development & Unity
- Understanding the core elements of gameplay, such as mechanics, dynamics, and aesthetics.
- Interactive tutorial on Unity, exploring the interface and project setup.
- Navigate Unity and set up a basic project.

Module 2: Game Design Principles, Visual and Audio Design

- Game Design Principles & Basic Scripting - implementing basic game mechanics.
- implement simple player controls and game mechanics using C#.
- create responsive player controls using various input methods.
- Player Control and Game Technologies - Hands-on scripting for player controls.

Module 3: Game Mechanics, Technology, and Development

- Creating Game Assets- modelling and texturing basic game assets.
- Physics and Interactions - Practical exercises adding physics and collisions to objects.
- UI & Menus - UI development sessions for creating intuitive game menus.
- Audio and Visual Effects - Implementing background music and particle effects.

Module 4: Critical Analysis, Feedback, and Ethical Considerations

- Coding challenges to implement state machines and level progression.
- Testing and Debugging
- Debugging tools and techniques,
- Refine gameplay and fix issues, Optimisation

Module 5: Game Project & Presentation

- Students will work in groups of 4-5 to design and develop a functional video game prototype.
- The game should incorporate concepts and mechanics from at least two different genres.
- A GDD (Game Design Document) will be required as part of this project.
- Students will present their game prototype and GDD to the class and receive feedback from peers and instructors.

Course Outcome:**At the end of the course, the student should be able to:**

- navigate Unity and set up a basic project, implement simple player controls and game mechanics using C#.
- create responsive player controls using various input methods and import custom assets into Unity.
- Integrate Unity's Physics engine into their game projects and develop functional game menus and UI elements.
- enhance their games with audio cues and visual effects.
- use advanced scripting to manage game states and progression and perform debugging to refine gameplay and fix issues.

WEBSITE REFERENCES:

1. <https://www.youtube.com/watch?v=XtQMytORBmM>
2. <https://www.youtube.com/watch?v=AmGSEH7QcDg>
3. <https://www.youtube.com/watch?v=AmGSEH7QcDg>
4. <https://www.youtube.com/watch?v=HAvfA1F3qTo>
5. <https://www.youtube.com/playlist?list=PLfhhBaEcybmg-WnFoWDxgSIatmrzBRWSQ>
6. <https://www.youtube.com/watch?v=ldP0c2o1FJI>
7. <https://www.youtube.com/watch?v=ldP0c2o1FJI>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	1	3	1	1	2	2	1	2	-	-
CO2	3	2	3	2	3	1	1	2	2	1	2	-	-
CO3	3	2	3	2	3	2	1	2	2	1	2	-	-
CO4	3	2	3	2	3	2	1	2	2	1	2	-	-
CO5	3	3	3	3	3	1	1	2	2	1	3	-	-
AVG	3	2.2	3	2	3	1.4	1	2	2	1	2.2	-	-

SEMESTER 3

JMA2301	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		2	2	0	3

COURSE OBJECTIVES:

- To explain various methods of solving partial differential equations.
- To enable students understand Fourier series expansions and Harmonic analysis.
- To demonstrate use of Fourier series in solving standard partial differential equations occurring in boundary value problems.
- To conceptualize Fourier transforms and its properties.
- To outline the applications of Z-transform in solving difference equations.

UNIT I - PARTIAL DIFFERENTIAL EQUATIONS

9+3

Formation of partial differential equations (PDEs) – Solutions of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types

UNIT II - FOURIER SERIES

9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic analysis

UNIT III - FOURIER SERIES SOLUTION OF PDEs

9+3

Classification of PDEs – Fourier series solutions – one-dimensional wave equation and heat conduction equation – Steady state two-dimensional equation of heat conduction

UNIT IV - FOURIER TRANSFORMS

9+3

Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity

UNIT V - Z-TRANSFORMS AND DIFFERENCE EQUATIONS

9+3

Z-transforms – Elementary properties – Initial and final value theorems – Convolution theorem – Inverse Z-transform (using partial fraction and convolution theorem) – Formation of difference equations – Solution of difference equations using Z-transform

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Evaluate singular and general solution of standard partial differential equations.
- Deduce Fourier series expansions analytically and numerically.
- Apply Fourier series in solving partial differential equations occurring in boundary value problems.
- Find Fourier transforms by efficient use of properties.
- Apply Z-transforms in solving difference equations.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2021.
2. Kreyszig Erwin., "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.

REFERENCES:

1. Bali. N.P and Manish Goyal., "A Textbook of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd, 2016.
2. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.

WEB REFERENCES:

- <https://nptel.ac.in/courses/111106046/>
- <https://nptel.ac.in/courses/111102129/>
- <https://nptel.ac.in/courses/111101153/>
- <https://nptel.ac.in/courses/111105093/>

CO-PO & PSO MAPPING

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	3	-	-	2	-	-	1	2	1
CO2	3	2	1	2	3	-	-	2	-	-	1	2	1
CO3	3	2	1	2	3	-	-	2	-	-	1	2	2
CO4	3	2	1	2	3	-	-	2	-	-	1	2	2
CO5	3	2	1	2	3	-	-	2	-	-	1	2	2
AVG	3	2	1	2	3	-	-	2	-	-	1	2	1.6

JBM2321	BIOSCIENCES	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To familiarize the students with major biomolecules namely carbohydrates, lipids, proteins and nucleic acids
- To explain the fundamentals of cellular metabolism of carbohydrates, lipids, amino acids, and enzymes.
- To describe the concept of Biochemical analysing instruments, chemicals and normal ranges of biochemical components in our body.
- To explain the theoretical basis of the tools, technologies and methods common to general microbiology
- To synthesize the pathogenesis of diseases, effective treatment and mechanisms of health maintenance to prevent diseases.

UNIT I - BIOMOLECULES

9

Biomolecules present in living cells. Properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids, Amino acid and nucleotide sequences of proteins and DNA.

UNIT II – METABOLISM

9

Importance of lipids as storage molecules and as structural component of biomembranes. Importance of high energy compounds, electron transport chain, synthesis of ATP under aerobic and anaerobic conditions. Role of TCA cycle in central carbon metabolism, metabolic engineering for the production of useful biomolecules.

UNIT III - CLINICAL BIOCHEMISTRY

9

Constituents of urine, blood and their significance, liver and kidney metabolic disorders, mechanism of Cancer, Triglycerides and lipoproteins and their relationship with various diseases, Role of enzymes in diagnosis of various diseases.

UNIT IV - MICROBIOLOGY

9

Structure of bacteria and virus, Routes of infection and spread, culture media and its types, culture techniques, Identification and Observation of bacteria, Morphological, biochemical and cultural characteristics.

UNIT V - IMMUNOLOGY

9

Immune system, Structure and functions of immunoglobulin, the genetic basis of antibody diversity, types of hypersensitivity, conventional vs. recombinant vaccines. Antigen-antibody interaction in disease diagnosis, Principles of tolerance, Autoimmunity.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS

- Urine physical and chemical examination
- Estimation of blood glucose
- Estimation of creatinine
- Estimation of urea
- IMViC test for identification of bacteria
- Estimation of Hemoglobin
- Blood Grouping

TOTAL: 30 PERIODS

TOTAL: 75 HOURS

LAB Requirements for a Batch of 30 students:

- Optical Microscope
- Refrigerator
- Hemoglobinometer
- Blood grouping kit
- Colorimetry
- Spectrophotometer
- Centrifuge
- Microslides
- lancets

WEB REFERENCES:

- <https://www.youtube.com/watch?v=Ng1s2wsGeJQ>
- https://www.youtube.com/watch?v=aJrWP_cmNpw
- <https://www.youtube.com/watch?v=a4dPeLtIEKg>

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Acquire an insight into various biomolecules which constitute the living organisms
- Analyse the metabolic pathways of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins, glycolipids and their importance in biological systems
- Discuss the fundamental biochemistry knowledge related to health.
- Implement biochemical principles to understand the molecular basis of various diseases and disorders.
- Interpret the mechanisms of antigen recognition, processing, presentation, and the generation of immune responses.

TEXT BOOKS:

1. J. B. Reece, L. A. Urry, M. L. Cain, S. A. Wasserman, P. V. Minorsky, R. B. Jackson, "Campbell Biology", Benjamin Cummings publishers, 9th edition, 2010. (Unit 1)
2. D. L. Nelson and M. M. Cox, "Lehninger Principles of Biochemistry", W H Freeman & Co; 8th edition, 29 January 2021 (Unit 2 & 3).
3. Subhash Chandra Parija, "Textbook of Microbiology and Immunology", Elsevier, 3rd Edition, 2016. (Unit 4 & 5)

REFERENCES:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, "Molecular Biology of the Cell", Garland Science, 2014.
2. Gerard J. Tortora, Berdell R. Funke, and Christine, "Microbiology: An Introduction", Garland Science, 2018.
3. R. Phillips, J. Kondev and J. Theriot, "Physical Biology of the Cell", Garland science publishers, 1st edition, 2008.

WEB REFERENCES:

- https://onlinecourses.nptel.ac.in/noc22_cy06/preview
- <https://archive.nptel.ac.in/courses/102/105/102105083/>
- https://onlinecourses.nptel.ac.in/noc24_ge36/preview
- https://onlinecourses.nptel.ac.in/noc22_bt17/preview
- https://onlinecourses.nptel.ac.in/noc22_ee77/preview/
- <https://www.coursera.org/courses?query=microbiology>

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	1	1	-	-	-	-	1	2	1
CO2	3	3	-	-	1	1	-	-	-	-	1	2	1
CO3	2	3	-	2	2	2	-	-	-	-	1	3	2
CO4	2	2	-	3	3	1	-	-	-	-	1	3	2
CO5	2	2	-	2	1	3	-	-	-	-	2	2	2
AVG	2.4	2.4	-	2.33	1.6	1.6	-	-	-	-	1.2	2.4	1.6

JEC2321	SIGNALS AND SYSTEMS (INTEGRATED)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the basic representation, properties and classification of signals.
- To understand the use of Fourier and Laplace Transforms in the analysis of continuous time signals.
- To study about the classification of continuous time systems and their analysis using Laplace Transform.
- To understand frequency domain representation of discrete time signals using Discrete time Fourier Transform and Z transform.
- To study about the classification of Discrete time systems and their analysis using Z transform.

UNIT - I CLASSIFICATION OF SIGNALS

9

Introduction to signals and systems -Analog signals, Generation of DT signals, Standard CT and DT signals - Classification of CT and DT signals- Periodic & Aperiodic, Deterministic & Random, Energy & Power, Basic Operation on signals.

UNIT - II FREQUENCY DOMAIN ANALYSIS OF CONTINUOUS TIME SIGNALS

9

Fourier series of Periodic signals -Trigonometric representation, Fourier Transform of CT signals, Laplace Transform of CT signals

UNIT - III CLASSIFICATION AND ANALYSIS OF CONTINUOUS TIME SYSTEMS

9

Properties of CT systems- Linearity, Time in-variance, Causality, Stability, LTI System–Impulse response, Convolution Integral & Differential Equation representation, Laplace transform Analysis of LTI systems.

UNIT – IV FREQUENCY DOMAIN ANALYSIS OF DISCRETE TIME SIGNALS

9

Introduction to Sampling theorem - Nyquist sampling rate, Fourier Transform of discrete time signals (DTFT), Z Transform of DT signals - ROC & Properties

UNIT - V CLASSIFICATION AND ANALYSIS OF DISCRETE TIME SYSTEMS

9

Properties of DT systems- Linearity, Time in-variance, Causality, Stability, Recursiveness, LTI System–Impulse response, Convolution sum & Difference equation representation, Z Transform Analysis of LTI systems.

TOTAL: 30 PERIODS

LIST OF EXPERIMENTS:

- Introduction to MATLAB
- Generation of signals
- Basic operations on signals
- Linear convolution
- Circular convolution
- Auto and Cross Correlation
- Plotting spectrum of discrete signals using DTFT
- Sampling and effect of aliasing

TOTAL: 30 PERIODS

TOTAL: 60 HOURS

LAB Requirements for a Batch of 30 students (3 students per experiment):

- MATLAB/ EQUIVALENT software package for simulation experiments
- PCs - 15 Nos

WEB REFERENCES:

- <https://www.vlab.co.in/participating-institute-iit-kharagpur>
- <http://vlabs.iitkgp.ernet.in>
- <https://www.iitk.ac.in>

COURSE OUTCOMES:**At the end of the course, the student will be able:**

1. To classify continuous and discrete time signals based on properties.
2. To analyze CT signals in frequency domain using Fourier transform and Laplace transform.
3. To classify CT systems and analyze frequency response using Laplace transform.
4. To analyze DT signals in frequency domain using Discrete Time Fourier transform and Z Transform
5. To classify DT systems and analyze frequency response using Z Transform.

TEXT BOOKS:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", 2nd Edn., Pearson, 2015.
2. P.Ramesh Babu and R.Ananda Natarajan, "Signals and Systems", Scitech 2017

REFERENCES:

1. H. P. Hsu, "Signals and Systems" Schaum's Outline Series, McGraw Hill Professional, 3rd Edition, 2013.
2. A.Anandkumar, "Signals and Systems", 2nd Edn, PHI Learning 2012
3. B. P. Lathi, "Principles of Linear Systems and Signals", Second Edition, Oxford, 2009.
4. R.E.Zeimer, W.H.Tranter and R.D.Fannin, "Signals & Systems - Continuous and Discrete", Pearson, 2007.
5. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.
6. Simon Haykin and Barry Van Veen "Signals and Systems", Wiley & Sons, 3rd Edition, 2012.
7. John G Proakis and Manolakis, "Digital Signal Processing Principles, Algorithms and Applications", Pearson Education, 4th Edition, 2014.

WEB REFERENCES:

- <https://nptel.ac.in/courses>
- https://www.youtube.com/watch?v=7Z3LE5uM-6Y&list=PLbMVogVj5nJQQZbah2uRZIRZ_9kfoqZyx
- [https://www.academia.edu/34693866/Continuous_and_Discrete_Time_Signals and Systems](https://www.academia.edu/34693866/Continuous_and_Discrete_Time_Signals_and_Systems)
- <https://web.stanford.edu/~boyd/ee102/laplace.pdf>
- https://www.youtube.com/watch?v=WXwQ_fb7NEk
- <https://www.youtube.com/watch?v=IanYg7ujpo0>

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	1	1	—	—	—	—	—	1	2	1
CO2	3	3	-	2	1	—	—	—	—	—	1	2	1
CO3	3	3	-	3	2	—	—	—	—	—	1	3	2
CO4	3	3	-	2	2	—	—	—	—	—	1	3	2
CO5	3	3	-	3	2	—	—	—	—	—	2	3	2
AVG	3	2.8	-	2.2	1.6	—	—	—	—	—	1.2	2.6	1.6

JBM2301	HUMAN ANATOMY AND PHYSIOLOGY	<table><tr><td>L</td><td>T</td><td>P</td><td>C</td></tr><tr><td>3</td><td>0</td><td>0</td><td>3</td></tr></table>	L	T	P	C	3	0	0	3
L	T	P	C							
3	0	0	3							

COURSE OBJECTIVES:

- To describe the general structure and functions of all the organelles of cell and Integumentary system as a whole.
- To explain the structures and functions of the musculoskeletal system and sense organs of human physiological system.
- To illustrate the significance of anatomical features and physiology of heart, lymphatic system, respiratory system.
- To describe the structure, physiology, transmission processes, and reflex action of neurons.
- To explain the phenomena and significance of digestion and absorption of nutrition from food.

UNIT I - BASIC ELEMENTS OF HUMAN BODY 9

Cell – Structure and its organelles – Functions of each cell component - Transport across cell Membrane – Homeostasis – Cell Division – Tissue: Types and functions – Integumentary System- Structure of Skin, Hair Follicles and Nail.

UNIT II - SKELETAL AND MUSCULAR SYSTEM 9

Skeletal System: Structure of Bone and its function, Divisions of Skeletal system and functions – Types of Cartilage and function, Structure and Functions of Joints, Types of joint movements and its articulation, Muscular System: Properties and Types of muscles, Sliding filament theory of Muscle Contraction, Neuro Muscular Junction.

UNIT III - CARDIO VASCULAR AND RESPIRATORY SYSTEMS 9

Cardiovascular: Anatomy of Heart, Conduction System of Heart – Cardiac Cycle – Regulation of Heart rate, Blood vessels- Structure and types, Respiratory: Parts of Respiratory Systems – Respiratory Physiology and Regulation, Lung volume and Capacities- Gaseous Exchange.

UNIT IV – NERVOUS AND SPECIAL SENSORY SYSTEM 9

Nervous: Structure and functions of nervous tissue, Types of Neurons – Brain and Spinal cord – Function of CNS – Nerve conduction and synapse – Somatic and Autonomic nervous system – Special Sensory system- Physiology of Vision, Hearing, Integumentary, Olfactory system, Taste Buds.

UNIT V – DIGESTIVE AND EXCRETORY SYSTEMS 9

Digestive System: Organs and Functions of Gastrointestinal system, Urinary System: Structure of Kidney and Nephron – Mechanisms of Urine formation– Regulation of Blood pressure by Urinary System – Micturition reflex.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Demonstrate an understanding of the anatomical and physiological basis of life.
- Explain the anatomy and physiology of the muscular system and the mechanism of muscle contraction.
- Describe the basic structures and functions of the cardiovascular and respiratory systems.
- Discuss the structure, physiology, reflex transmission, and the role of endocrine glands in physiological processes.
- Explain the major structures involved in digestion and nutrient absorption, and describe the mechanism of urine formation by the urinary system.

TEXT BOOKS:

1. Guyton & Hall, "Medical Physiology", 13th Edition, Elsevier Saunders, 2015.
2. Prabhjot Kaur, "Text Book of Anatomy and Physiology", 2nd edition, Lotus Publishers, 2014.
3. Elaine. N.Marieb, "Essential of Human Anatomy and Physiology ", 8th Edition, Pearson Education, New Delhi, 2007
4. Charles E. Tobin, Basic Human Anatomy, McGraw Hill, 1980.
5. J Gibson, Modern Physiology & Anatomy for Nurses; Black-well Scientific Publishers, 1981.

REFERENCES:

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, "Fundamentals of Anatomy and Physiology". 11th edition, Pearson Publishers, 2020.
2. Gillian Pocock, Christopher D. Richards, "The Human Body – An introduction for Biomedical and Health Sciences", Oxford University Press, USA, 2013.
3. William F. Ganong, "Review of Medical Physiology", 22nd Edition, McGraw Hill, New Delhi, 2010.
4. Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology" 4th edition, W.B. Saunders Company, 2014

WEB REFERENCES:

- <https://nptel.ac.in/courses/122103039/>
- <https://www.edx.org/learn/human-anatomy>
- <https://www.youtube.com/watch?v=Orumw-PyNjw>
- <https://www.youtube.com/watch?v=URUJD5NEXC8>
- <https://www.youtube.com/watch?v=gSW2ryFmihk>
- <https://www.youtube.com/watch?v=28CYhgjrBLA>

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	1	-	2	-	-	-	-	1	3	2
CO2	3	2	-	1	-	2	-	-	-	-	1	3	2
CO3	3	2	-	2	-	3	-	-	-	-	1	3	3
CO4	3	2	-	2	-	2	-	-	-	-	1	3	2
CO5	3	2	-	1	-	2	-	-	-	-	1	3	2
AVG	3	2	-	1.4	-	2.2	-	-	-	-	1	3	2.2

JBM2302	BIOSENSORS AND MEASUREMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the methods and characteristics of measurement system.
- To gain knowledge about the principle of transduction, classifications and their characteristics
- To understand the different bio potentials and bio sensors
- To gain knowledge on the biosignal conditioning and analysis
- To be acquainted with the different display and recording devices

UNIT I - SCIENCE OF MEASUREMENT 9

Measurement System – Static and Dynamic characteristics- Errors in Measurements and their statistical analysis – Calibration – Standards - Characteristics of Transducers.

UNIT II - TRANSDUCERS 9

Classification of transducers, Passive Transducers: Resistance type: strain gauges - rosettes, RTD, Thermistor, Inductive type: LVDT, Capacitive type, Photoelectric type, Active Transducers - Thermocouple, Piezoelectric, Photo Voltaic. Biomedical applications of transducers.

UNIT III - BIOPOTENTIAL, BIOCHEMICAL SENSORS 9

Half cell potential (or) Electrode potential, Types of Electrodes - Micro electrodes, Depth and needle electrodes, Surface electrodes, Biochemical sensors - pH, pO₂ and pCO₂, Biosensors in glucose monitoring, drug discovery, detection of pathogens, routine analytical measurement.

UNIT IV - BIOSIGNAL CONDITIONING & ANALYSIS 9

AC and DC Bridges –wheat stone bridge, Maxwell, Hay, Schering bridges, Bio amplifiers, Power line interference – band pass filtering, Bio-Analyzers: Blood gas analyzers, photometers and auto analyzer.

UNIT V - RECORDING DEVICES 9

DSO, Medical Oscilloscopes. PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Explain the principles of measurement systems, characteristics of instruments, and calibration methods.
- Classify various transducers and illustrate their biomedical applications.
- Describe the operation of biopotential and biochemical sensors used in clinical diagnostics.
- Analyze biosignal conditioning circuits, bridge networks, and biomedical analyzers.
- Compare different medical recording devices and interpret their functional characteristics.

TEXT BOOKS:

1. Sawhney A.K, "A course in Electrical and Electronic Measurements and Instrumentation", Nineteenth Revised Edition, Dhanpat Rai & Co, New Delhi, 2011.
2. Kalsi H.S, "Electronic Instrumentation", 3rd Edition, Tata McGraw Hill Education Pvt Ltd, 2010.
3. Geddes L.A and Baker L.E, "Principles of Applied Biomedical Instrumentation", 3rd Edition, Wiley India Pvt. Ltd, New Delhi, 2008.

REFERENCES:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", 2nd edition, Prentice- Hall of India Pvt. Ltd, New Delhi, 2015.
2. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.
3. Richard S.C. Cobbold, Transducers for Biomedical Measurements: Principles and Applications, John Wiley & Sons, 2004.
4. Nandini K. Jog, Electronics in Medicine and Biomedical Instrumentation, PHI, 2nd Edition 2013.
5. Harry N, Norton, Biomedical sensors – Fundamentals and Application, 2001. 7. Tatsuo Togawa, Toshiyo Tamma and P. AkeÖberg, Biomedical Transducers and Instruments, 2018.

WEB REFERENCES:

- <https://nptel.ac.in/courses/108/105/108105064/>
- <https://nptel.ac.in/courses/108/102/108102097/>
- <https://vlab.amrita.edu/?sub=3&brch=310&sim=1848&cnt=4>
- <https://www.youtube.com/watch?v=gJd0MeECLHA>
- <https://www.youtube.com/watch?v=49CWbXNJ3WE>
- <https://www.youtube.com/watch?v=WnKK11UEvVE>
- <https://www.youtube.com/watch?v=D-malae4448>
- <https://www.youtube.com/watch?v=VoX85L8zykE>
- <https://www.youtube.com/watch?v=XWTw--FmumM>

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	2	-	—	—	—	—	—	1	2	1
CO2	3	2	2	2	1	—	—	—	—	—	1	3	2
CO3	3	2	2	2	1	2	—	—	—	—	1	3	3
CO4	3	2	2	2	2	—	—	—	—	—	2	3	3
CO5	2	1	1	2	2	—	—	—	—	—	2	2	2
AVG	2.8	1.8	1.75	2	1.5	2	—	—	—	—	1.4	2.6	2.2

JNC2361	DISASTER RISK REDUCTION AND MANAGEMENT	L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

- To impart knowledge on concepts related to disaster, disaster risk reduction, disaster management
- To acquaint with the skills for planning and organizing disaster response

UNIT I - HAZARDS, VULNERABILITY AND DISASTER RISKS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced – Earthquake, Landslide, Flood, Drought, Fire etc – Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies - Inter relations between Disasters and Sustainable development Goals

UNIT II - DISASTER RISK REDUCTION (DRR) 9

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies.- Relevance of indigenous Knowledge, appropriate technology and Local resources.

UNIT III - DISASTER MANAGEMENT 9

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management, Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans, programmes and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA-DDMA-NRDF- Civic Volunteers)

UNIT IV - TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT 9

Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management

UNIT V - DISASTER MANAGEMENT: CASE STUDIES**9**

Discussion on selected case studies to analyze the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.- Field work-Mock drill -

TOTAL: 45 PERIODS**TEXT BOOKS:**

1. Taimpo (2016), Disaster Management and Preparedness, CRC Publications
2. Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
3. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
4. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]

REFERENCES:

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.
2. Government of India, National Disaster Management Policy, 2009.
3. Shaw R (2016), Community based Disaster risk reduction, Oxford University Press

COURSE OUTCOME:

- Explain the fundamental concepts of disasters, hazards, vulnerabilities, and global–regional disaster trends.
- Analyze disaster risk reduction strategies, community-based DRR measures, and early warning mechanisms.
- Interpret the components, policies, legal frameworks, and institutional structures involved in disaster management.
- Apply tools and technologies such as GIS, early warning systems, and damage assessment methods for disaster response.
- Evaluate real-world disaster case studies to assess impacts, risk scenarios, and mitigation actions.

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	–	–	–	2	2	1	–	2	1	1	1
CO2	2	3	1	–	–	3	3	2	1	2	1	2	2
CO3	2	2	–	–	–	3	3	2	1	3	2	2	2
CO4	2	2	2	3	2	2	2	–	–	2	2	2	1
CO5	2	3	2	2	–	3	3	2	–	2	1	2	1
AVG	2.2	2.4	1.66	2.5	2	2.6	2.6	1.75	1	2.2	1.4	1.8	1.4

JBM2311	BIOMEDICAL DATA ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To impart knowledge on MATLAB environment for generation and analysis of signals
- To make them understand basic R programming
- To visualize and elucidate the data statistics using R programming
- To impart knowledge on 3D Slicer for visualization, processing, segmentation, registration, and analysis of medical, biomedical 3D images.
- To make them understand 3D Slicer extensions such as Quantitative Imaging, planning and navigating image-guided procedures.

EXPERIMENTS USING MATLAB

Basic commands, assigning variables and operations with variables Operations on matrix 2D and 3D plot Loops and Conditional Statements Generation of signals

EXPERIMENTS USING R PROGRAMMING

Basic language elements and datatypes Data input/output Data preparation, Data visualization, Data statistics

EXPERIMENTS USING 3D SLICER

Data loading and visualization - Medical Atlases Image phenotyping, segmentation, Quantitative imaging. Diffusion tensor imaging, Fiber bundle volume measurement, Lung CT analysis

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- Execute Basic arithmetic operations, Boolean operations, demonstrate signal generation in MATLAB.
- Execute programs for data input and preparation in R programming.
- Perform data statistics in R programming.
- Access and visualize different medical data types in 3D Slicer and reference medical data atlases.
- Perform Image phenotyping, quantitative images using segmentation, analyze DTI image, calculate Fiber bundle volume, and conduct Lung CT image analysis.

TEXT BOOKS:

1. Y. Kirani Singh & B.B. Chaudhuri, Matlab Programming, First Edition, Third Reprinting, PHI Learning Pvt Ltd., New Delhi, 2010.
2. Dr. Jeeva Josse, Beginner's Guide for Data Analysis using R Programming, Khanna Book Publishing Co (P) Ltd., Reprint 2019.

REFERENCES:

1. Holly Moore, Matlab for Engineers, Pearson Education, Limited, 2011.
2. Hadley Wickham & Garrett Grolemund, R for Data Science, O'Reilly Media Publisher, 2016.
3. Tilman M. Davies, The Book of R, No Starch Press, 2016.

LAB Requirements for a Batch of 30 students:

- PCs - 15 Nos
- MATLAB - software package for simulation experiments
- R Programming (Open source)
- 3D Slicer program

WEB REFERENCES:

- https://nptel.ac.in/content/storage2/courses/103106118/Week%20%201/1_MATLAB_Basics.pdf
- <https://nptel.ac.in/courses/108/102/108102044/>
- <https://nptel.ac.in/courses/111/104/111104100/>
- <https://nptel.ac.in/courses/111/104/111104120/>
- https://onlinecourses.nptel.ac.in/noc21_ma37/preview
- <https://www.slicer.org>

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	1	-	-	-	1	3	2	-
CO2	3	3	2	3	3	1	-	-	-	-	3	1	-
CO3	3	3	2	3	3	1	-	-	-	-	3	2	-
CO4	3	3	2	2	3	1	-	-	-	-	3	3	1
CO5	3	3	2	2	3	1	-	-	-	-	3	3	1
AVG	3	3	2.2	2.6	3	1	-	-	-	1	3	2.2	1

JPT2041	SOFT SKILLS AND APTITUDE
----------------	---------------------------------

OBJECTIVE:

- To make students analyze and solve problems in technical as well as aptitude. Enhance the technical skills and basics of programming language
- To make the students understand how to apply the practical knowledge with real time applications.
- To make the students think and draw a conclusion from different scenarios.
- To help the students understand C programming concepts

UNIT-I SOFT SKILLS AND APTITUDE - I 6

Synonyms - Antonyms - Odd Words - Idioms and Phrases - Error Spotting - Interpersonal Communication- Sentence Correction - Resume Writing Skills - Interview Skills.

UNIT-II SOFT SKILLS AND APTITUDE-II 6

Reading Comprehension - Sentence Improvement - Jumbled Sentences - Parts of speech - Fact, Inference, Judgements - . Paragraph formation -Fill in the Blanks - Group Discussion - Mock Interview Sessions.

UNIT III QUANTITATIVE APTITUDE 6

Number Theory - Divisibility rule - LCM and HCF - Simplification - Surds and Indices - Average - Percentage

UNIT IV LOGICAL REASONING 6

Number and letter Series - Coding and Decoding - Ranking and Ordering - Odd man out - Image Based Relationships

UNIT V TECHNICAL APTITUDE IN C-I 6

Pointers - Pointer dereferencing - Functions - Call by value, Call by reference - Structures - Structure Pointers - Arrays - One Dimensional, Two Dimensional, Multi Dimensional - Sorting - Time Complexity - Strings - String Methods.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Develop different types of content using the skills learnt
- Manage time and stress competently
- Find answers to real time application problems
- Use Logical reasoning skills to solve problems differently
- Apply C programming concepts for coding

TEXT BOOKS:

1. Dr.RS Aggarwal, "Quantitative Aptitude", S Chand Publishing, 2020
2. Dr.R.S Aggarwal. "A Modern Approach To Verbal Reasoning", S.Chand Publishing, 2017
3. Dr. R. S. Aggarwal, "A Modern Approach to Non-Verbal Reasoning". S. Chand Publishing, 2017
4. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C. First

REFERENCES:

1. Data Communications and Networks- 2nd edition -Achyut S Godbole- and Atul Kahate Tata McGraw-Hill, 2017.
2. Computer Networking - James F. Kurose & Keith W. Ross- PEARSON, 6th EDITION, 2017.
3. Computer Communications and Networking Technologies - Michael A. Gallo & William M. Hancock- BROOKS&COLE, 2001.

WEB REFERENCES:

- <https://www.indiabix.com/aptitude-questions-and-answers>
- <https://m4maths.com/placement-puzzles.php>
- www.freshersworld.com

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	-	-	-	-	3	3	3	3	1	1
CO2	2	2	2	-	-	-	-	3	3	3	3	-	1
CO3	2	3	2	2	2	-	-	3	3	3	3	2	2
CO4	2	3	2	2	2	-	-	3	3	3	3	2	1
CO5	3	3	2	2	3	-	-	3	3	3	3	3	2
AVG	2.2	2.6	2	2	2.2	-	-	3	3	3	3	2	1.4

SEMESTER 4

JMA2401	APPLIED NUMERICAL METHODS	L	T	P	C
		2	2	0	3

COURSE OBJECTIVES:

- To introduce numerical techniques for solving algebraic, transcendental equations and system of equations.
- To acquaint students with interpolation for various intervals in real-time problems.
- To outline numerical methods for differentiation and integration.
- To explain concepts of numerical methods involved in solving ordinary differential equations.
- To familiarize students in solving partial differential equations numerically.

UNIT I - SOLUTION OF EQUATIONS

9+3

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations – Direct methods of Gauss elimination and Gauss-Jordan – Iterative methods of Gauss-Jacobi and Gauss-Seidel

UNIT II - INTERPOLATION AND APPROXIMATION

9+3

Interpolation with equal intervals – Newton's forward and backward difference formulae – Interpolation with unequal intervals – Lagrange's interpolation – Newton's divided difference interpolation – Spline Interpolation

UNIT III - NUMERICAL DIFFERENTIATION AND INTEGRATION

9+3

Approximation of derivatives using interpolation polynomials – Numerical integration using Trapezoidal, Simpson's 1/3 and 3/8 rule – Romberg's Method – Evaluation of double integrals by Trapezoidal and Simpson's rules

UNIT IV - INITIAL VALUE PROBLEMS

9+3

Single step methods – Taylor's series method – Modified Euler's method – Fourth order Runge-Kutta method for solving first order equations – Multi step methods – Milne's and Adam-Bashforth's predictor corrector methods for solving first order equations

UNIT V - BOUNDARY VALUE PROBLEMS

9+3

One dimensional heat flow equation by explicit and implicit methods – One dimensional wave equation by explicit method – Finite difference method for Laplace equation on rectangular domain.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Solve algebraic, transcendental equations and system of equations numerically.
- Interpolate and extrapolate data numerically.
- Apply numerical methods for differentiation and integration.
- Demonstrate efficient use of numerical techniques in solving first order ordinary differential equations.
- Solve standard partial differential equations through numerical methods.

TEXT BOOKS:

1. Burden R.L. and Faires J.D., "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.

REFERENCES:

1. Brian Bradie., "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi, 2006.

WEB REFERENCES:

- <https://nptel.ac.in/courses/127106019/>
- <https://nptel.ac.in/courses/111101003/>
- <https://nptel.ac.in/courses/111101165/>
- <https://nptel.ac.in/courses/105105043/>

Mapping of CO with PO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	3	-	-	2	-	-	1	3	2
CO2	3	2	1	2	3	-	-	2	-	-	1	3	2
CO3	3	2	1	2	3	-	-	2	-	-	1	3	1
CO4	3	2	1	2	3	-	-	2	-	-	1	3	2
CO5	3	2	1	2	3	-	-	2	-	-	1	2	1
AVG	3	2	1	2	3	-	-	2	-	-	1	2.8	1.6

JBM2401	BIOMATERIALS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the functional characteristics and classification of Biomaterials.
- To understand the bio compatibility of different metals, ceramics as biomaterials
- To learn the basic structure, types and applications of polymeric materials and its Implants.
- To demonstrate the use of biomaterials in soft tissue and hard tissue replacements
- To appreciate the design, development, test and sterilization of materials to ensure its functionalities.

PREREQUISITE:

- JBM2301 - Human Anatomy and Physiology

UNIT I - BIOMATERIALS

9

Definition and Classification, functional requirements of bio-materials, Visco elasticity, Biomaterial's performance, Physiological response to implants, Wound healing, Blood compatibility.

UNIT II - METALLIC AND CERAMIC IMPLANT MATERIALS

9

Metallic implant materials - Stainless steels, Co-based alloys, Ti-based alloys Dental metals, shape memory alloy, degradation and Corrosion of Metallic implants, nano structured metallic implants. Ceramic implant materials – Bio inert, Bio resorbable, Bioactive ceramics, Applications, Nano structured Bio Ceramics.

UNIT III - POLY MERIC IMPLANT MATERIALS

9

Basic structure of Polymers, Polymerization and its types, Factors influencing polymers properties, Polymers as biomaterials, Biodegradable polymers, Polyamides, PTFE, Biopolymers, Polymeric Membranes for plasma separation and Blood oxygenation, Dental Filling Composites, Polymeric Materials in ophthalmology.

UNIT IV - TISSUE REPLACEMENT IMPLANTS

9

Soft-tissue replacements: sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Drug delivery system, Vascular grafts, Hard tissue replacement Implants: joint replacements, tissue scaffolding, Total Knee Replacements.

UNIT V - TESTING AND STERILIZATION OF BIOMATERIALS

9

Blood compatibility tests, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and In vivo testing; Sterilization of implants and devices: ETO, gamma radiation, autoclaving, Effects of sterilization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Appreciate and evaluate the design aspects and desirable properties of biomaterials used in medical applications.
- Explain the functional characteristics of metals used in implant design.
- Identify and analyze the properties of polymers used in medical applications.
- Describe and assess the use of biomaterials in soft and hard tissue replacements.
- Design, develop, and test biomaterials to determine their biocompatibility.

TEXT BOOKS:

1. Sujata V.Bhatt, “Biomaterials Second Edition”, Narosa Publishing House, 2005. (Unit 1 to 4)
2. Sreeram Ramakrishna, Murugan Ramalingam, Sampath Kumar T.S, and Winston O. Soboyejo, “Biomaterials: A Nano Approach”, CRC Press, 2010.

REFERENCES:

1. MyerKutz, “Standard Handbook of Biomedical Engineering & Design”, McGrawhill, 2003.
2. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, “Introduction to Biomedical Engineering”, Elsevier, 2005.
3. Park J.B., “Biomaterials Science and Engineering”, Plenum Press, 1984.
4. Anand A.C, Kennedy JF,Miraftab. M, S.Rajendran, Wood head, Medical Textiles and Biomaterials for Healthcare”, Publishing Limited 2006.
5. Monika Saini, Yashpal Singh, Pooja Arora,Vipin Arora, and Krati Jain. “Implant biomaterials: A comprehensive review”, World Journal of Clinical Cases, 2015.

WEB REFERENCES:

- <https://nptel.ac.in/courses/113104009/>
- <https://www.youtube.com/watch?v=1oAbeWO3SvI>
- <https://www.youtube.com/watch?v=8p2CYTPGiYE>
- <https://www.youtube.com/watch?v=Ao2p19NkcQI>
- <https://www.youtube.com/watch?v=ANHhZJguz3U>

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	1	2	2	2	2	1	–	2	2	2
CO2	2	2	2	2	2	1	1	1	2	–	2	2	2
CO3	2	2	2	2	2	1	1	1	2	–	2	2	2
CO4	3	3	3	3	3	2	3	2	3	1	3	3	2
CO5	2	3	3	1	2	2	1	2	2	1	3	3	1
AVG	2.2	2.4	2.4	1.8	2.2	1.6	1.6	1.6	2	1	2.4	2.4	1.8

JBM2402	BIOMEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the origin of various biological signals, their characteristics and electrode configurations specific to bio-potential measurements.
- To understand the characteristics of Bio signals.
- To explain the different techniques used for measurement of non-electrical bio-parameters.
- To explain the flow and sensory measurement techniques as applicable for diagnosis and treatment.
- To understand the design of bio amplifiers

UNIT I – BIOPOTENTIAL ELECTRODES 9

Basic transducer principles, sources of bioelectric potential, electrodes, Origin of bio potential and its propagation, Electrode-electrolyte interface, electrode–skin interface impedance, polarization effects of electrode, Types of electrodes - surface, needle and micro electrodes and their equivalent circuits, Recording problems - measurement with two electrodes.

UNIT II – ELECTRODE CONFIGURATION 9

Bio signals characteristics, ECG - Einthoven's triangle, standard 12 lead system, EEG - 10-20 electrode system, unipolar, bipolar and average mode, EMG, ERG and EOG - unipolar and bipolar mode, Biofeedback Instrumentation.

UNIT III - MEASUREMENT OF NON-ELECTRICAL PARAMETERS 9

Temperature, respiration rate and pulse rate measurements, Blood Pressure - indirect methods: auscultatory method, oscillometric method, ultrasonic method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit, Pulse oximeter, biotelemetry.

UNIT IV - FLOW AND SENSORY MEASUREMENTS 9

Blood flow: Electromagnetic and ultrasound blood flow measurement, cardiac output measurement: Indicator dilution, dye dilution, thermal dilution, EGG (Electrogastrograph), Galvanic Skin Resistance (GSR).

UNIT V - BIO AMLIFIERS 9

Need for bio-amplifier - Single ended amplifier, Differential bio-amplifier - Band pass filtering, isolation amplifiers - transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At end of the course the students will be able to:

- Illustrate the origin and characteristics of various biological signals.
- Describe the modules used for monitoring and transmitting human vital signs.
- Explain the measurement techniques for non-electrical bio-parameters.
- Discuss flow and sensory measurement methods used in diagnosis and treatment.
- Explain the standards and safety measures required for operating biomedical equipment.

TEXT BOOKS:

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice Hall of India, New Delhi, 2015. **(Unit I, II, IV)**
2. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt Ltd, New Delhi, 2015. **(Unit I & III)**
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003. **(Unit II, IV)**

REFERENCES:

1. John Enderle, Susan Blanchard, Joseph Bronzino, "Introduction to Biomedical Engineering", second edition, Academic Press, 2005.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
3. Joseph D. Bronzino, "The Biomedical Engineering Handbook", Second Edition, Boca Raton: CRC Press LLC, 2000.

WEB REFERENCES:

- <https://nptel.ac.in/courses/108105101/>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9185290/>
- <https://www.mdpi.com/1424-8220/22/3/897>
- <https://www.electrical4u.com/biological-amplifiers/>

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	1	1	1	-	-	1	1	3	2
CO2	3	2	3	2	3	1	1	1	-	1	-	3	2
CO3	2	1	2	3	3	1	-	-	-	1	-	3	2
CO4	3	2	3	2	3	1	1	1	1	2	2	2	3
CO5	2	2	1	3	2	3	3	1	1	2	1	3	3
AVG	2.6	1.8	2.0	2.2	2.4	1.4	1.5	1	1	1.4	1.33	2.8	2.4

JBM2421	INTEGRATED CIRCUITS (INTEGRATED)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To study the Boolean algebra using logic gates and combinational circuits.
- To understand the design of sequential systems.
- To study the basic principles, practical limitations of op-amp and to understand the various linear and non-linear applications of op-amp
- To analyze, design and explain the characteristics and applications of active filters, deignop-amp oscillators, single chip oscillators and frequency generators
- To understand the operation of the most commonly used timer, D/A & A/Dconverter types and its applications

PREREQUISITE:

- Number systems

UNIT I - DIGITAL FUNDAMENTALS AND COMBINATIONAL CIRCUITS 9

Number systems - code conversion: BCD, Binary Gray Code - Boolean Laws and theorems – Boolean Algebra, Logic gates - Truth Tables and Logic circuits - The Karnaugh Map – half adder, full adder, Multiplexers and Demultiplexers - Decoders and encoders.

UNIT II - REGISTERS AND COUNTERS 9

Flip Flops – RS, D, T, JK Flip Flops – Characteristic equations, excitation tables – JKMaster–Slave flip-flop – Universal shift register. Design of modulo-N counters – counter design using state diagram.

UNIT III - OPERATIONAL AMPLIFIERS 9

Ideal & practical op-amp – Open &closed loop configurations – DC & AC characteristics of op-amp. Op-amp circuits: Inverting & Non-inverting amplifiers – Voltage follower – AC amplifiers. Applications: Instrumentation Amplifiers – V-to-I & I-to-V converters - Differentiators &Integrators, Comparator - Schmitt Trigger.

UNIT IV - ACTIVE FILTERS AND SIGNAL GENERATORS 9

Filters: Comparison between Passive and Active Networks-Design of LPF, HPF,BPF and Band Reject Filters. Waveform Generators: Sine-wave Generators – Square / Triangle / Saw- tooth Wavegenerators.

UNIT V - TIMER, A/D AND D/A CONVERTERS 9

IC 555 Timer: Monostable operation, astable operation and applications, DAC: Weighted Resistor DAC, R-2R Ladder DAC, Monolithic DAC, ADC: Ramp Type ADC - Successive Approximation ADC - Dual Slope.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

- Design and implementation of full Adder/ full Sub tractor
- Design and implementation of Multiplexer and De-multiplexer using logic gates.
- Design and implementation of 3-bit synchronous up/down counter.
- Inverting and non-inverting using op-amp
- RC Integrator and Differentiator circuits using Op-Amp
- Active low-pass, High pass & Band pass filters
- Monostable multivibrator using IC555

TOTAL: 30 PERIODS

TOTAL: 75 HOURS

LAB Requirements for a Batch of 30 students (3 students per experiment):

- Digital IC's, IC741, IC555, NE 555, Bread board, connecting wires
- Digital trainer kits – 15 Nos.
- CRO-10 No's
- Power supply-10 No's
- Function generators – 8 Nos.
- Resistors & capacitors

WEB REFERENCES:

- https://www.youtube.com/watch?v=Bq4EaNNkY_4
- <https://www.youtube.com/watch?v=H1eQhZ9Gq5s>
- <https://www.youtube.com/watch?v=svFUEJkoeVY>
- <https://www.youtube.com/watch?v=EOZyofNXWXc>
- <https://www.youtube.com/watch?v=G0D7m3DzCto>
- <https://www.allaboutcircuits.com/video-tutorials/op-amps-low-pass-and-high-pass-active-filters/>

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Apply Boolean algebra to design and implement combinational and sequential digital circuits using logic gates and flip-flops.
- Analyze the characteristics and performance of operational amplifiers and construct linear and nonlinear op-amp applications.
- Design and implement active filters, waveform generators, and various signal generation circuits.
- Demonstrate the operation of timer IC 555 and evaluate different A/D and D/A converter architectures.
- Develop and test practical electronic circuits such as adders, multiplexers, counters, filters, and waveform generators using laboratory equipment.

TEXT BOOKS:

1. Digital Design, 5/e, Morris Mano and Michael D. Cilette, Pearson, 2011 (Unit - 1,2)
2. Roy Choudhury and Shail Jain, "Linear Integrated Circuits", 2nd Edition, New Age International Publishers, 2003. (Unit - 3,4,5)

REFERENCES:

1. Digital Principles, 3/e, Roger L. Tokheim, Schaum's outline series, 1994 (Unit-1,2)
2. Robert F. Coughlin, Frederick F. Driscoll, "Operational-Amplifiers and Linear Integrated Circuits", 6th Edition, Prentice Hall, 2001. (Unit-3,4,5)
3. S.Salivahanan and V.S. Kanchana Bhaaskaran, "Linear Integrated Circuits", 6th Edition, Tata McGraw-Hill, 2011. (Unit-3,4,5)
4. Ramakant A.Gayakwad, "Op-Amps and Linear Integrated Circuits", 4th Edition, Prentice Hall, 2000. (Unit-3,4,5)

WEB REFERENCES:

- <https://nptel.ac.in/courses/117106086>
- <https://www.youtube.com/watch?v=clTA0pONnMs>
- <https://www.digimat.in/nptel/courses/video/108108114/L01.html>
- <https://www.youtube.com/watch?v=80WTmTblr6Y>
- <https://www.rohm.com/electronics-basics/ad-da-converters/what-is-binary>
- <https://www.youtube.com/watch?v=P8VRRmr3gm4>

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	2	–	–	1	–	–	1	2	1
CO2	3	2	2	2	2	–	–	1	–	–	1	3	1
CO3	3	2	3	2	2	–	–	1	–	–	1	3	1
CO4	3	2	2	2	2	–	–	1	–	–	1	2	2
CO5	3	2	3	3	3	–	–	2	2	1	1	3	2
AVG	3	2.2	2.4	2	2.2	–	–	1.2	2	1	1	2.6	1.4

JBM2411	BIOMEDICAL INSTRUMENTATION LABORATORY	L 0	T 0	P 4	C 2
----------------	--	----------------------	----------------------	----------------------	----------------------

COURSE OBJECTIVES:

- To design biological pre-amplifier
- To record and analyze bio signals
- To measure and record peripheral blood flow.
- To study the characteristics of isolation amplifier
- To record and analyze the non-electrical physiological measurements of the body

LIST OF EXPERIMENTS:

- Study of characteristics of optical isolation amplifier
- Recording of various physiological parameters using patient monitoring system and telemetry units
- Measurement of pH and conductivity
- Recording of EMG and analysis
- Measurement of blood pressure using sphygmomanometer
- Design of ECG Amplifiers
- Recording of ECG signal and analysis
- Design of EOG amplifier to detect eye blink
- Measurement and recording of peripheral blood flow
- Measurement of EEG and visually evoked potential
- Measurement of respiration using spirometer

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course student will be able to:

- Measure various physiological parameters using biomedical sensors and patient monitoring systems.
- Record and analyze bioelectric signals such as ECG, EMG, EOG, and EEG using appropriate acquisition systems.
- Design and test basic biomedical amplifier circuits including ECG and EOG amplifiers.
- Evaluate physiological measurements such as blood pressure, respiration, pH, and conductivity using standard biomedical instruments.
- Interpret diagnostic trends from recorded signals and physiological data for clinical relevance.

WEBSITE REFERENCES:

1. <https://medcraveonline.com/IJBSBE/design-of-an-ecg-sensor-circuitry-for-cardiovascular-disease-diagnosis.html>
2. https://www.youtube.com/watch?v=tZcKT4l_JZk
3. https://www.youtube.com/watch?v=8Q57q_kQPQY
4. <https://ieeexplore.ieee.org/document/6290719>

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS:

S.no	Description	Quantity
1	Multiparameter patient monitoring system	1 No
2	PC	3 No
3	ECG recorder	1 No
4	pH meter, conductivity meter	1 No
5	Blood flow measurement system using ultrasound transducer	1 No
6	EMG recorder	1 No
7	EEG recorder	1 No
8	Spirometer	1 No
9	Sphygmomanometer	1 No
10	Function Generators	2 No
11	DSOs	2 No
12	Regulated Power Supplies	2 No
13	Breadboards	10 No
14	IC 741, LM 324, AD 620	20 each

MAPPING OF CO WITH PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	2	–	1	–	–	1	1	3	2
CO2	3	3	2	2	2	–	1	–	–	2	1	3	2
CO3	3	3	3	2	2	–	–	–	–	2	1	3	3
CO4	2	2	1	2	2	–	1	–	–	1	1	2	2
CO5	2	3	2	3	2	–	1	–	–	2	1	3	2
AVG	2.6	2.6	1.8	2.2	2	–	1	–	–	1.6	1	2.8	2.2

JGE2441	E-PROTOSHOP	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To help students to Identify societal needs and problems and able to find solutions.
- To help students learn the fundamentals/essentials of the Design Thinking and Innovation process.
- To creates awareness in the students through design tools, observation, discovery, analysis, experience, collaboration, visualization and reflection.
- To nurture the student's curiosity and enhance their explorative abilities to foster creativity and innovation in students in any field.
- To enable the students to realize their ideas as prototypes and set a roadmap to commercialize the product developed.

1. **Design thinking** - Determine Innovative Idea – Need, understand the requirement, Define and redefine the problem, Brainstorm to generate ideas.
2. **Product design** – Conceptualization, Analysis, sketching a design that represents a product idea, Optimize a design through market experts.
3. **Virtual model Generation** – create realistic model of the proposed design using a 3D imaging software.
4. **Training on Skills and Tools** - Specific training on tools and machinery relevant to the prototype generation – Knowledge on specific tools, machinery, etc. (Hands-on workshops)
5. **Minimum Viable product** – POC contains hardware and software components, Hardware-software codesign, operatable like a finished product.
6. **Prototype creation** – Deployment, testing, redesign, user satisfaction and feedback, prototype upgradation.
7. **Roadmap to startup** – Analysis of target market, Marketing and sales plan, Business plan, Financial projections, Team building, Register your startup, licensing, permissions and certifications.

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Understand the problem identification and finding solutions using one or more domains of technology.
- Create virtual mode of design.
- Use the tools and techniques relevant to the prototype generation.
- Develop a prototype of product ad a minimum viable product.
- Initiate start up and commercialize the product developed.

REFERENCES:

1. Arun Jain, From Teenager to Achiever, School of Design thinking www.d-thinking.com
2. Chakku 7C's <https://www.idc.iitb.ac.in/~chakku/chakku7Cs.pdf>
3. Collaborative Model For Innovation https://www.idc.iitb.ac.in/~chakku/COLLABORATIVE_MODEL_FOR_INNOVATION.pdf
4. Pitfalls in the Innovation process https://www.idc.iitb.ac.in/~chakku/Pitfalls_in_the_innovation_process.pdf
5. Innovation By Design – Collaboration is the key to cross the Pitfalls in the Innovation Process https://www.idc.iitb.ac.in/~chakku/Innovation_by_Design.pdf

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	3	2	3	2	2	3	3	3	3	3	2
CO2	2	2	3	2	3	2	2	3	3	3	3	3	1
CO3	2	2	3	3	3	2	2	3	3	3	3	2	3
CO4	2	2	3	3	3	2	2	3	3	3	3	3	2
CO5	2	2	3	3	3	3	3	3	3	3	3	2	1
AVG	2	2.2	3	2.6	3	2.2	2.2	3	3	3	3	2.6	1.8

TEXT BOOKS:

1. Herbert Schildt, "Java The complete reference", 8th Edition, McGraw Hill Education, 2011.
2. Cay S. Horstmann, Gary cornell, "Core Java Volume –I Fundamentals", 9th Edition, Prentice Hall, 2013.
3. Dr. R.S Agrawal, "Quantitative Aptitude" and Non Verbal Reasoning published in 2000.
4. S.Chand – A Modern Approach to Logical Reasoning Published in 2000.

WEBSITE REFERENCES:

- <https://www.indiabix.com/aptitude/questions-and-answers/>
- <https://m4maths.com/placement-puzzles.php>
- [www.freshers world.com](http://www.freshersworld.com)
- www.careerride.com
- www.youtube.com/watch/python
- [www.youtube.com/watch/concepts of python](http://www.youtube.com/watch/concepts%20of%20python)
- <https://stackoverflow.com/>
- <https://www.w3schools.com/>
- <https://www.geeksforgeeks.org/>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	-	-	2	2	2	3	2	1
CO2	3	3	3	2	3	-	-	2	2	2	3	2	1
CO3	3	3	3	2	3	1	-	2	2	2	3	2	1
CO4	3	3	3	3	3	1	-	2	2	3	3	3	2
CO5	3	3	3	3	3	-	-	3	3	3	3	1	1
AVG	3	3	2.8	2.4	3	1	-	2.2	2.2	2.4	3	2	1.2

SEMESTER 5

JBM2501	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the devices and therapeutic procedures related to cardiology.
- To study the working of equipment used in neurology.
- To understand various equipment relevant to muscular and pulmonary procedures.
- To familiarize with the diagnostic and therapeutic uses of ultrasonic and diathermy equipment.
- To understand the importance of patient safety against electrical hazard and special medical procedures.

Prerequisites needed: Biomedical Instrumentation

UNIT I - CARDIAC EQUIPMENT

9

ECG - Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, ECG machine maintenance and troubleshooting, Cardiac Pacemaker - Internal and External Pacemaker - Batteries, AC & DC Defibrillators, ECG telemetry, Application of cardiac equipment - CathLab.

UNIT II - NEUROLOGICAL EQUIPMENT

9

Clinical significance of EEG- Multi-channel EEG recording system, Epilepsy, Sleep patterns, Evoked Potential - Visual, Auditory and Somatosensory, MEG (Magneto Encephalograph). EEG Bio Feedback Instrumentation - EEG system maintenance and troubleshooting.

UNIT III - MUSCULAR AND RESPIRATORY EQUIPMENT

9

Recording and analysis of EMG waveforms, fatigue characteristics, Nerve conduction velocity measurement, Pressure myography, Neuromuscular stimulators - TENS, EMG Bio Feedback Instrumentation. Respiratory equipment - Spirometer, Pneumotachometer, Types of Ventilators - Pressure, Volume and Time controlled. Flow, Patient Cycle Ventilators, CPAP, BiPAP, Humidifiers, Nebulizers and Inhalators.

UNIT IV - ULTRASONIC AND DIATHERMY TECHNIQUES

9

Basic principles of Echo technique, display techniques A, B and M scan modes, Application of ultrasound as diagnostic tool - Echocardiogram, Echoencephalogram, Abdomen, Obstetrics and Gynecology, Ophthalmology. Diathermy equipment - Shortwave, Ultrasonic, Microwave diathermy, Electro cautery machine.

UNIT V - PATIENT SAFETY AND SPECIAL TECHNIQUES

9

Physiological effects of electricity, important susceptibility parameters, Macro shock, Micro shock hazards, Patient's electrical environment, Isolated Power system, Electrical safety codes and standards, Basic Approaches to Protection against shock, Protection equipment design, Electrical safety analyzer, Testing the Electric system. Principles of Cryogenic technique and application, Endoscopy, Laparoscopy, Thermography.

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):**At end of the course the students will be able to:**

- Identify and interpret the functionality of medical devices used in cardiology.
- Explain and analyze the functionality of medical devices used in neurology.
- Assess and evaluate various equipment relevant to muscular and pulmonary procedures.
- Explain and compare different types of diathermy equipment and justify the usefulness of ultrasound in diagnosis.
- Elaborate and apply techniques involved in patient safety against electrical hazards, and describe special diagnostic and therapeutic equipment.

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt. Ltd, New Delhi, 2015.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology, Pearson Education, 2004.
3. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.

REFERENCE BOOKS:

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", 2nd edition, Prentice hall of India, New Delhi, 2015.
2. Anthony Y.K. Chan, "Biomedical Device Technology - Principles and Design", Charles C Thomas Publisher Ltd., 2008.
3. Joseph D.Bronzino, "The Biomedical Engineering Handbook", Third Edition: Three Volume Set, CRC Press, 2006
4. Richard Aston, "Principles of Biomedical Instrumentation and Measurement", Merrill Publishing Company. 2006
5. Albert M.Cook and WebsterJ.G, "Therapeutic Medical devices", Prentice Hall Inc., New Jersey, 1982.

WEBSITE REFERENCES:

- <https://www.youtube.com/watch?v=hxTxROuUj4g>
- <https://www.youtube.com/watch?v=BLfwZ1NPNKY>
- https://www.youtube.com/watch?v=gk_Qf-JAL84&t=786s
- <https://www.youtube.com/watch?v=KNmQCQi-fnE>
- <https://www.youtube.com/watch?v=Cg6oh4D8DHs>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2
CO1	3	2	1	—	2	1	—	—	1	—	1	2	3
CO2	3	2	1	1	2	1	—	—	1	—	1	2	3
CO3	3	2	2	1	2	1	—	—	1	—	1	2	3
CO4	3	2	2	—	2	1	—	—	1	—	1	3	2
CO5	3	2	1	1	2	3	3	—	1	—	1	1	3
AVG	3	2	1.4	1	2	1.4	3	—	1	—	1	2	2.8

JBM2521	BIOMEDICAL SIGNAL PROCESSING (INTEGRATED)	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand various types of noise and artifacts encountered in biomedical signals
- To analyze filter characteristics, implement digital filters for signal enhancement
- To remove artifacts from acquired biomedical signals before processing
- To focus on detection and interpretation of physiological signals
- To estimate R-R intervals from processed ECG signals and analyze

UNIT I - TYPES OF NOISE AND ARTIFACTS

9

Objectives and Challenges in Biomedical Signal Analysis, Types of noise: Random and Structured, stationary and non-stationary processes, Artifacts in biomedical signals - types; Removal of noise and artifacts from biosignals; Need for filtering in biomedical signals.

UNIT II - IIR AND FIR FILTERS

9

IIR filters - Design of Butterworth filters for removal of low and high frequency noise, Impulse invariant and bilinear transformation methods. FIR Filter - Fourier Series Method, design using window technique, Comparison of IIR and FIR Filters.

UNIT III - FILTERING FOR ARTIFACT REMOVAL

9

Time domain filters - synchronized averaging and MA filters - derivative based operators to remove low frequency artifact, frequency domain filters - removal of periodic artifacts: notch and comb filters, Optimal filtering and Adaptive filtering techniques.

UNIT IV - BIOMEDICAL SIGNAL ANALYSIS

9

ECG: Detection of P, Q, R, S, and T waves, EEG analysis: Linear prediction theory, autoregressive method, sleep EEG analysis. EEG rhythms, waves, and transients. Detection techniques for waves and transients. Correlation and coherence analysis of EEG channels.

UNIT V - BIOMEDICAL APPLICATIONS

9

ECG averaging, maternal ECG cancellation in fetal electrocardiography, removal of artifacts in ECG signals, QRS detection techniques - estimation of R-R interval - arrhythmia analysis monitoring, EEG – spectral analysis of EEG signals, Removal of artifacts in ERP signals.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. Preprocessing of Biosignals
2. Determination of Heart rate
3. Arrhythmia detection in ECG
4. Analysis of EEG bands
5. Feature extraction in EMG signals
6. Removal of noises and filtering applied to biological signals
7. Analysis of EOG signals
8. Signal processing techniques using Fourier Transforms
9. Basic waveform generation

TOTAL: 30 PERIODS

LAB Requirements for a Batch of 30 students:

1. MATLAB software package for simulation experiments
2. PCs - 15 Nos

TOTAL: 75 PERIODS

WEBSITE REFERENCES:

- https://www.youtube.com/watch?v=n6iE9XGw_wE
- <https://www.youtube.com/watch?v=2tmilbi4L0o>
- <https://www.youtube.com/watch?v=78yscS49mYI>
- <https://www.youtube.com/watch?v=DpSczYKtJg4>
- <https://www.youtube.com/watch?v=1QNAnFr73Lo>

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Describe the nature, types, and sources of biomedical signals.
- Identify and apply suitable filtering techniques to remove noise and artifacts from biomedical signals.
- Design FIR filters using windowing methods.
- Explain and characterize the fundamental concepts of multirate signal processing.
- Apply and optimize biosignal processing techniques for clinical applications.

TEXT BOOKS:

1. Rangayyan, R.M., 2015. Biomedical signal analysis (Vol. 33). John Wiley & Sons.
2. Reddy, D.C., 2005. Biomedical signal processing: principles and techniques. McGraw-Hill
3. W. J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall, 1993.

REFERENCE BOOKS:

1. Eugene N Bruce, Biomedical Signal Processing and Signal Modeling, John Wiley & Son's publication, 2001.
2. D C Reddy, Biomedical Signal Processing, McGraw Hill, 2005.
4. Duda, R. O., Hart, P.E. and Stork, D.G., Pattern classification, JohnWiley & sons, 2012.
3. Emmanuel C. Ifeachor, Barrie W.Jervis, "Digital Signal processing- A Practical Approach", Pearson education Ltd., 2004.
4. John L.Semmlow, "Biosignal and Biomedical Image Processing Matlab Based applications", Taylor& Francis Inc, 2004.
5. Kayvan Najarian and Robert Splerstor, "Biomedical signals and Image processing", CRC – Taylor and Francis, New York, 2nd Edition, 2012.

WEBSITE REFERENCES:

1. <https://www.youtube.com/watch?v=U5DSugtDGY8>
2. https://www.youtube.com/watch?v=NOKOJWQ2_iE
3. <https://www.youtube.com/watch?v=xmYZD7xWHI>
4. https://www.youtube.com/watch?v=QBGjPtU_C6s
5. https://www.youtube.com/watch?v=0vcMaeN9_rg

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	1	1	2	–	–	–	–	–	1	2	1
CO2	3	3	3	2	3	–	–	–	–	–	1	3	1
CO3	3	3	3	2	3	–	–	–	–	–	2	3	1
CO4	3	3	2	2	3	1	–	–	–	–	2	3	2
CO5	3	3	1	2	3	1	–	–	–	–	3	2	2
AVG	3	3	2	1.8	2.8	1	–	–	–	–	1.8	2.6	1.4

JBM2502	MEDICAL PHYSICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To familiarize the physics of radiation and its effects on living tissues
- To discuss the physics of the acoustics in clinical applications
- To illustrate the phenomena of radioactivity and production of radionuclides
- To explain bioeffects in living tissues due to interaction of radiation
- To describe radiation exposure limit and safety measures

UNIT I - PHYSICS OF RADIATION

9

Physics of light, limits of vision and color vision an overview, Types and properties of Radiation, Overview of non-ionizing radiation effects-Low Frequency Effects - Higher frequency effects, KERMA, Tissue as leaky dielectric, Relaxation processes, Debye model, Cole-Cole model.

UNIT II - ACOUSTICS IN MEDICINE

9

Physics of sound, Normal sound levels - ultrasound fundamentals - Generation of ultrasound (Ultrasound Transducer) - Interaction of Ultrasound with matter; Cavitations, Reflection, Transmission - Scanning systems - Artefacts - Ultrasound - Doppler-Double Doppler shift.

UNIT III - RADIOACTIVITY

9

Sources of Radioisotopes - Natural and Artificial radioactivity, Radioactive Decay, Decay series, Production of radionuclides - Cyclotron produced Radionuclide - Reactor produced Radionuclide fission and electron Capture reaction, Technetium generator, Radionuclide in Medicine.

UNIT IV - INTERACTION OF RADIATION WITH MATTER

9

Interaction of charged particles with matter - Specific ionization, Linear energy transfer range - Bremsstrahlung radiation, Bragg's curve, Annihilation, Interaction of X-ray and Gamma radiation with matter - Photoelectric effect, Compton Scattering, Pair production, LET (Linear Energy Transfer) and RBE (Relative Biological Effectiveness), Proton and carbon ion therapy

UNIT V - RADIATION SAFETY

9

Radiation Exposure - Inverse square law - stopping power, Different radiation Unit, Roentgen, gray, Sievert, Sources & Classification of radioactive wastes, Radiation Measurement and Dosimetry, Regulatory aspects, LD50 - Stochastic and Non-stochastic effects.

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Interpret the radiation characteristics.
- Differentiate the intensities of sensory stimuli
- Summarize the production of radiation, radioactivity and radioactive isotopes
- Evaluate the interactions of radiation with tissue and its biological effects.
- Apply radiation monitoring instruments for dose measurement, exposure assessment, and use radiation protection standards.

TEXT BOOKS:

1. B. H. Brown, R. H. Smallwood, D. C. Barber, P.V. Lawford and D. R. Hose, 'Medical Physics and Biomedical Engineering', CRC Press, 2006.
2. 'Medical Physics: Imaging', Jean A. Pope, Heinemann Publishers, 2012.
3. F.M.Khan, 'The Physics of Radiation Therapy', Fifth Edition, Lippincott Williams and Wilkins, 2015.

REFERENCE BOOKS:

1. D. V. Rai, R Bahadur, Trends in Medical physics and Biomedical instrumentation. New Era international, India, 2009.
2. R. A Cooper, H. Ohnabe, and D. A. Hobson An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering), Taylor & Francis, 2008.

WEBSITE REFERENCES:

1. <https://www.iomp.org/medical-physics-references/>
2. https://onlinecourses.swayam2.ac.in/ini24_ph03/preview
3. https://www.irsu.fr/sites/default/files/documents/professionnels_sante/documentation/syllabus_chapitre_1.pdf
4. <https://ocw.mit.edu/courses/22-55j-principles-of-radiation-interactions-fall-2004/pages/lecture-notes/>
5. https://onlinecourses.swayam2.ac.in/ini24_ph03/preview
6. <https://www.coursera.org/learn/medical-applications-particle-accelerators>
7. <https://aapm.onlinelibrary.wiley.com/journal/24734209>
8. <https://www.iaea.org/resources/hhc/medical-physics>
9. <https://www.medphys.org/>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	1	1	-	-	1	-	1	1	1
CO2	3	2	1	-	1	1	-	-	1	-	1	1	2
CO3	3	2	1	-	1	1	-	-	1	-	1	1	2
CO4	3	3	1	1	2	1	1	-	1	-	1	2	2
CO5	2	3	1	1	1	3	3	-	2	-	1	1	3
AVG	2.8	2.4	1	1	1.2	1.4	2	-	1.2	-	1	1.2	2

JEC2521	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To explain the 16 bit and 32 bit microprocessors.
- To make students learn the design aspects of I/O and Memory Interfacing circuits
- To explore the need and use of peripherals and interfacing.
- To explain the architecture and programming of 8051 microcontroller.
- To introduce the concepts of advanced processors and discuss system design.

UNIT I - 16-BIT PROCESSORS 9

Introduction to 16 bit and 32 bit Microprocessors - Architecture of 8086 processor - Instruction set, Addressing modes, Programming, Bus structure - Timing Diagram-Minimum and Maximum mode configurations.

UNIT II - MEMORY AND I/O INTERFACING 9

Memory Interfacing: Classification – Address decoding – Memory interface and DMA,
I/O Interfacing: Address decoding, IO Mapped IO, Memory Mapped IO, Interrupt Driven IO

UNIT III - PERIPHERAL INTERFACING UNITS 9

PPI (8255), Keyboard display (8279), ADC0808 and DAC0808 Interface, Programmable Timer (8254), PIC (8259), Serial Communication (8251)

UNIT IV - 8-BIT MICROCONTROLLER 9

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

UNIT V - SYSTEM DESIGN AND ADVANCED PROCESSORS 9

System Design - RTC Interfacing using I2C Standard Motor Control- Relay, PWM, DC & Stepper Motor. Introduction to ARM, PIC and Embedded processors

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

Microprocessor based experiments using MASM software

- Basic arithmetic and Logical operations using processor
- Move a data block
- Programming with control instructions

Microcontroller based experiments with kits

- Basic arithmetic and logical operations
- Code conversion & calling subroutines

Peripherals and Interfacing

- Traffic light control
- Stepper motor control
- Key board and Display
- Serial interface and Parallel interface
- A/D and D/A interface and Waveform Generation

TOTAL: 30 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S. No.	EQUIPMENT	REQUIRED
1	8086 Microprocessor kits	15 Nos.
2	8051 Microcontroller kits	15 Nos.
3	Interfacing kits	5 each
4	Personal Computer with MASM Software	15 Nos.

TOTAL: 75 PERIODS**COURSE OUTCOMES (CO):****At end of the course the students will be able to:**

- Explain the architecture and programming the microprocessors.
- Discuss the aspects of I/O and Memory interfacing
- Describe and demonstrate the interfacing of peripherals units.
- Explain the architecture and programming the 8-bit microcontroller
- Develop skills on system design and explain the advanced processors.

TEXT BOOKS:

1. Doughlas V.Hall, “Microprocessors and Interfacing, Programming and Hardware”, TMH, 2016.
2. Krishna Kant, “Microprocessor and Microcontrollers, Architecture, Programming and System Design 8085, 8086, 8051”, Second Edition, PHI Learning Private Limited, 2014.
3. A,Nagoor Kani, “Microprocessor and Microcontrollers”, CBS Publishers, Second Edition, 2022.

REFERENCE BOOKS:

1. Krishna Kant, “Microprocessor and Microcontrollers”, Eastern Company Edition, Prentice Hall of India, New Delhi, 2007.
2. B.RAM, “Computer Fundamentals Architecture and Organization” New Age International Private Limited, Fifth edition, 2017.
3. Muhammad Ali Mazidi, Janice G. Mazidi, “The 8051 Microcontroller and Embedded Systems”, 2nd edition, 2007.

WEBSITE REFERENCES:

- <https://www.javatpoint.com/8086-microprocessor>
- <https://www.javatpoint.com/peripheral-devices>
- <http://www.digimat.in/nptel/courses/video/108105102/L31.html>
- <https://microcontrollerslab.com/lpc-2148-microcontroller-architecture/>
- GitHub - vivekkj123/ktu-s5-csl-331-ssmp-lab: KTU S5 System Software and Micro Processors Lab (CSL 331) Programs (2019 - Scheme)

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	-	1	-	-	-	-	1	2	2	1
CO2	3	3	3	1	2	-	-	1	-	1	2	3	2
CO3	3	2	3	1	3	-	-	1	-	1	2	3	2
CO4	3	2	3	2	3	-	-	1	-	1	2	3	2
CO5	3	2	3	2	3	-	-	2	-	1	2	3	3
AVG	3	2.2	3	1.5	2.4	-	-	1.25	-	1	2	2.8	2

JHS2541	PROFESSIONAL COMMUNICATION	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To enhance reading comprehension and oral communication through self-reflection and peer feedback
- To improve listening and speaking skills through exposure to diverse accents and group discussions
- To develop professional writing and critical thinking through email composition and career-related tasks
- To refine presentation skills and job application writing for effective workplace communication
- To build interview confidence and problem-solving abilities through simulations and case analysis

List of Experiments and Activities:

1. Reading: 21st Century Skills

Activity: Read an article or infographic on 21st-century skills, summarize key skills and conduct a quiz.

2. Speaking: Self-introduction

Activity: Deliver a 2 to 3-minute self-introduction or elevator pitch and receive peer feedback on content and delivery.

3. Listening: Accents in English

Activity: Listen to English audio clips in British, American, and Indian accents and answer comprehension questions based on the content.

4. Speaking: Group Discussion Dynamics

Activity: Participate in a formal group discussion on a current or technical topic and observe turn-taking, assertiveness, and relevance.

5. Writing: Working in Virtual Teams

Activity: Conduct a virtual team-based design challenge, simulate and record a remote meeting, and complete a reflective report on communication effectiveness.

6. Reading: Career Planning and Research Proposals

Activity: Read and analyse a sample career plan or research proposal, extract key points and compare effectiveness.

7. Speaking: Presentation Skills

Activity: Prepare and deliver a 4 to 5-minute oral or PPT presentation on a technical or career-related topic and receive peer and instructor feedback.

8. Writing: Job Application and Resume Writing

Activity: Prepare a tailored cover letter and resume—both by mail and email—for a specific job description, emphasizing clarity, proper formatting, and relevance.

9. Speaking: Interview Skills

Activity: Participate in mock interviews in pairs or with instructors, practice behavioural questions and receive structured feedback.

10. Listening: Professional Challenges

Activity: Listen to workplace case studies based on real-life experiences shared by friends or relatives, identify challenges and discuss possible solutions and ethical considerations.

TOTAL: 30 PERIODS

COURSE OUTCOMES (CO):**At end of the course the students will be able to:**

- To demonstrate improved reading and speaking through summarization and structured self-introductions
- To apply listening and discussion strategies by interpreting diverse accents and engaging in collaborative dialogues
- To produce professional emails and analyse career-related documents with clarity
- To deliver concise presentations and craft effective job applications tailoring to contexts
- To show interview readiness and ethical awareness by engaging in mock interviews and analysing workplace challenges.

TEXT BOOKS:

1. Meenakshi Raman & Sangeeta Sharma, Technical Communication: Principles and Practice Oxford University Press, 2022.
2. Pushp Lata & Sanjay Kumar, Communication Skills, Oxford University Press, 2011

REFERENCE BOOKS:

1. Alex, K, 2019, Soft Skills: Know Yourself and Know the World, New Delhi: S. Chand & Company Limited.
2. Butterfield, Jeff, 2015, Soft Skills for Everyone. New Delhi: Cengage Learning.
3. Dhawan, Erica. (2021). Digital Body Language: How to Build Trust and Connection, No Matter the Distance. New York: St. Martin's Press.
4. Gallo, Carmine. (2014). Talk Like TED: The 9 Public-Speaking Secrets of the World's Top Minds. New York: St. Martin's Press.
5. Interact English Lab Manual for Undergraduate Students, 2016, Hyderabad: Orient BlackSwan.
6. Mitra, Barun K, 2016, Personality Development and Soft Skills, New Delhi: Oxford University Press.
7. Raman, Meenakshi and Sangeeta Sharma, 2022, Professional Communication, Oxford: Oxford University Press.
8. Rizvi, Ashraf, M, 2018, Effective Technical Communication, Chennai: McGraw-Hill Education.

WEBSITE REFERENCES:

- <https://www.coursera.org/learn/english-for-career-development>
- <https://owl.purdue.edu/>
- <https://www.mindtools.com/>
- <https://www.toastmasters.org/resources/public-speaking-tips>
- <https://www.ted.com/topics/communication>
- <https://learnenglish.britishcouncil.org/skills>
- <https://www.indeed.com/career-advice/resumes-cover-letters>
- <https://www.skillsyouneed.com/>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	2	-	2	3	-	1	1	1
CO2	-	-	-	-	-	2	-	2	3	-	1	1	2
CO3	-	-	-	-	-	2	-	2	3	-	1	1	3
CO4	-	-	-	-	-	2	-	2	3	-	1	1	3
CO5	-	-	-	-	-	2	-	2	3	-	1	1	3
AVG	-	-	-	-	-	2	-	2	3	-	1	1	2.4

JBM2511	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To understand the principles and applications of various biomedical therapeutic devices.
- To understand the principles and applications of various biomedical diagnostic devices.
- To learn the working mechanisms of electrosurgical units and their role in medical procedures
- To develop skills in biomedical safety and testing by performing electrical safety measurements
- To gain hands-on experience in operating and analyzing bioelectrical signals using both real and virtual lab environments.

LIST OF EXPERIMENTS:

1. Shortwave diathermy
2. Ultrasonic diathermy
3. Study of Medical Stimulator
4. Cutting and Coagulation operations using Electrosurgical Unit
5. Recording of Audiogram
6. Fibrillation correction using Defibrillator
7. Study of Pacemaker
8. Study of Hemodialysis unit
9. Electrical Safety measurements

Virtual Lab Experiments:

10. Simulation of Electrocardiogram (ECG)
11. Monitoring of Electroencephalogram (EEG) signal
12. Simulation of Hemodialysis Dialysis Machine

TOTAL: 60 PERIODS

LAB REQUIREMENTS FOR 30 STUDENTS

1. Short wave Diathermy 1No.
2. Ultrasound diathermy 1No.
3. Medical stimulator 1No
4. Defibrillator 1No.
5. Pacemaker 1No.
6. Electrical Safety Analyzer 1No.
7. Surgical diathermy with analyzer 1No
8. Audiometer 1No
9. PC with high speed internet connectivity 5Nos.

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Demonstrate the operating principles and therapeutic effects of shortwave, ultrasonic diathermy and electrosurgical units.
- Measure and interpret physiological signals such as audiograms, ECG and EEG using diagnostic instrumentation.
- Analyze the functioning of life-support devices including pacemakers, defibrillators and hemodialysis units.
- Evaluate electrical safety parameters in biomedical equipment to ensure patient and operator protection.
- Perform virtual simulations of diagnostic and therapeutic equipment to strengthen practical understanding of biomedical systems.

WEBSITE REFERENCES:

- <https://www.youtube.com/watch?v=KNmQCQi-fnE>
- <https://www.youtube.com/watch?v=Q03SbmORSbY>
- https://www.youtube.com/watch?v=_IVtDi1pb3Q
- <https://www.youtube.com/watch?v=UGoG0qORoqA>
- https://www.youtube.com/watch?v=FHpuzI_zYKU
- <https://www.youtube.com/watch?v=WgKCUjPcDY0>
- <https://www.youtube.com/watch?v=e7iWrj7rUjA>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	1	2	1	1	1	1	-	1	1	3
CO2	2	2	2	1	2	1	1	1	1	-	1	1	3
CO3	2	2	1	1	2	2	3	1	1	-	1	1	3
CO4	2	2	1	2	3	1	-	1	1	-	1	2	2
CO5	1	1	1	1	1	1	-	3	3	1	2	1	2
AVG	1.8	1.8	1.4	1.2	2	1.2	1.66	1.4	1.4	1	1.2	1.2	2.6

JGE2541	INDUSTRY 4.0 LABORATORY	L	P	T	C
		0	0	4	2

COURSE OBJECTIVES

- To provide a thorough understanding of Arduino and ESP32 platforms
- To equip learners with foundational and practical knowledge of the Raspberry Pi platform
- To develop a deep understanding of industrial sensor and actuator networks
- To provide a comprehensive introduction to build basic IoT sensing systems
- To introduce the foundational concepts of mobile robotics

MODULE I ARDUINO AND ITS APPLICATIONS

Arduino Fundamentals, Advanced Interfacing & ESP32 Concepts, Hands-on Lab -ESP32 GPIO & Advanced Applications, Project presentations.

MODULE II RASPBERRY PI FOR EMBEDDED SYSTEMS AND IOT

Raspberry Pi fundamentals, setting up Raspberry Pi (OS installation, configurations), Hands-on Lab – GPIO, Serial port & Data collection, Hands – on Lab – Actuators & Complete Projects.

MODULE III INDUSTRIAL SENSOR NETWORKS AND AUTOMATION

Industrial sensor networks – Hands – on lab: Advanced actuators. Industry applications and case studies – Complete sensor – actuator system, Project presentations.

MODULE IV FUNDAMENTALS OF IoT SYSTEMS AND CLOUD INTEGRATION

IoT Fundamentals, Sensors in IoT applications, Hands – on lab: Basic IoT sensing, IoT Connectivity and Cloud Integration, Hands – on lab: Cloud integration, IoT project planning and deployment, Project presentations.

MODULE V INTRODUCTION TO ROBOTICS, SENSORS AND ACTUATORS

Introduction to robotics basics and key components, Introduction to sensors and actuators, Mobile robot fundamentals, Basic motion control principles, Introduction to sensor – based navigation, Project Integration, building a robot that can follow lines and avoid obstacles.

TOTAL: 60 PERIODS

COURSE OUTCOMES

At the end of the course, the student should be able to:

- Program using Arduino and interfacing techniques
- Design and implement end-to-end embedded and IoT solutions.
- Apply knowledge in industrial automation and smart systems
- Build basic IoT sensing systems
- Develop a mobile robot capable of line follow and obstacle avoidance

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	-	-	2	2	-	3	2	1
CO2	3	3	3	3	3	-	-	2	2	-	3	3	2
CO3	3	3	3	3	3	2	-	3	2	2	3	3	2
CO4	3	3	3	3	3	2	-	3	2	2	3	2	1
CO5	3	3	3	3	3	2	2	3	3	3	3	3	2
AVG	3	3	3	3	3	2	2	2.6	2.2	2.3	3	2.6	1.6

JPT2042	TECHNICAL SKILLS AND APTITUDE	L	T	P	C
		0	0	2	*

COURSE OBJECTIVES:

- To make students analyze and solve problem in technical as well as aptitude. Enhance the Technical skills and basics of programming language
- To make the students understand how to apply the practical knowledge with real time applications.
- To make the students think and draw a conclusion from different scenarios.
- To help the students understand OOPS and python programming concepts
- To help the students understand concepts and problems in OOPS and python.

UNIT 1 - FUNDAMENTALS OF C++

6

Introduction to C++ - Data Types and Operators - Control Structures - Functions in C++ - Arrays and Strings - Structures and Unions - File Handling

UNIT 2 - OBJECT-ORIENTED PROGRAMMING (OOP) & ADVANCED C++

6

Object-Oriented Programming (OOP) - Inheritance & Polymorphism - Operator Overloading - Templates and Exception Handling - Standard Template Library (STL) - Multi-threading & Advanced Topics

UNIT 3 - PYTHON BASICS & FUNDAMENTALS

6

Introduction to Python - Data Types & Variables - Operators & Expressions - Control Flow Statements - Functions & Modules - File Handling - Exception Handling

UNIT 4 - QUANTITATIVE APTITUDE

6

Time and work - Pipes and Cistern - Time and Distance - Problems on Trains - Boats and streams - Arithmetic and Geometric progression

UNIT 5 - LOGICAL REASONING

6

Syllogism: Statement and Conclusion - Clocks - Inequalities - Non Verbal Reasoning - Logical Sequence, Inferred Meaning

TOTAL: 30 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Enhance their knowledge in OOPS concepts
- Enhance knowledge in PYTHON programming
- Gain knowledge in Coding the concepts of python programming.
- Solve the complex Arithmetic problems practically with real time application problems
- Think logically in solving problems enhance their decision making for difficult situations.

TEXT BOOKS:

1. Dr.E. Balagurusamy,"Programming in C++" complete reference 8th Edition.
2. "THE COMPLETE REFERENCE PYTHON", Herbert schildt., McGraw Hill Education, 2011.
3. Python: The Complete Reference by Martin Brown and Martin C.Brown Published in 2014.
4. Python in a nutshell by Alex Martelli Revised in March 2013.
5. Dr. R.S Agrawal, "Quantitative Aptitude" and Non Verbal Reasoning published in 2000

WEBSITE REFERENCES:

- <https://www.indiabix.com/aptitude/questions-and-answers/>
- <https://m4maths.com/placement-puzzles.php>
- www.freshers world.com
- www.careerride.com
- www.youtube.com/watch/python
- www.youtube.com/watch/concepts of python
- <https://stackoverflow.com/>
- <https://www.w3schools.com/>
- <https://www.geeksforgeeks.org/>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	3	-	-	2	2	2	3	3	2
CO2	3	3	3	3	3	-	-	2	2	2	3	3	2
CO3	3	3	3	3	3	-	-	2	2	2	3	3	2
CO4	3	3	3	3	3	-	-	2	2	2	3	2	1
CO5	3	3	3	3	3	-	-	3	3	3	3	2	1
AVG	3	3	3	2.8	3	-	-	2.2	2.2	2.2	3	2.6	1.6

SEMESTER 6

JBM2601	ARTIFICIAL INTELLIGENCE AND PATTERN RECOGNITION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To evaluate various Artificial Intelligent agents
- To explain about the different searching strategies involved in problem solving
- To specify the representation of knowledge and reasoning
- To understand the concepts of pattern recognition
- To outline the various applications of AI and Pattern Recognition in Healthcare

UNIT I - FOUNDATIONS OF ARTIFICIAL INTELLIGENCE 9

Introduction - Foundations of AI - History of AI - Intelligent agent - Types of agents – Structure - Problem solving agents - Software Agents Architecture for Intelligent Agents - Agent communication.

UNIT II - PROBLEM SOLVING AND SEARCHING 9

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics –Local Search Algorithms and Optimization Problems - Constraint Satisfaction Problems - Backtracking Search - Game Playing - Optimal Decisions in Games - Alpha - Beta Pruning - Stochastic Games

UNIT III - KNOWLEDGE REPRESENTATION AND REASONING 9

Knowledge Representation - predicate logic — semantic nets - frames and inheritance, Ontological Engineering - Categories and Objects - Events - Mental Events and Mental Objects - knowledge using rules, Reasoning Systems for Categories - Reasoning with Default Information - Reasoning under uncertainty

UNIT IV - PATTERN RECOGNITION AND CLUSTERING TECHNIQUES 9

Overview of Pattern recognition - Types of Pattern recognition, Parametric and Nonparametric approach, Unsupervised learning- Hierarchical clustering - Similarity measures, Single and Complete and Average-linkage algorithm, Ward's method. Partitional clustering, Forgy's Algorithm, k-means algorithm,

UNIT V – PATTERN RECOGNITION MODELS IN HEALTHCARE 9

Principal Component Analysis (PCA), Independent Component Analysis (ICA), Self-organizing maps, Diagnostic medical imaging analysis, Natural Language Processing in Healthcare, Predictive analytics for disease diagnosis and prognosis.

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Analyze the characteristics and behavior of problem-solving agents.
- Compare different searching strategies involved in problem solving.
- Assess the representation of knowledge and reasoning.
- Apply pattern recognition techniques for classification.
- Develop applications using Artificial Intelligence and Pattern Recognition in the healthcare domain.

TEXT BOOKS:

1. Stuart J. Russell, Peter Norvig, "Artificial Intelligence - A Modern Approach", 4th Edition, Pearson Publishers, 2022.
2. Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", 1st Edition, Pearson Publishers, 2023.

REFERENCE BOOKS:

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair, "Artificial Intelligence", Third Edition, Tata McGraw-Hill Education, 2008.
2. Dheepak Khemani, "A first course in Artificial Intelligence", McGraw Hill Education Pvt. Ltd., New Delhi, 2013.
3. Anke Meyer-Baese, Volker J. Schmid, "Pattern Recognition and Signal Analysis in Medical Imaging", Elsevier Science, 2016.
4. Ronald M. Razmi, "AI Doctor: The Rise of Artificial Intelligence in Healthcare", Wiley Publications, 2024.
5. Adam Bohr, Kaveh Memarzadeh, "Artificial Intelligence in Healthcare", Elsevier Science, 2020.
6. Eric Topol. Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. New York: Basic Books, 2019
7. Sudip Misra and Subhadeep Sarkar. Internet of Things in Healthcare: Technologies, Applications, and Challenges. Boca Raton: CRC Press, 2017.
8. Eric Topol and Steven R. Steinhubl. Wearable Sensors in Healthcare. Cambridge, MA: Academic Press, 2019.

WEBSITE REFERENCES:

- <https://cloudsek.com/blog/intelligent-searching-techniques-in-artificial-intelligence>
- <https://www.aiforanyone.org/glossary/first-order-logic>
- <https://www.analyticsvidhya.com/blog/2021/10/an-introduction-to-problem-solving-using-search-algorithms-for-beginners/>
- <https://www.geeksforgeeks.org/pattern-recognition-introduction/>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	1	1	–	–	1	–	2	2	1
CO2	3	3	1	3	1	1	–	–	1	–	2	2	2
CO3	3	3	1	2	1	–	–	–	1	–	2	2	2
CO4	3	3	2	2	2	–	–	–	1	–	2	3	2
CO5	3	2	2	2	2	1	–	–	1	–	2	3	3
AVG	3	2.6	1.4	2.2	1.4	1	–	–	1	–	2	2.8	2.2

JBM2621	MEDICAL IMAGE PROCESSING	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To introduce human visual perception, image acquisition and representation
- To equip in various image enhancement techniques for improving image quality
- To recover high-quality images from degraded or incomplete data
- To provide knowledge on segmentation techniques for accurate analysis of medical images
- To extract and analyze relevant features from medical images for classification

UNIT I - BASICS OF MEDICAL IMAGE PROCESSING

9

Fundamentals of Image processing, visual perception, image sensing, sampling, quantization, Spatial and intensity resolution, pixel relationships, arithmetic/logical operations, Image transforms, and medical image file formats.

UNIT II - IMAGE ENHANCEMENT TECHNIQUES

9

Intensity transformations, histogram equalization/specification, spatial and frequency domain filtering (smoothing, sharpening), homomorphic filtering, and hybrid filters for medical image enhancement.

UNIT III - IMAGE RESTORATION TECHNIQUES

9

Image restoration - Image degradation models, estimation - blur model, medical image restoration, blur identification, super resolution method - applications of image restoration.

UNIT IV - IMAGE SEGMENTATION

9

Image Segmentation - points detection - line detection - edge detection methods, segmentation methods: histogram, split and merge, region growing, watershed, K-means.

UNIT V - FEATURE EXTRACTION AND ANALYSIS

9

Selection of features - shape related features, Fourier descriptors, texture analysis, feature extraction, classification and evaluation of computer aided diagnostic systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Understand and apply image acquisition, representation, basic operations, and medical image file formats.
- Apply appropriate enhancement techniques to effectively enhance medical images.
- Analyze and apply restoration and reconstruction methods, for medical image enhancement.
- Evaluate various segmentation methods to extract significant information from medical images.
- Extract shape and texture-based features, apply classification methods, and evaluate the performance of computer-aided diagnostic systems.

LIST OF EXPERIMENTS:**Simulation using MATLAB**

1. Image sampling and quantization.
2. Analysis of spatial and intensity resolution of images
3. Intensity transformation of images
4. Histogram Processing and basic thresholding functions.
5. Transforms - Walsh, Hadamard, DCT, Haar
6. Image segmentation - Edge detection, Line detection, Point detection.
7. Segmentation using watershed transformation.
8. Display of bit planes of an image
9. Basic Morphological operations
10. Image Compression techniques

TOTAL: 30 PERIODS

TOTAL: 75 HOURS

LAB Requirements for a Batch of 30 students:

- PCs with related accessories -15 No.s
- MATLAB software licence with Image Processing toolbox - 15 No.s

TEXT BOOKS:

1. Digital Image Processing , Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins. Prentice Hall, Fourth Edition, 2018. (Unit I and II)
2. G.R. Sinha, Bhagwaticharan patel, Medical Image Processing: Concepts and Applications, PHI Learning private limited 2014. (Unit III)
3. Kayvan Najarian and Robert Splinter, "Biomedical Signal and Image Processing", Second Edition, CRC Press, 2005.
4. Rangaraj M. Rangayyan, "Biomedical Image Analysis", CRC Press, 2000.
5. E. R. Davies, "Computer & Machine Vision", Fourth Edition, Academic Press, 2012.

REFERENCE BOOKS:

1. Medical Image Processing, Reconstruction and Restoration, Jiri Jan, Taylor & Francis Group, 2006.
2. Biosignal and Biomedical Image Processing, MATLAB Based Applications, John L. Semmlow. Publisher: Marcel Dekker, Inc.
3. Isaac N. Bankman, Handbook of Medical Image Processing and Analysis, 2nd Edition, Elsevier, 2009.

WEBSITE REFERENCES:

- <https://biomedikal.in/2011/01/lecture-notes-on-basics-of-digital-image-processing/>
- <https://archive.nptel.ac.in/courses/117/105/117105135/>
- https://www.cse.lehigh.edu/~huang/Chapt10_CRC.pdf
- <https://ocw.mit.edu/courses/hst-582j-biomedical-signal-and-image-processing-spring-2007/>
- <https://www.youtube.com/watch?v=QIXGu4HZAD4&list=PLxRh1iCA-FASB5SQbTXSw50IJtiQivTsQ&index=1>
- Fourier reconstruction of MRI images - http://irep.iium.edu.my/7325/1/MRI_Reconstruction_Using_Discrete_Fourier.pdf
- CAD systems and evaluation metrics -

<https://pmc.ncbi.nlm.nih.gov/articles/PMC4108682/>

- Retinal Image Analysis -
<https://www.siue.edu/~sumbaug/RetinalProjectPapers/REVIEW%20ARTICLE%20Retinal%20image%20analysis%20--%20Concepts,%20applications%20and%20potential.pdf>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	1	1	2	–	–	–	1	–	1	2	2
CO2	3	2	1	2	3	–	–	–	1	–	1	2	2
CO3	3	2	1	2	3	–	–	–	1	–	1	2	3
CO4	3	2	2	2	3	–	–	–	1	–	1	3	3
CO5	3	2	2	2	3	–	–	1	2	1	2	3	3
AVG	3	1.8	1.4	1.8	2.8	–	–	1	1.2	1	1.2	2.4	2.6

JBM2602	RADIOLOGICAL EQUIPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the generation of X-ray and its uses in imaging
- To interpret the internal structures, diagnose diseases and injuries
- To understand the techniques used for visualizing cross-sections of the whole body
- To learn the fundamental physics of nuclear medicine
- To discuss design, components and working of various modalities of radiation therapy

UNIT I - X-RAY TECHNOLOGY

9

X-Ray Equipment - X-Ray imaging: X-ray Image intensifier, flat panel detector and source of noise - Digital and Computed Radiography - Fluoroscopy, Digital fluoroscopy, 3D fluoroscopy, Angiography, Cine angiography, Digital Subtraction Angiography, Mammography, High-frequency X-ray generators, Rotating anode tube technology.

UNIT II - COMPUTED TOMOGRAPHY

9

Principles of tomography, Tomosynthesis, Generations of CT, CT Equipment, Cone Beam CT, Flat panel detector CT, spiral CT scanning, ultrafast CT scanners. Image reconstruction techniques - back projection and iterative method.

UNIT III - MAGNETIC RESONANCE IMAGING

9

MRI Equipment - gradient coils, radio frequency coils, shim coils, rotation and precession, Induction of magnetic resonance signals - bulk Magnetization, Relaxation time T1 and T2, Image sequences, Free Induction Decay, Functional MRI, Diffusion Weighted Imaging, perfusion MRI, Cardiac MRI.

UNIT IV - NUCLEAR MEDICINE SYSTEM

9

Radio Isotopes, Radiation detectors types, Gamma camera, Theranostics, Pulse Height Analyzer, targeted alpha therapy, Single photon emission computed tomography, Positron emission tomography, Hybrid imaging.

UNIT V - RADIATION THERAPY

9

LINAC, Tele-Cobalt unit, Gamma Knife, CT simulator, Stereotaxic Radiosurgery, 3D CRT, EBRT, IMRT, IGRT TomoTherapy, Cyber Knife, Brachytherapy, Proton therapy, Radiation measuring films and badges, Thermo Luminescent dosimeters (TLD), Optically Stimulated Luminescence (OSL) dosimeter and electronic personal dosimeter (EPD), Annual dose limits & Regulations.

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Analyze image quality parameters and factors affecting image resolution and contrast.
- Explain CT image acquisition, reconstruction techniques, and image quality factors.
- Describe MRI image formation, pulse sequences and contrast mechanisms.
- Explain the working principles of nuclear medicine imaging equipment.
- Describe the construction and functioning of radiation therapy equipment.

TEXT BOOKS:

1. Steve Webb, “Webb’s Physics of Medical Imaging”, Second Edition, CRC Press, 2012. (Units I,II, III & IV).
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi,2003. (Unit V)

REFERENCE BOOKS:

1. Gopal.B.Saha, “Physics and Radiobiology of Nuclear Medicine” - Third edition Springer, 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”, 2007.
5. R.Hendee and Russell Ritenour, “Medical Imaging Physics”, Fourth Edition William,Wiley Liss, 2002
6. Thayalan K, Basic radiological Physics (2017), 2nd Ed: Jaypee brothers medical Publishers (P) Ltd., New Delhi
7. 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.

WEBSITE REFERENCES:

- <https://www.ncbi.nlm.nih.gov/books/NBK546155/>
- <https://www.mayoclinic.org/tests-procedures/stereotactic-radiosurgery/about/pac-20384526>
- <https://medicine.lau.edu.lb/related-entities/zahi-hakim-museum/files/introduction-to-rotating-anode-tubes.pdf>
- <https://radiopaedia.org/articles/mr-perfusion-weighted-imaging-1>
- <https://info.atlantisworldwide.com/blog/the-difference-between-a-ct-scanner-ct-simulator>
- <https://my.clevelandclinic.org/health/diagnostics/21961-heart-mri>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	-	1	-	1	2	2
CO2	3	2	1	2	2	1	1	-	1	-	1	2	2
CO3	3	2	1	2	2	1	1	-	1	-	1	2	3
CO4	3	2	1	1	2	1	1	-	1	-	1	2	3
CO5	3	2	1	1	2	2	2	-	1	-	1	2	3
AVG	3	2	1	1.4	2	1.2	1.2	-	1	-	1	2	2.6

JBM2611	VIRTUAL INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To understand the concept of virtual instrumentation and its applications
- To design and develop virtual instruments using software platforms like LabVIEW, VLab & Biopython
- To apply appropriate techniques to analyze biomedical signals.
- To apply VI tools to extract features from physiological signals.
- To Implement signal processing techniques, including feature extraction, wavelet transformation, and digital filtering.

List of Experiments

LabVIEW based

Experiments

1. Basic Arithmetic and Logical operations
2. Simulation of ECG signal
3. Acquisition of ECG
4. Analysis of ECG
5. Feature extraction of ECG using Wavelet transformation
6. Analysis of EEG
7. Analysis of EMG
8. Design of Digital Filters
9. Generation and manipulation of Signal

VLAB & Biopython based Experiments

1. Basic arithmetic and logical operations
2. Design and Simulation of decoders, encoders, multiplexer and demultiplexer
3. Study of Sampling theorem and the effect of under sampling
4. Study of FIR filter design using Windowing method
5. Physiological signal Processing using Biopython

TOTAL: 60 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Perform basic arithmetic, logical operations, and signal generation/manipulation using LabVIEW and Biopython.
- Acquire and analyze physiological signals including ECG, EEG, and EMG using LabVIEW and Biopython tools.
- Extract and interpret features from biomedical signals using wavelet transformation and other signal processing techniques.
- Design and implement digital filters, decoders, encoders, multiplexers, and demultiplexers for biomedical signal processing applications.
- Simulate and evaluate sampling, FIR filter designs, and physiological signal processing algorithms for practical biomedical applications.

WEBSITE REFERENCES:

- <https://www.youtube.com/watch?v=l2rCLGsylgY>
- <https://www.youtube.com/watch?v=yFoF51eao7g>
- <https://www.vlab.co.in/>
- <https://biopython.org/>

LAB REQUIREMENTS FOR A BATCH OF 30 STUDENTS:

1. PC with LABVIEW Software - 8 No.s
2. PCs with high speed internet connectivity with VLAB Platform - 5 No.s
3. PC with Python Software (Biopython tool package) - 17 No.s

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	3	-	-	1	1	-	1	3	2
CO2	2	2	1	2	3	-	-	1	1	-	1	3	2
CO3	2	2	1	2	3	-	-	1	1	-	1	3	2
CO4	2	2	2	2	3	-	-	2	1	1	1	3	2
CO5	2	2	2	2	3	-	-	2	2	1	2	3	2
AVG	2	1.8	1.4	1.8	3	-	-	1.4	1.2	1	1.2	3	2

JGE2641	PRODUCT DEVELOPMENT LABORATORY	L	P	T	C
		0	0	4	2

COURSE OBJECTIVES:

- To provide overview of product development boards
- To familiarize students with embedded platforms, sensors, actuators, communication protocols, and cloud-based IoT integration.
- To enhance problem-solving skills in real-world applications across various domains
- To develop prototyping skills using modern tools and techniques
- To provide hands-on experience in designing and product development.

LIST OF EXPERIMENTS / MODULES

Module 1: Introduction to Product Development & Embedded Platforms

- Introduction to IoT and Embedded Systems in various domains.
- Overview of development boards (Arduino, ESP32, STM32, Raspberry Pi).
- Basics of sensors, actuators, and communication modules.
- Industry best practices and future scope in IoT and embedded systems.
- Hands-on: Blinking LED, sensor interfacing, GPIO control.

Module 2: Communication Protocols & IoT Integration

- Overview of wired and wireless communication protocols (UART, I2C, SPI, Bluetooth, Wi-Fi, MQTT, LoRa).
- Hands-on: Interfacing with an IoT cloud platform (Thingspeak, Firebase, AWS IoT, Google Firebase).
- Data acquisition and visualization using IoT dashboards.

Module 3: Embedded System Development & Real-Time Processing

- Introduction to RTOS for embedded applications.
- Hands-on: Task scheduling and real-time data processing using FreeRTOS on ESP32.
- Sensor fusion techniques for real-world applications.

Module 4: Domain-Specific Product Development

Students will choose a domain and develop a prototype based on real-world needs. Sample applications are listed but not limited to: Consumer electronics, wearable electronics, automotive Electronics, Agricultural, EV, BMS, Energy monitoring, smart metering, biomedical products such as IoT based patient monitoring, signal processing etc. home automation, product for automobile industries.

Module 5: Prototyping, Testing, Product deployment and Documentation

Hardware design: PCB designing using KiCad / Eagle.

- Firmware development and debugging using Keil / MPLAB / Arduino IDE.
- Product reliability testing and performance analysis.
- Project presentations, demonstration of working prototypes.
- Writing technical documentation, reports, and product manuals.

TOTAL: 60 PERIODS

TOOLS & SOFTWARE REQUIRED:

- **Development Boards:** Arduino UNO, ESP32, STM32, Raspberry Pi
- **Sensors & Actuators:** Temperature, humidity, motion, pressure sensors, servo motors, relays
- **Communication Modules:** Bluetooth (HC-05), Wi-Fi (ESP8266/ESP32), LoRa modules
- **Embedded Development Environments:** Arduino IDE, STM32CubeIDE, Keil uVision, MPLAB X, PlatformIO
- **IoT Platforms:** Thingspeak, AWS IoT, Google Firebase, Blynk
- **PCB Design Tools:** KiCad, Eagle, Altium Designer
- **Simulation Tools:** Proteus, Tinkercad, MATLAB Simulink

COURSE OUTCOMES:

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

- Design and implement embedded systems for real-world applications.
- Develop IoT-based solutions using appropriate hardware and software tools.
- Interface sensors, actuators, and communication modules with microcontrollers.
- Analyze product requirements and create working prototypes.
- Document product development processes and present project outcomes.

TEXTBOOKS:

1. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill.
2. Arshdeep Bahga, Vijay Madisetti, Internet of Things: A Hands-On Approach, Universities Press.
3. Muhammad Ali Mazidi, The 8051 Microcontroller and Embedded Systems, Pearson.

REFERENCE BOOKS:

1. Pethuru Raj, Anupama C. Raman, The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press.
2. Jan Axelson, Embedded Ethernet and Internet Complete, Lakeview Research.
3. Jonathan W. Valvano, Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, CreateSpace.
4. Adrian McEwen, Designing the Internet of Things, Wiley.

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	3	-	3	2	-	-	1	-	-	3	1
CO2	3	-	3	-	3	2	-	-	2	-	-	3	2
CO3	3	2	3	-	3	-	-	-	2	-	-	3	3
CO4	3	3	3	2	3	2	-	-	2	-	-	2	2
CO5	-	-	-	-	-	-	-	2	2	2	2	1	1
AVG	3	2.5	3	2	3	2	-	2	1.8	2	2	2.4	1.8

JPT2042	TECHNICAL SKILLS AND APTITUDE	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To make students analyze and solve problem in technical as well as aptitude. Enhance the technical skills and basics of programming language
- To make the students understand how to apply practical knowledge with real time applications.
- To make the students think and draw a conclusion from different scenarios.
- To help the students understand JAVA programming concepts
- To help the students understand concepts and develop new Applications in JAVA.

UNIT I - OBJECT-ORIENTED & ADVANCED PYTHON

6

Object-Oriented Programming (OOP) - Advanced Data Structures & Algorithms - Decorators & Closures - Regular Expressions & String Manipulation - Multi-threading & Multiprocessing

UNIT II - JAVA FUNDAMENTALS

6

Introduction to Java - Data Types & Variables - Operators & Control Statements - Functions & Methods - Arrays & Strings

UNIT III - OBJECT-ORIENTED PROGRAMMING (OOP) & ADVANCED JAVA

6

Object-Oriented Programming (OOP) Basics - Exception Handling - Inheritance & Polymorphism - Collections Framework - File Handling & Serialization

UNIT IV - QUANTITATIVE APTITUDE

6

Permutation and combination: Letter, Number and circular permutation - Probability - Logarithm - Mensuration - Data sufficiency

UNIT V - LOGICAL REASONING

6

Calendar - Visual Reasoning - Mirror Image and Water Image - Picture analogy - Pattern completion - Data Interpretation - Selection decision table

TOTAL: 30 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- To enhance their knowledge in OOPS & PYTHON concepts
- To gain knowledge in Coding the concepts of JAVA programming
- Gain knowledge in coding the concepts of OOPS and JAVA programming.
- To solve the complex Arithmetic problems practically with real time application problems
- To think logically in solving problems enhance their decision making for difficult situations.

TEXT BOOKS:

1. Herbert Schildt, "Java The complete reference", 8th Edition, McGraw Hill Education, 2011.
2. Cay S. Horstmann, Gary cornell, "Core Java Volume –I Fundamentals", 9th Edition, Prentice Hall, 2013.
3. Dr. R.S Agrawal, "Quantitative Aptitude" and Non Verbal Reasoning published in 2000.
4. S.Chand - A Modern Approach to Logical Reasoning Published in 2000.

WEBSITE REFERENCES:

- <https://www.indiabix.com/aptitude/questions-and-answers/>
- <https://m4maths.com/placement-puzzles.php>
- [www.freshers world.com](http://www.freshersworld.com)
- www.careerride.com
- www.youtube.com/watch/python
- [www.youtube.com/watch/concepts of python](http://www.youtube.com/watch/concepts%20of%20python)
- <https://stackoverflow.com/>
- <https://www.w3schools.com/>
- <https://www.geeksforgeeks.org/>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	3	-	-	2	2	2	3	2	2
CO2	3	3	3	3	3	-	-	2	2	2	3	2	2
CO3	3	3	3	3	3	-	-	2	2	2	3	1	1
CO4	3	3	3	3	3	-	-	2	2	2	3	1	1
CO5	3	3	3	3	3	-	-	3	3	3	3	1	1
AVG	3	3	3	2.8	3	-	-	2.2	2.2	2.2	3	1.4	1.4

SEMESTER 7

JNC2761	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	-

COURSE OBJECTIVES

- To Understand the Introduction and basic Terminologies safety.
- To enable the students to learn about the Important Statutory Regulations and standards.
- To enable students to Conduct and participate the various Safety activities in the Industry.
- To have knowledge about Workplace Exposures and Hazards.
- To assess the various Hazards and consequences through various Risk Assessment Techniques.

UNIT I - SAFETY TERMINOLOGIES

9

Hazard - Types of Hazard - Risk-Hierarchy of Hazards Control Measures - Lead indicators - lag Indicators – Flammability - Toxicity Time-weighted Average (TWA) - Threshold Limit Value (TLV) - Short Term Exposure Limit (STEL) - Immediately dangerous to life or health (IDLH) - acute and chronic Effects- Routes of Chemical Entry - Personnel Protective Equipment - Health and Safety Policy-Material Safety Data Sheet MSDS.

UNIT II - STANDARDS AND REGULATIONS

9

Indian Factories Act-1948- Health- Safety- Hazardous materials and Welfare- ISO 45001:2018 occupational health and safety (OH&S) - Occupational Safety and Health Audit IS14489:1998- Hazard Identification and Risk Analysis- code of practice IS 15656:2006

UNIT III - SAFETY ACTIVITIES

9

Toolbox Talk- Role of safety Committee- Responsibilities of Safety Officers and Safety Representatives- Safety Training and Safety Incentives- Mock Drills- On-site Emergency Action Plan- Off-site Emergency Action Plan- Safety poster and Display- Human Error Assessment

UNIT IV - WORKPLACE HEALTH AND SAFETY

9

Noise hazard- Particulate matter- musculoskeletal disorder improper sitting posture and lifting Ergonomics RULE & REBA- Unsafe act & Unsafe Condition- Electrical Hazards- Crane Safety- Toxic gas Release

UNIT V - HAZARD IDENTIFICATION TECHNIQUES

9

Job Safety Analysis-Preliminary Hazard Analysis-Failure mode and Effects Analysis- Hazard and Operability- Fault Tree Analysis- Event Tree Analysis Qualitative and Quantitative Risk Assessment- Checklist Analysis- Root cause analysis- What-If Analysis- and Hazard Identification and Risk Assessment

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- To Understand the basic concept of safety.
- To Obtain knowledge of Statutory Regulations and standards.
- To Know about the safety Activities of the Working Place.
- To Analyze on the impact of Occupational Exposures and their Remedies
- To Obtain knowledge of Risk Assessment Techniques.

TEXT BOOKS

1. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems, Khanna Publishers
2. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education

REFERENCE BOOKS:

1. Frank Lees (2012) 'Lees' Loss Prevention in Process Industries. Butterworth-Heinemann publications, UK, 4th Edition.
2. John Ridley & John Channing (2008) Safety at Work: Routledge, 7th Edition.
3. Dan Petersen (2003) Techniques of Safety Management: A System Approach.
4. Alan Waring (1996) Safety management system: Chapman & Hall, England
5. Society of Safety Engineers, USA

WEBSITE REFERENCES:

- ISO 45001:2018 occupational health and safety (OH&S) International Organization for Standardization <https://www.iso.org/standard/63787.html>
- Indian Standard code of practice on occupational safety and health audit <https://law.resource.org/pub/in/bis/S02/is.14489.1998.pdf>
- Indian Standard code of practice on Hazard Identification and Risk Analysis IS 15656:2006 <https://law.resource.org/pub/in/bis/S02/is.15656.2006.pdf>

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	1	1	3	2	3	3	1	3	3	3
CO2	2	3	2	2	1	3	3	3	2	1	3	3	3
CO3	2	2	2	2	1	2	2	3	2	1	2	3	3
CO4	3	3	3	2	2	3	2	3	2	1	3	3	3
CO5	3	2	3	2	2	3	2	3	2	2	3	3	3
AVG	2.6	2.6	2.6	1.8	1.4	2.8	2.2	3	2.2	1.2	2.8	3	3

JHS2741	UNIVERSAL HUMAN VALUES	L	T	P	C
		1	0	2	2

COURSE OBJECTIVES:

The objective of the course is four-fold:

- Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
- Strengthening of self-reflection.
- 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 Practical) PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Become more aware of themselves, and their surroundings (family, society, nature);
- Have more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.
- Have better critical ability.
- Become sensitive to their commitment towards what they have understood (human values, human relationship and human society).
- 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.

REFERENCE BOOKS:

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 - Pandit Sunderlal
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)

WEBSITE REFERENCES:

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

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	-	-	-	3	3	3	3	2	3	-	-
CO2	1	1	-	-	-	3	3	3	3	2	3	-	-
CO3	1	2	1	-	-	3	3	3	3	2	3	-	-
CO4	1	2	1	-	-	3	3	3	3	3	3	-	-
CO5	1	2	1	-	-	3	3	3	3	3	3	-	-
AVG	1	1.6	1	-	-	3	3	3	3	2.4	3	-	-

JGE2751	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- Learn basic concepts in entrepreneurship, develop mind-set and skills necessary to explore entrepreneurship
- Apply process of problem - opportunity identification and validation through human centred approach to design thinking in building solutions as part of engineering projects
- 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
- 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
- Prepare and present an investible pitch deck of their practice venture to attract stakeholders

MODULE - I: ENTREPRENEURIAL MINDSET

Introduction to Entrepreneurship: Definition - Types of Entrepreneurs - Emerging Economics - 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

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

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

Business Model and Types - Lean Approach - 9 block Lean Canvas Model - Riskiest assumptions to Business Models - 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

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 (CO):

At end of the course the students will be able to:

- Develop an Entrepreneurial Mind-set and Understand the Entrepreneurial Ecosystem Components and Funding types
- Comprehend the process of opportunity identification through design thinking, identify market potential and customers
- Generate and develop creative ideas through ideation techniques
- Create prototypes to materialize design concepts and conduct testing to gather feedback and refine prototypes to build a validated MVP
- Analyse and refine business models to ensure sustainability and profitability
Prepare and deliver an investible pitch deck of their practice venture to attract stakeholders

REFERENCE BOOKS:

1. Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020). Entrepreneurship, McGrawHill, 11th Edition
2. Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business
3. Blank, S. G., & Dorf, B. (2012). The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company. K&S Ranch
4. Roy, R. (2017). Indian Entrepreneurship: Theory and Practice. New Delhi: Oxford University Press
5. Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. John Wiley & Sons

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	-	1	-	1	3	2	2	2	2	2	-	-
CO2	1	2	1	-	2	3	2	2	2	2	2	-	-
CO3	1	2	3	-	2	2	2	2	2	2	2	1	-
CO4	1	2	3	-	3	2	1	3	3	3	2	1	-
CO5	1	1	3	-	2	2	2	3	3	3	2	1	-
AVG	1	1.75	2.2	-	2	2.4	1.8	2.4	2.4	2.4	2	1	-

JBM2741	COMPREHENSION AND TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To revamp the knowledge gained in the semester and prepare the students to face interview both at the academic and the Industrial Sector
- To encourage the students to study about the recent developments in the field
- To prepare and present technical reports
- To encourage the students to use various teaching aids such as power point presentation and demonstrative models

METHOD OF EVALUATION:

COMPREHENSION:

One period is allotted for comprehension. During this period, a test with objective type questions from competitive exams is conducted in identified technical courses. The evaluation is purely internal. Average of all the test marks shall be calculated, a weightage of 50 marks is awarded to the comprehension component.

TECHNICAL SEMINAR:

Three periods are allotted for the technical seminar. During the seminar session each student is expected to prepare and present a technical topic for duration of 10 minutes.

Each student is expected to make presentation at least twice during the semester and the student is evaluated based on various parameters such as topic chosen, content delivery, communication skills and presentation. A faculty guide is allotted who shall guide and monitor the progress and attendance of all the students. Equal weightage is considered for the two seminar sessions for a total weightage of 50 marks.

The total mark awarded for the course shall be the sum of marks scored out of 50 each for the two components. Evaluation is purely internal.

EVALUATION:

Technical Seminar (50)	Comprehension (50)	Total (100)	Internal Marks (50)	Internal Marks (100)
-----------------------------------	-------------------------------	------------------------	--------------------------------	---------------------------------

TOTAL: 30 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Consolidate all the engineering concepts acquired in the course of study.
- Enrich their technical knowledge.
- Prepare and present technological developments.
- Communicate effectively the concepts related to the various topics.
- Face the interviews with confidence during the placement drives.

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	-	-	-	-	-	1	1	1	2	1	-
CO2	1	1	-	-	-	-	-	1	2	1	3	1	-
CO3	-	-	-	-	1	-	1	2	3	2	2	1	1
CO4	-	-	-	-	1	-	1	2	3	2	2	1	1
CO5	-	-	-	-	-	1	2	2	3	3	3	1	1
AVG	1.5	1	-	-	1	1	1.33	1.6	2.4	1.8	2.4	1	1

JBM2742	HOSPITAL TRAINING	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To expose to real-time clinical environments
- To understand the operation, application, and maintenance of biomedical equipment used in various hospital departments
- To observe standard procedures in patient monitoring, diagnosis and treatment
- To demonstrate patient-care in a hospital setting.
- To prepare and present technical report on devices of various department

ASSESSMENT:

- Students need to complete training in any leading Multi-speciality hospital for a period of 15 days. They need to prepare an extensive report and submit to their respective course in-charge during the session.
- **Out of the following departments, it is mandatory to complete hands-on training in any 6 departments.** The students can give a presentation of the remaining departments during laboratory hours.
- **Hard copy or certificate must be submitted along with the report, as a proof of training undergone. The report shall contain:**
 - Cover page
 - Acknowledgement
 - Table of Contents
 - Introduction
 - Hospital Profile
 - Training undergone
 - Name of the department (Instruments observed/ Procedures witnessed/ Manufacturer details/ Skills learned/ Observation/ Photos attached)
 - Conclusion

Mark split for the final examination shall be as follows:

Project report (30)	Power Point Presentation (30)	Observation & VIVA (20)	Certificate (20)	Total (100)
------------------------	-------------------------------------	----------------------------	------------------	----------------

S. No.	Departments
1	Lab Safety Protocol (Infection Control/Quality Control/CSSD)
2	Hematology and Clinical Pathology (Microbiology/Serology/Immunology/Molecular Diagnostics/Blood Bank)
3	Orthopedic and Physiotherapy
4	Nuclear Medicine (CT Scan/MRI Scan/PET/SPECT/Gamma Camera)
5	Operation Theatre (Intensive Care Units/Critical Care Units/Casualty/Trauma Care/Palliative Care)
6	Urology & Nephrology (Dialysis/Artificial Kidneys/Endoscopy)
7	Obstetrics and Gynecology
8	Dental & ENT
9	Neurology (Brain & Spine)

TOTAL: 30 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Demonstrate practical understanding of biomedical equipment operation and application in real-time clinical environments.
- Observe and interpret standard procedures in patient monitoring, diagnosis, and treatment across multiple hospital departments.
- Perform patient-care activities under supervision, applying hospital protocols and safety standards.
- Analyze and document technical details, procedures, and observations of biomedical devices in various departments.
- Prepare and present comprehensive technical reports and presentations reflecting hands-on hospital training experience.

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	-	-	-	-	3	3	2	2	1	3	1	-
CO2	-	-	-	-	-	2	2	3	3	1	3	1	-
CO3	-	-	-	-	-	3	3	3	2	1	2	1	-
CO4	-	-	-	-	-	2	3	2	2	1	3	1	-
CO5	-	-	-	-	-	3	3	2	2	1	3	1	-
AVG	1	-	-	-	-	2.6	2.8	2.4	2.2	1	2.8	1	-

JBM2743	INTERNSHIP	L	T	P	C
		-	-	4	2

COURSE OBJECTIVES:

- To get connected with reputed industry/ laboratory/academia / research institute
- To get practical knowledge on Product Development / Software Design and Development / Testing / Analytics/ research/ startups/ professionalism / business processes and insights / domain knowledge/ Industry Practices/ and other related aspects and develop skills to solve related problems
- To develop technical, soft, team skills to cater to the needs of the industry / academia / businesses / research / organizations in the core aspects of Automation, Digitalization

The students may undergo Industrial training for a period as specified in the Curriculum during summer/winter vacation. In this case the training has to be undergone continuously for the entire period. In lieu of Industrial training, students may undergo Internship at Industry / Research organizations / University (after due approval from Head of the Department) during the IV, V or VI semester breaks for a continuous period of 30 days to an Industry / Organization / University and two credit is allotted in the Seventh semester based on a viva voce examination.

The Industrial / Practical Training, Summer Project, Internship, shall carry 100 marks and shall be evaluated through internal assessment only.

At the end of Industrial/Practical Training/Internship/ Summer Project, the student shall submit an attendance certificate from the organization where he / she has undergone training and a brief report. The evaluation will be made based on this report and a viva-voce Examination, conducted internally by a three-member Departmental Committee constituted by the Head of the Institution consisting of the course coordinator and two experts from the Department. The certificates (issued by the organization) submitted by the students shall be attached to the mark list sent by the Head of the Institution to the Controller of Examinations.

EVALUATION:

Internship Report (40)	Presentation (30)	Viva Voce (30)	Total Marks (100)
-----------------------------------	--------------------------	-----------------------	--------------------------

TOTAL: 30 DAYS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Do Industry Practices, Processes, Techniques, technology, automation and other core aspects of software industry.
- Analyze, Design solutions to complex business problems.
- Build and deploy solutions for target platform.
- Prepare Technical reports and presentation.
- Acknowledge the value of continuing education for oneself and to stay up with technology advancements.

CO-PO/PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	2	1	3	1	1	1	2	2	2	2	1
CO2	3	3	3	2	3	1	1	1	1	2	2	2	1
CO3	2	2	3	2	3	2	1	1	1	2	2	2	1
CO4	1	1	1	1	2	-	-	2	3	2	2	1	1
CO5	1	1	1	1	2	1	1	1	2	1	3	1	1
AVG	1.8	1.8	2	1.4	2.6	1.25	1	1.2	1.8	1.8	2.2	1.6	1

SEMESTER 8

JBM2831	PROJECT WORK	L	T	P	C
		0	0	20	10

COURSE OBJECTIVES:

- To develop the ability to solve a specific problem related to their subject expertise.
- To develop the methodology to solve the identified problem.
- To design, analyze and implement the chosen problem using the hardware components.
- To validate the simulation, hardware results with the theoretical results.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

METHOD OF EVALUATION:

The students in a group of 3 to 4 work on a topic approved by the Head of the Department under the guidance of a faculty member, prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee is constituted by the Head of the Department. The project work is evaluated based on oral presentation and the project report, jointly by external and internal examiners.

PROJECT EVALUATION ZEROth REVIEW

Novelty/Problem Identification & Objectives (20)	Literature survey (30)	Methodology (10)	Guide (20)	PowerPoint Presentation (20)			Total (100)
				BL (5)	CS (5)	CP (10)	

FIRST REVIEW

Implementation of Methodology (20)	Design/ Analysis/ Testing/ Algorithm/Model (30)	Inferences (10)	Guide (20)	Power Point Presentation (20)			Total (100)
				BL (5)	CS (5)	CP (10)	

SECOND REVIEW

Progress (20)	Results (30)	Preparation of Conference Paper (10)	Guide (20)	Power Point Presentation (20)			Total (100)
				BL (5)	CS (5)	CP (10)	

THIRD REVIEW

Results & Discussions (30)	Conclusions (20)	Publications (10)	Guide (20)	Power Point Presentation (20)			Total (100)
				BL (5)	CS (5)	CPS (10)	

BL - Body Language, CS-Communication Skills, CP-Content of Presentation

TOTAL: 300 PERIODS

END SEMESTER EXAM

Project report (External Only) (30)	Result/Demonstration (30)		Power Point Presentation (20)		Viva (External Only) (20)	Total (100)
	Internal	External	Internal	External		

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Apply the technical knowledge acquired for solving real world problems.
- Develop skills such as self-learning, critical thinking, problem solving, project management and finance.
- Apply modern tools and techniques for implementing the project.
- Work with teammates and collectively work towards the success of the project.
- Communicate effectively to present the outcomes of the project both in written and oral forms.

CO-PO/PSO MAPPING:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	1	1	3	2	2	3	3	1	3	3
CO2	2	3	2	2	1	3	2	3	3	2	1	3	3
CO3	2	2	2	2	1	2	2	2	3	2	1	3	3
CO4	3	3	3	2	2	3	2	2	3	2	1	3	3
CO5	3	2	3	2	2	3	2	2	3	2	2	3	3
AVG	2.6	2.6	2.6	1.8	1.4	2.8	2	2.2	3	2.2	1.2	3	3

JERUSALEM COLLEGE OF ENGINEERING

(An Autonomous Institution, Affiliated to Anna University & Accredited by NAAC 'A' Grade)

DEPARTMENT OF BIOMEDICAL ENGINEERING

(Accredited by NBA)

LIST OF PROFESSIONAL ELECTIVES AS VERTICALS

(REGULATION – 2023)

VERTICAL I HEALTHCARE INFORMATICS & MANAGEMENT	VERTICAL II BIOSIGNAL & IMAGE PROCESSING	VERTICAL III MEDICAL DEVICE INNOVATION & DEVELOPMENT	VERTICAL IV BIO- ENGINEERING	VERTICAL V COMMUNICATION SYSTEMS IN MEDICINE	VERTICAL VI MECHANICS & MODELLING
JBM2001 Hospital Planning and Management	JBM2008 Medical Imaging Systems	JBM2015 Biomedical Entrepreneurship	JBM2022 Genetic Engineering	JBM2029 Virtual Reality in Medicine	JBM2036 Medical Haptics
JBM2002 Computers in Medicine	JBM2009 Speech and Audio Signal Processing	JBM2016 Critical Care Equipment	JBM2023 Bioprinting	JBM2030 Body Area Networks	JBM2037 Neuromechanics of Human Movement
JBM2003 Clinical Engineering	JBM2010 Computer Vision in Healthcare	JBM2017 Medical Device Design	JBM2024 BioMEMS	JBM2031 Principles of Communication	JBM2038 Physiological Modelling
JBM2004 Quality Control for Medical Devices	JBM2011 Biometric Systems	JBM2018 Biophotonics	JBM2025 Nanotechnology and Applications	JBM2032 Telehealth Technology	JBM2039 Rehabilitation Engineering
JBM2005 Medical Informatics	JBM2012 Virtual Instrumentation for Biomedical Engineers	JBM2019 Regulatory Perspectives of Medical Devices	JBM2026 Medical Implants	JBM2033 Robotics in Medicine	JBM2040 Ergonomics
JBM2006 Medical Ethics	JBM2013 Soft Computing Techniques	JBM2020 Human Assist Devices	JBM2027 Artificial Organs	JBM2034 Wearable Systems	JBM2041 Biomechanics
JBM2007 Medical Waste Management	JBM2014 Brain Computer Interface Techniques	JBM2021 Patient Safety Standards	JBM2028 Neural Engineering	JBM2035 Neural Networks	JBM2042 Biofluids and Dynamics

VERTICAL I - HEALTHCARE INFORMATICS & MANAGEMENT

JBM2001	HOSPITAL PLANNING AND MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the importance of hospital planning
- To elucidate planning of radiological and laboratory services
- To explain operation theatre and sterilization process planning
- To describe the challenges in hospital management and administration
- To explicate organizing and delegating the hospital administration

UNIT I - HOSPITAL PLANNING	9
Types of Hospital, Hospital as a System, need of hospital planning, hospital planning team, hospital planning process, bed planning, site selection, size of the hospital, circulation of routes, equipping hospital, steps in equipment planning and procurement, Construction and Commissioning.	
UNIT II – CLINICAL AND SUPPORTIVE SERVICES	9
Radiology and imaging services: Classification of radiological work, Space Requirement, different layouts of radiology department, Laboratory Services: Function Planning of laboratory service, Sitting and space requirement, Layout Design of Radiation Facility, Laboratory equipment placing, policies and laboratory procedure.	
UNIT III - OPERATION THEATRE STERILIZATION	9
OT circulation pattern, location of OT, number of OTs, Time utilization planning, zoning, lighting, Electrical and Air - Conditioning, Function of CSSD, Location and space requirement, Policies and procedure of CSSD.	
UNIT IV – HOSPITAL ADMINISTRATION	9
Challenges in Hospital Management, roles and functions of hospital administration, administration skills of Hospital managers, planning and forecasting Strategic planning: Systems Engineering in Strategic Planning.	
UNIT V - ORGANIZING AND DELEGATION	9
Realities of Hospital Organization, Authority Relationships, Delegation: Principles of Delegation, Steps in Delegation, Organization chart of Hospital administration, Characteristics of Static vs Dynamic organization.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):**At end of the course the students will be able to:**

- Explain the basic concepts and processes involved in hospital planning.
- Analyze the planning and space requirements of radiology and laboratory services.
- Evaluate the design and workflow of operation theatres and sterilization services.
- Discuss the roles, skills, and strategies in hospital administration.
- Apply principles of organization and delegation in hospital management.

TEXT BOOKS:

1. Dinesh Bhatia, Prabhat Kumar Chaudhari, Bhupinder Chaudhary, “A Guide to Hospital Administration and Planning”, Singapore: Springer Nature Singapore, 2023.
2. BM Sakharkar, “Principles of Hospital Administration and Planning”, 2nd Edition Jaypee Brothers Medical Publishers, 2015.

REFERENCES:

1. R.C.Goyal, “Hospital Administration and Human Resource Management”, PHI, 4th Edition, 2006
2. Joshi, M, “Hospital Administration”, Jaypee Brothers Medical Publishers, 2022.

WEB REFERENCES:

- <https://www.coursera.org/learn/eu-law-doing-business/lecture/K83OQ/fundamental-company-law-concepts>
- https://books.google.co.in/books/about/Hospitals.html?id=N_mvAAAACAAJandredir_esc=y
- <https://www.kobo.com/us/en/ebooks/hospital-administration-care>
- <https://www.slideshare.net/jenishaadhikari/disaster-management-in-hospital-setting-126372414>

Mapping of CO with PO/PSO

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	1	-	2	-	-	1	-	1	1	1
CO2	2	3	2	1	1	2	-	-	-	-	1	2	2
CO3	2	3	3	1	1	2	-	-	-	-	1	3	3
CO4	1	1	2	1	-	1	2	2	3	2	1	1	2
CO5	1	2	1	1	1	1	2	3	3	3	1	1	3
AVG	1.6	2.2	1.8	1	1	1.6	2	2.5	2.33	2.5	1	1.6	2.2

JBM2002	COMPUTERS IN MEDICINE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To realize the 8086 architectures, instruction sets and various units.
- To study the technique of data acquisition, storage, retrieval and transmission of bioinformation.
- To apply tools of informatics in patient monitoring.
- To understand the application of computers in system modelling
- To elucidate pattern recognition, medical imaging and development of expert systems.

UNIT I - BASIC COMPUTER HARDWARE	9
8086 architecture, system connections, Instruction set and programming, Microcontrollers, Motherboard and its logic, RS232-C and IEEE bus standards, CRT controllers, FDC, HDC and Post sequence, PC based video card, modems and networking.	
UNIT II – SYSTEM DESIGN	9
Multichannel computerized ECG, EMG and EEG data acquisition, storage and retrieval, transmission of signal and images.	
UNIT III - COMPUTERS IN PATIENT MONITORING	9
Physiological monitoring, automated ICU, computerized arrhythmia monitoring, information flow in a clinical lab, computerized concepts, interfacing to HIS.	
UNIT IV – MEDICAL SYSTEMS MODELLING	9
Radiotherapy, drug design, drug delivery system, physiological system modeling and simulation.	
UNIT V - COMPUTERS IN MEDICAL RESEARCH	9
Role of expert systems, pattern recognition techniques in medical image classification, ANN concepts.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):**At end of the course the students will be able to:**

- Explain the architecture and communication standards of basic computer hardware used in medical systems.
- Interpret the techniques for acquiring, storing, and transmitting computerized ECG, EMG, and EEG signals.
- Assess computerized patient monitoring systems and interpret clinical information flow in healthcare settings.
- Apply modeling and simulation concepts in radiotherapy, drug design, and physiological system analysis.
- Evaluate expert systems, pattern recognition methods, and ANN techniques used in medical research and image classification.

TEXT BOOKS:

1. R.D.Lee, "Computers in Medicine", Tata McGraw-Hill, New Delhi, Fifth edition, 2005.
2. Douglas V.Hall, "Microprocessors and Interfacing: Programming and hardware", McGraw-Hill, Singapore, 2019.

REFERENCES:

1. Atul Khate, "Cryptography and network security", Tata McGraw Hill Publishing Company, New Delhi, 2008.
2. B.Govindarajalu, "IBM PC and Clones: Hardware, Trouble shooting and Maintenance", Tata McGraw Hill Publishing Company, New Delhi, 2005.
3. H M Dietel, "Internet and World Wide Web", AB Goldberg publishers, New Delhi, 2007.
4. N.Mathivanan, "PC Based Instrumentation: Concepts and Practice", Prentice Hall of India, New Delhi 2007.

WEBSITE REFERENCES:

1. <https://www.javatpoint.com/uses-of-computer-in-hospitals>
2. <https://www.online-sciences.com/computer/computers-in-medicine-uses-advantages- and-disadvantages/>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	2	-	-	-	1	1	-	1	-
CO2	3	2	2	2	3	-	-	-	1	1	-	2	2
CO3	3	2	3	2	3	-	-	-	2	2	-	2	3
CO4	3	3	3	2	2	-	-	-	-	1	-	3	1
CO5	3	3	2	3	3	-	-	-	-	1	-	3	2
AVG	3	2.4	2.2	2.25	2.6	-	-	-	1.33	1.2	-	2.2	2

JBM2003	CLINICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide a central core of knowledge and essential information the clinical engineer needs to practice the profession.
- To impart knowledge on Medical technology and Device management to improve health and contribute to sustainable healthcare.
- To make the students aware of efficient asset optimization, reliability through proactive strategies and efficient processes in order to control costs and boost overall productivity.
- To provide basic knowledge on the concept of Hospital Standardization towards continuous improvement of patient care.
- To equip the students with the basic concepts of Patient Safety and Risk Management.

PREREQUISITE:

- Total Quality Management

UNIT - I CLINICAL ENGINEERING IN HOSPITAL	9
Evolution, Clinical Engineering Department, Duties and Responsibilities of Clinical Engineer, Qualities of Clinical Engineers, Patient Focused engineering, Clinical Engineer as consultant.	
UNIT - II MEDICAL TECHNOLOGY AND DEVICE MANAGEMENT	9
Medical Technology Management Programs and Practices, Strategic Planning, Classification of Medical Equipment, Equipment Planning, Procurement and Evaluation, Development of Equipment Support plans (ESP), Equipment Inventory control and Asset management, Medical Device standards, regulations and the law.	
UNIT - III MAINTENANCE AND SERVICE MANAGEMENT	9
Maintenance and Repair of Medical Devices, Computerized Maintenance Management systems, Vendor and service management, Cost effectiveness analysis (CEA) in health care, Financial Management of Clinical Engineering services, Clinical engineering program indicators.	
UNIT - IV QUALITY AND STANDARDS IN HEALTHCARE SERVICES	9
Need for Standardization, Total Quality Management in Healthcare organization, Quality Assurance Methods, Reliability and Quality Assurance Practices in Diagnostic and Treatment services, Legal aspects on hospital management, Healthcare Quality and ISO 9001:2000, Hospital Facilities Safety standards.	
UNIT V - PATIENT SAFETY AND RISK MANAGEMENT	9
Role of Clinical Engineer in enhancing patient safety, Risk Management in regulating medical devices, Stages of Regulatory tool, Patient safety best practices model, Hospital facilities safety standards.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Explain the roles, responsibilities, and competencies of clinical engineers in modern hospital environments.
- Describe medical technology management practices including equipment planning, procurement, evaluation, and regulatory compliance.
- Interpret maintenance, service-management systems, and financial evaluation methods used for medical device upkeep.
- Analyze healthcare quality systems, standardization needs, and legal aspects related to hospital management and safety.
- Assess patient safety practices and risk-management strategies for medical devices and hospital facilities.

TEXT BOOKS:

1. Joseph Dyro, "The Clinical Engineering Handbook", Academia Press, 2004.
2. Azzam Taktak, Paul Gannev, David Long, Richard Axell, "A Handbook for Clinical and Biomedical Engineers", Academic Press, second edition, 2020.

REFERENCES:

1. Yadin David Wolf, W.Von Maltzahn, Michael R. Neuman, Joseph D. Bronzino, "Clinical Engineering", CRC Press, 2003.
2. Ernesto Iadanza, "Clinical Engineering Handbook", Second Edition, Academic Press, 2019.

WEB REFERENCES:

- <https://www.cmbes.ca/about/what-is-a-biomedical-engineer>
- <https://journals.lww.com/jcejournal/pages/default.aspx>
- <https://www.intechopen.com/chapters/18021>
- <https://www.sciencedirect.com/book/9780128037676/clinical-engineering>
- <https://www.scribd.com/presentation/95875427/02-Clinical-Engineering>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	-	1	-	-	-	1	-	2	3
CO2	3	3	3	3	1	1	-	-	-	1	2	2	3
CO3	3	3	3	3	-	1	-	-	-	1	2	2	3
CO4	3	3	3	3	-	1	-	-	-	1	-	2	3
CO5	3	3	3	2	-	1	-	-	-	1	-	2	3
AVG	3	3	3	2.8	1	1	-	-	-	1	2	2	3

JBM2004	QUALITY CONTROL FOR MEDICAL DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify the Medical Device Regulatory Framework.
- To utilize different medical device standards
- To employ six sigma process and improvement in medical device manufacturing
- To identify and incorporate basic risk management concepts into Quality Management System
- To familiarize and utilize the different product development life cycle.

UNIT I - MEDICAL DEVICES	9
Definition, Differences between Medical Device and Drug development, Classification of medical device, Major Steps in the Design and Development of Medical Device, Medical device life cycle.	
UNIT II – MEDICAL DEVICES STANDARDS	9
Basics of the different systems for the Medical Device regulations - FDA, AERB Regulation, The ISO 13485 Standard - ISO 9000.	
UNIT III - SIX SIGMA PROCESS	9
Six Sigma Fundamentals, Process Modeling, Process Mapping, Value Stream Mapping, Business Process Management, Six Sigma Improvement, Phases of Six sigma improvement.	
UNIT IV – QUALITY MANAGEMENT SYSTEM	9
Design Control, Core Components of QMS, Software Development, Risk Management, Risk Management Procedures, Risk Management Roles and Responsibilities, Biocompatibility, Electromagnetic compatibility testing, Electrical Safety Testing.	
UNIT V - PRODUCT DEVELOPMENT PROCESS	9
Waterfall Model, Iterative Model, Stage, Gate PDP, Agile Methodologies in MedDev PDP, Clinical trial design considerations, Technology readiness levels.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Explain and differentiate the global and national regulatory frameworks governing medical devices.
- Assess and interpret the role and implementation of medical device regulatory standards in compliance activities.
- Analyze and apply Six Sigma methodologies for improving the design and performance of medical devices.
- Analyze and integrate fundamental risk-management principles within a medical device Quality Management System.
- Apply and evaluate product-development life-cycle models for effective medical device design and manufacturing.

TEXT BOOKS:

1. DeMarco, C. T “Medical Device Design and Regulation”, ASQ Quality Press, 2011.
2. Mekki, K. S., El-Haik, B. “Medical Device Design for Six Sigma: A Road Map for Safety and Effectiveness” Germany: Wiley, 2011.

REFERENCES:

1. Saiko, G. “Bringing a Medical Device to the Market: A Scientist’s Perspective” Jenny Stanford Publishing Singapore, 2022.

WEBSITE REFERENCES:

- <https://www.cfpie.com/the-importance-of-quality-control-in-the-manufacturing-of-medical-devices>
- <https://www.fda.gov/medical-devices/postmarket-requirements-devices/quality-system-qs-regulationmedical-device-good-manufacturing-practices>
- <https://www.mastercontrol.com/quality/quality-control/medical-device/>

Mapping of CO with PO/PSO

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	3	2	-	1	-	2	1	1
CO2	2	3	1	1	2	2	2	-	1	-	2	1	2
CO3	2	2	3	2	3	1	-	1	1	2	2	2	2
CO4	2	3	2	2	3	2	1	1	-	1	2	2	3
CO5	2	2	3	1	2	1	-	1	1	2	2	2	2
AVG	2.2	2.4	2	1.4	2.4	1.8	1.66	1	1	1.66	2	1.6	2

JBM2005	MEDICAL INFORMATICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To apply ICT tools in medicine with an introduction to health informatics.
- To access the theories and practices adopted in Hospital Information Systems in the light of medical standards, medical data formats and recent trends in HIS.
- To manage the data storage and automation of the hospital modules in informatics.
- To estimate the different approach of health Informatics.
- To evaluate recent trends in medical informatics.

UNIT I - INFORMATICS SYSTEM IN MEDICINE	9
Introduction, Medical Informatics, Bioinformatics, Health Informatics, Structure of Medical Informatics, Functional capabilities of Hospital Information System, On-line services and Off-line services, Dialogue with the computer.	
UNIT II – MEDICAL STANDARDS	9
Evolution of Medical Standards, IEEE 11073, HL7, DICOM, IRMA, LOINC, HIPPA, Electronics Patient Records, Healthcare Standard Organizations, JCAHO (Joint Commission on Accreditation of Healthcare Organization), JCIA (Joint Commission International Accreditation), Evidence Based Medicine, Bioethics.	
UNIT III - DATA ACQUISITION AND STORAGE	9
Representation of Data, Data modeling Techniques, Relational Hierarchical and network Approach, Normalization techniques for Data handling, Factors to be considered in acquiring Data, Fundamentals of data acquisition system, acquiring sensor data, Plug-in Data Acquisition and Control Boards, Data Acquisition using Serial Interface, Medical Data formats, signal, Image and Video Formats, Data protection and security.	
UNIT IV – HEALTH INFORMATICS	9
Bioinformatics Databases, Bio-information technologies, Semantic web and Bioinformatics, Genome projects, Clinical informatics, Nursing informatics, Public health informatics, Education and Training, Aarogya setu app, Coronavirus contact tracing app, Education and Training.	
UNIT V - RECENT TRENDS	9
Medical Expert Systems, Virtual Environment, Surgical simulation, Radiation therapy and planning, Telemedicine, virtual hospitals, Smart Medical Homes, Personalized e-health services, Biometrics, GRID and Cloud Computing in Medicine, Nanomedicine, 3D Bioprinting.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):**At end of the course the students will be able to:**

- Describe the basic concepts of medical, health, and bioinformatics and the functions of hospital information systems.
- Explain major medical standards, coding systems, accreditation bodies, and basic bioethical principles.
- Identify data acquisition methods, data modeling techniques, and medical data storage with security considerations.
- Discuss the applications of health informatics in clinical, nursing, public health, and genomic domains.
- Summarize recent developments such as expert systems, telemedicine, virtual environments, smart medical homes, cloud computing, and nanomedicine.

TEXT BOOKS:

1. R.D.Lele, "Computers in medicine progress in medical informatics", Tata McGraw Hill Publishing Ltd, 2005 (Units I, III and IV).
2. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003 (Units II, IV and V).

REFERENCES:

1. Orpita Bosu and Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University press, 2007.
2. Yi Ping Phoebe Chen, "Bioinformatics Technologies", Springer International Edition, New Delhi, 2007.
3. Khandpur R S, "Telemedicine - Technology and Applications", PHI Learning Pvt Ltd., New Delhi, 2017.
4. Norris A C, "Essentials of Telemedicine and Telecare", John Wiley, New York 2002.

WEBSITE REFERENCES:

- <https://healthinformatics.uic.edu/blog/what-is-medical-informatics/>
- <https://www.youtube.com/watch?v=fdLP99Kxbck>
- <https://www.youtube.com/watch?v=pzS--PaGC9o>
- <https://jech.bmj.com/content/56/11/808>
- <https://link.springer.com/article/10.1007/s41666-018-0040-y?shared-article-renderer>

Mapping of CO with PO/PSO

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	1	1	-	-	-	-	1	1	1
CO2	1	2	1	1	1	-	1	-	-	-	1	1	1
CO3	2	2	1	1	3	1	1	1	-	1	2	2	2
CO4	2	2	3	1	3	2	1	2	-	1	2	2	2
CO5	2	2	1	1	3	1	-	1	-	1	3	3	2
AVG	1.8	1.8	1.4	1	2.2	1.25	1	1.33	-	1	1.8	1.8	1.6

JBM2006	MEDICAL ETHICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To investigate on human values and ethical consideration
- To understand and apply medical ethics to be practiced by healthcare workers
- To review and apply safety measures in designing and using medical devices
- To review on the accreditation standards in hospital
- To discuss on different safety aspects to be followed in hospital

UNIT I - HUMAN VALUES	9
Morals, Values and Ethics, Integrity, Work Ethics, Service Learning, Respect for Other, Living Peacefully, caring, commitment, Empathy, Self-Confidence.	
UNIT II – MEDICAL ETHICS	9
Definition of Medical ethics, Scope of ethics in medicine, international code of ethics for occupational health professionals, Role of ethics in healthcare workplace, Decision Model for Healthcare Dilemmas.	
UNIT III - MEDICAL DEVICES SAFETY	9
Shared Responsibility for Medical device safety, WHO, International Health Regulations, Stages of regulatory control of medical devices, Ethics committee - members and functions, Global Harmonization Task Force.	
UNIT IV – HOSPITAL ACCREDITATION	9
Accreditation, Benefits of Accreditation, JCI accreditation, NABH and NABL, Joint Commission on Accreditation of Healthcare Organizations.	
UNIT V - SAFETY IN HOSPITAL	9
Alara principal Radiation safety, Safety precautions, hazardous effects of radiation, allowed levels of radiation, ICRP regulations for radiation safety, Disposal of Biological waste - Electrical and Fire safety.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Explain the fundamental principles, codes and frameworks governing medical ethics and professional conduct.
- Analyze ethical issues related to patient rights, confidentiality, autonomy, and informed consent in clinical practice.
- Apply ethical decision-making models to resolve dilemmas arising in diagnosis, treatment and biomedical practice.
- Evaluate the ethical, legal and societal implications of emerging biomedical technologies and clinical research.
- Demonstrate responsible and professional behaviour by integrating ethical standards into real-world healthcare scenarios.

TEXT BOOKS:

1. B.M.Sakharkar, Principles of Hospital administration and Planning, Jaypee Brothers, Medical Publishers, 2015.
2. Joseph F Dyro, “Clinical Engineering Handbook”, Elsevier Publishers, 2004.

REFERENCES:

1. Karen Parsley, Karen Parsley Philomena Corrigan, “Quality improvement in Healthcare”, 2nd edition, Nelson Thrones Pub, 2012.
2. K.Shridhara Bhat, Quality Management, Himalaya Publishing House, 2010.

WEBSITE REFERENCES:

- <https://www.nspe.org/resources/ethics>

Mapping of CO with PO/PSO

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	–	–	–	3	3	1	–	–	2	–	–
CO2	1	2	–	–	–	2	3	1	–	–	2	–	–
CO3	2	2	2	–	2	3	–	–	–	–	2	2	2
CO4	1	2	–	–	–	2	–	–	–	–	2	–	1
CO5	1	2	–	–	–	3	–	1	–	–	2	–	1
AVG	1.4	2	2	–	2	2.6	3	1	–	–	2	2	1.33

JBM2007	MEDICAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To have a basic understanding of healthcare hazards and accidents controls
- To gain knowledge about waste disposal procedures for different biowastes
- To differentiate different biowastes based on its properties
- To gain information about different safety facility in hospitals
- To get an exposure on various regulations and safety norms

UNIT I - HEALTHCARE HAZARD AND ACCIDENTS CONTROL	9
Hazard Control Management, Responsibilities, Control Practice, Hazard Correction, Personal Protective Equipment, Ergonomics. Accident Causation Theories, Accident Deviation Models, Reporting, Investigations, Analysis, Organizational Functions That Support Accident Prevention, Orientation, Education, and Training.	
UNIT II - BIOMEDICAL WASTE MANAGEMENT	9
Biomedical wastes – Types –Sources- Management and handling – control of biomedical wastes– Sources – Domestic and Industrial - Inorganic pollutants – Environmental effects – Need for disposal of biomedical waste – waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal	
UNIT III - HAZARDOUS MATERIALS	9
Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.	
UNIT IV - FACILITY SAFETY	9
Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA, Heating, Ventilating, and Air-Conditioning Systems.	
UNIT V - INFECTION CONTROL, PREVENTION AND PATIENT SAFETY	9
Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety- Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Analyze various healthcare hazards, accident causation factors, and corresponding control measures.
- Design appropriate waste disposal procedures for different categories of biomedical wastes.
- Classify biomedical waste types based on their properties, sources, and environmental impacts.
- Develop safety facility plans and protocols for preventing hazards in hospital environments.
- Recommend applicable regulations and safety norms based on national and international standards.

TEXT BOOKS:

1. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012) (Unit - 1,2,3)
2. Tweedy, James T., Healthcare hazard control and safety management-CRC Press Taylor and Francis (2014) (Unit - 1,4,5)

REFERENCES:

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006
2. V.J. Landrum, "Medical Waste Management and disposal", Elsevier, 1991

WEB REFERENCES:

- <https://www.youtube.com/watch?v=LgW0l8vf6YA>
- https://www.youtube.com/watch?v=CbW6N_nSje4
- <https://www.youtube.com/watch?v=u9i3P1m4aqg>
- <https://www.youtube.com/watch?v=P59XexPb1qY>
- <https://www.youtube.com/watch?v=32KyVb-Ggn8>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	3	2	1	1	1	2	1	2
CO2	3	3	3	2	2	3	2	1	1	2	2	1	3
CO3	3	2	2	1	2	3	2	1	1	1	2	1	2
CO4	2	3	3	2	2	3	2	2	1	2	2	1	3
CO5	2	3	3	2	2	3	3	1	1	2	2	1	3
AVG	2.6	2.8	2.6	1.8	2	3	2.2	1.2	1	1.6	2	1	2.6

***** END OF VERTICAL 1 *****

VERTICAL II - BIOSIGNAL & IMAGE PROCESSING

JBM2008	MEDICAL IMAGING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the nuclear magnetic resonance imaging techniques.
- To study the advanced Magnetic resonance techniques that estimates the axonal organization and neural tracts.
- To get accustomed with technique of planar scintigraphy.
- To study the technique of emission computed tomography.
- To study the ultrasonic imaging technique for diagnosis.

UNIT I - MAGNETIC RESONANCE IMAGING	9
Nuclear Magnetic Resonance (NMR) - Review of generation and detection of the Magnetic Resonance Signal, Spatial encoding, slice selection, k-space, Pulse Sequences, spin Echo, Perfusion and Diffusion Contrast, k-space Data Acquisition and Image Reconstruction, Three-Dimensional Fourier Transform Image Acquisition, Image Characteristics, Artifacts.	
UNIT II – DIFFUSION WEIGHTED IMAGING	9
Physics of Diffusion Weighted (DW) Imaging technique, representation of DW images, mechanisms, diffusion model, Measures of anisotropy and diffusivity, Diffusion Tensor Imaging (DTI), Diffusion Basis Spectrum Imaging, Fiber tractography, Quantitative analysis methods, Clinical applications.	
UNIT III - PLANAR SCINTIGRAPHY	9
Physics of Nuclear Medicine, Radiotracers, Instrumentation of scintigraphy, image formation – acquisition modes, angle camera equations, image quality, PET-MRI technique, electronic brachytherapy, thermal brachytherapy, phantoms - materials, phantoms with integrated radiation dosimeters, virtual/computational phantoms, patient-specific phantoms.	
UNIT IV – EMISSION COMPUTED TOMOGRAPHY	9
SPECT – Instrumentation, Image formation, Image quality; PET - Instrumentation, Image formation, Image quality.	
UNIT V - ULTRASOUND IMAGING	9
Physics of Ultrasound – wave equation, propagation, beam formation, instrumentation, scanning modes, steering and focusing, image characteristics and quality, multi-dimensional ultrasound image formation - 2D, 3D, 4D and 5D ultrasound techniques, fetal ultrasound monitoring, doppler ultrasound.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At end of the course the students will be able to:

- Explain the physical principles, signal generation, pulse sequences, image formation, and artifacts involved in Magnetic Resonance Imaging (MRI).
- Describe and interpret diffusion-weighted imaging (DWI) and diffusion tensor imaging (DTI) parameters to analyze anisotropy, diffusivity, and fiber tractography.
- Explain and evaluate the physics, instrumentation, image acquisition processes, and quality control methods used in planar scintigraphy.
- Analyze the principles, detectors, data acquisition, reconstruction techniques, and image quality parameters in SPECT and PET emission computed tomography systems.
- Explain and differentiate ultrasound physics, transducer mechanisms, beam formation, Doppler principles, scanning modes, and image quality factors.

TEXT BOOKS:

1. Jerry L. Prince, Jonathan M. Links, “Medical Imaging Signals and Systems”, Second Edition, Pearson Prentice Hall, 2015.
2. Jerrold T. Bushberg, J. Anthony Seibert, Edwin Marion Leidholdt, John M. Boone, “The Essential Physics of Medical Imaging”, Wolters Kluwer Health Publisher, 2020.

REFERENCES:

1. Masao Takano, Takeshi Iinuma, Yukio Tatenno, “Computed Radiography”, Springer Japan, 2012.
2. Andreas Maier, Stefan Steidl, Vincent Christlein, Joachim Hornegger, “Medical Imaging Systems: An Introductory Guide”, Creative Media Partners, LLC, 2020.
3. Kris Iniewski, Troy Farncombe, “Medical Imaging Technology and Applications”, CRC Press, 2017.
4. Arnulf Oppelt, “Imaging Systems for Medical Diagnostics”, Wiley, 2006.
5. Cornelius T Leondes, “Medical Imaging Systems Technology”, World Scientific Publishing Company, 2005.

WEB REFERENCES:

- <https://www.microscopemaster.com/microscopy-imaging-techniques.html>
- <https://www.radiologyinfo.org/en/info/bodymr>
- <https://www.radiologycafe.com/frcr-physics-notes/molecular-imaging/planar-imaging/>
- <https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/positron-emission-tomography-pet>
- <https://www.urologyhealth.org/urology-a-z/u/ultrasound-imaging>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	2	2	1	3	2	3	2	3
CO2	3	3	2	1	2	2	3	1	3	2	3	2	3
CO3	3	3	2	2	3	3	3	2	2	2	2	2	3
CO4	3	3	1	1	3	3	3	1	2	2	3	2	3
CO5	3	3	2	1	3	3	3	2	2	3	2	3	3
AVG	3	3	1.8	1.4	2.6	2.6	2.8	1.4	2.4	2.2	2.6	2.2	3

JBM2009	SPEECH AND AUDIO SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide an introduction to basic concepts and methodologies for the analysis, modelling, synthesis and coding of speech and music.
- To provide a foundation for developing applications and for further study in the field.
- To learn enhancement techniques using signal conditioning Applications
- To Implement efficient coding solutions in signals
- To introduce software tools for the analysis and manipulation of speech and music and to gain practical experience in the design and implementation of speech and music processing algorithms.

UNIT - I INTRODUCTION	9
Introduction, Anatomy and physiology of speech production, categorization of speech sounds, Prosody, Parameters of Speech: Pitch and Formants.	
UNIT - II ANALYSIS AND SYNTHESIS OF SPEECH AND AUDIO SIGNALS	9
Spectral Analysis Models, Linear Predictive Coding Model for Speech Recognition, The autocorrelation method, the covariance method, Short-Time Fourier Transform Analysis and Synthesis, Short-Time Fourier Transform Magnitude, Filter Bank Summation method, Overlap-Add method.	
UNIT - III FREQUENCY DOMAIN PITCH ESTIMATION	9
A correlation-based Pitch Estimator, Pitch Estimation based on Comb Filter, Pitch Estimation based on a Harmonic Sine wave Model.	
UNIT - IV SPEECH CODING & SPEECH ENHANCEMENT TECHNIQUE	9
Vector Quantization, Frequency-Domain Coding, Model-based Coding. Spectral subtraction, Cepstral Mean Subtraction, Wiener Filtering.	
UNIT - V SPEAKER RECOGNITION	9
Spectral Features required for Speaker Recognition, Minimum Distance classifier, Gaussian Mixture Model.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Explain the fundamentals of speech production, speech sound categorization, and prosodic parameters.
- Describe the analysis and synthesis techniques used for speech and audio signals using spectral and LPC models.
- Apply frequency-domain techniques for estimating pitch using correlation, comb filtering, and harmonic models.
- Analyze speech coding and enhancement methods such as vector quantization, spectral subtraction, and Wiener filtering.
- Evaluate speaker recognition methods using spectral features, minimum distance classifiers, and Gaussian mixture models.

TEXT BOOKS:

1. Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, 2000.
2. Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, John Wiley & Sons, 2006

REFERENCES:

1. Gold and Morgan, Speech and Audio Signal Processing: Processing and Perception of Speech and Music, 1999, John Wiley & Sons
2. Deller, Hansen and Proakis, Discrete-Time Processing of Speech Signals, 1993, Macmillan (Reprinted in 2000 by Wiley-Interscience and IEEE Press)
3. Oppenheim, Shafer and Buck, Discrete-time Signal Processing (2nd edition), 1998, Prentice Hall.
4. Roederer, The Physics and Psychophysics of Music: An Introduction, 1995, Springer-Verlag.

WEB REFERENCES:

- https://ceat.okstate.edu/che/site_files/docs/babatunde-a-ogunnaike.pdf
- <https://ocw.mit.edu/courses/res-6-007-signals-and-systems-spring-2011/>
- <http://www.ws.binghamton.edu/fowler/Fowler%20Personal%20Page/EECE301%20-%20Flipped.htm>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	1		-	-	-	1	1	-
CO2	3	2	2	3	2	-	-	1	-	-	1	2	-
CO3	3	2	2	3	2	-	-	1	-	-	1	2	-
CO4	3	2	3	3	2	-	-		-	-	1	3	1
CO5	3	2	3	3	2	-	-	1	-	-	1	3	1
AVG	3	2	2.2	3	2	1	-	1	-	-	1	2.22	1

JBM2010	COMPUTER VISION IN HEALTHCARE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Explain the basic principles of computer vision.
- Describe the various methods of image processing.
- Explain the formation of an image.
- Explain the image preprocessing and reconstruction techniques.
- To provide the programming experience from implementing computer vision and object recognition applications.

UNIT I - COMPUTER VISION	9
Brief history of Computer Vision, Image Processing, Machine Learning, Information Retrieval, Neuroscience, Robotics, Speech, Cognitive Sciences, Graphics, Algorithms, Systems and Theory, Pattern Recognition, Computer Graphics.	
UNIT II – IMAGE PROCESSING TECHNIQUES	9
Image Processing, Color, Edge Detection, Features and Fitting, Feature Descriptors, Image Resizing, Segmentation, Semantic Segmentation, Clustering, Object recognition, Dimensionality Reduction, Face Identification, Visual Bag of Words, Object Detection from Deformable Parts, Semantic Hierarchies and Fine-grained Recognition, Motion, Tracking.	
UNIT III – SEGMENTATION AND RECONSTRUCTION	9
Feature detection and matching, Segmentation, Edge detection, 2D and 3D feature based alignment, Pose estimation, Geometric intrinsic calibration, Factorization – Bundle adjustment – Constrained Structure and Motion – Dense motion estimation, Methods for 3D Vision - 3D reconstruction – Image based rendering, Image Recognition	
UNIT IV - IMAGE FORMATION	9
Geometric primitives and transformations, Photometric image formation, digital camera, Point operators, Linear Filtering. Neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations, Global optimization	
UNIT V - HEALTHCARE APPLICATIONS	9
Computer Vision for Cognition, Computer Vision for physical rehabilitation and training, Computer Vision for CAD systems in surgery, Computer Vision for human-machine interaction, Computer Vision for Ambient Assisted Living, Egocentric (first person) vision, Machine Learning Algorithms for Medical Images, Deep learning approaches for healthcare applications.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Explain the fundamental principles, terminology, and theoretical foundations of computer vision and image formation.
- Apply core image processing operations such as filtering, edge detection, segmentation, feature extraction, and clustering to solve vision tasks.
- Analyze image formation models and implement preprocessing techniques for enhancing medical and natural images.
- Implement segmentation, object recognition, feature matching, 2D/3D reconstruction, and motion analysis techniques used in computer vision.
- Evaluate and design computer vision-based solutions for healthcare applications through appropriate algorithms, tools, and system-level planning.

TEXT BOOKS:

1. D. Forsyth and J. Ponce K. P. Horn, “Computer Vision - A modern approach, by, Prentice Hall Robot Vision”, McGraw-Hill Publishers, 2015. **(Unit 1,2)**
2. Amita Nandal, Liang Zhou, Arvind Dhaka, Todor Ganchev, Farid Nait - Abdesselam “Machine Learning in Medical Imaging and Computer Vision”, IET Digital Library, 2023. **(Units 3,4)**
3. C.H.Chen, “Computer Vision in Medical Imaging”, World scientific publishers, Jan 2014. **(Unit 5)**

REFERENCES:

1. Mark Nixon and Alberto S. Aquado, “Feature Extraction & Image Processing for Computer Vision”, Third Edition, Academic Press, 2012.
2. Richard Szeliski, “Computer Vision - Algorithms and Applications”, Springer, 2011.
3. Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", Cambridge Publishers, 2004.

WEB REFERENCES:

- <https://web.stanford.edu/class/cs523/>
- <https://www.coursera.org/courses?query=computer%20vision>
- <https://www.edx.org/learn/computer-vision>
- <https://www.classcentral.com/subject/computer-vision>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	2	1	—	1	—	—	3	2	1
CO2	2	3	3	2	3	1	—	2	—	—	3	3	2
CO3	2	2	2	3	3	1	—	1	—	—	3	3	2
CO4	1	3	3	3	3	1	—	2	1	—	3	3	2
CO5	1	2	3	3	2	2	—	3	2	2	3	3	3
AVG	1.8	2.6	2.6	2.4	2.6	1.2	—	1.8	1.5	2	3	2.8	2

JBM2011	BIOMETRIC SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To describe the principles of biometric modalities and know how to deploy them in authentication scenarios;
- To organize and conduct biometric data collections, and apply for finger print
- To apply different models for face Recognition and hand geometry in biometric application
- To deploy statistical methods in Iris and retinal biometrics
- To itemize the most up-to-date examples of real biometric applications in human Authentication.

UNIT I - BIOMETRICS	9
Introduction and back ground – biometric technologies – passive biometrics – active biometrics, Biometric systems – Enrollment – templates – algorithm – verification – Biometric applications – biometric characteristics- Authentication technologies –Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications -performance measures.	
UNIT II – FINGER PRINT RECOGNITION	9
History of fingerprint pattern recognition - General description of fingerprints - Finger print feature processing techniques - fingerprint sensors using RF imaging techniques – fingerprint quality assessment – computer enhancement and modelling of fingerprint images – fingerprint enhancement – Feature extraction – fingerprint classification – fingerprint matching.	
UNIT III - FACE RECOGNITION AND HAND GEOMETRY	9
Introduction to face recognition, Neural networks for face recognition – face recognition from correspondence maps – Hand geometry – scanning – Feature Extraction – Adaptive Classifiers - Visual-Based Feature Extraction and Pattern Classification - feature extraction.	
UNIT IV – IRIS AND RETINAL BIOMETRICS	9
Principles of iris image capture, iris sensors. Iris image preprocessing, segmentation, formatting and filtering. Daugman’s method, iris code, statistical properties of the iris code. Other iris coding methods, wavelet analysis. Retina scanning: Technical description, Characteristics, Strengths – Weaknesses, Deployment. Retina vascular pattern.	
UNIT V - BIOMETRIC AUTHENTICATION	9
Introduction to Biometric Authentication Methods - Biometric Authentication Systems - Biometric authentication by fingerprint - Biometric Authentication by Face Recognition -Support Vector Machines - Biometric authentication by fingerprint - Multi-biometrics and Two-Factor Authentication.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course student will be able to:

- Explain the fundamental principles, modalities and operational characteristics of biometric systems.
- Collect, preprocess and analyze fingerprint data to implement fingerprint recognition techniques.
- Apply and compare feature-extraction and classification models in face recognition and hand-geometry biometrics.
- Employ and interpret statistical, signal-processing and pattern-analysis methods in iris and retinal biometric systems.
- Demonstrate and evaluate real-time biometric authentication workflows for human identification applications.

TEXT BOOKS:

1. Anil K Jain, Patrick Flynn, Arun A. (Eds.), Handbook of Biometrics, Springer, 2008
2. S.Y. Kung, S.H. Lin, M.W.Mak, "Biometric Authentication: A Machine Learning Approach" Prentice Hall, 2005

REFERENCES:

1. K. Jain, A. Ross, K. Nandakumar, Introduction to Biometrics: A Textbook, (2011), Springer Publishers, 2011.
2. Guide to Biometrics, By: Ruud M. Bolle, SharathPankanti, Nalini K. Ratha, Andrew W.Senior, Jonathan H. Connell, Springer 2009
3. Julian Ashbourn "Biometrics: Advanced Identify Verification: The Complete Guide", Springer-Verlag, 2000.
4. Derbel, Nabil & Kanoun, Olfa. "Advanced Methods for Human Biometrics"-springer,2021.
5. Paul Reid, "Biometrics for Network Security", Pearson Education, 2004.

WEB REFERENCES:

- <https://www.techtarget.com/searchsecurity/definition/biometrics>
- <https://www.digimat.in/nptel/courses/video/106104119/L08.html>
- <https://www.digimat.in/nptel/courses/video/106104119/L05.html>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	—	1	2	—	—	1	—	—	1	1	1
CO2	1	3	—	2	3	—	—	1	—	—	1	2	1
CO3	1	3	1	2	3	—	—	1	—	—	1	2	1
CO4	1	3	1	3	3	—	—	1	—	—	1	2	1
CO5	1	2	1	2	3	1	—	2	1	1	2	2	2
AVG	1.2	2.6	1	2	2.8	1	—	1.2	1	1	1.2	1.8	1.2

JBM2012	VIRTUAL INSTRUMENTATION FOR BIOMEDICAL ENGINEERS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enlighten the student on the basic concepts of Virtual instrumentation
- To inculcate knowledge on programming concepts of Virtual instrumentation.
- To know about data acquisition system used with Virtual instrumentation
- To provide an insight to various instrument interface
- To impart knowledge on various analysis tool and its applications

UNIT I - VIRTUAL INSTRUMENTATION	9
Virtual instrumentation (VI): Evolution, Definition, Architecture-Conventional-, and Distributed-VI, Comparison of VI with traditional Instruments, Need of VI, advantages, block diagram, data flow techniques, graphical programming, Comparison between graphical programming and conventional programming, VI in engineering process.	
UNIT II – VIRTUAL INSTRUMENTATION PROGRAMMING TECHNIQUES	9
VI: front panel, Block diagram, LABVIEW Environment: Startup-, Shortcut-, and Pull down menu, palletes, Control structures: FOR loop, WHILE loop, Shift Registers, feedback nodes, Selection Structures: Case and sequence structures, Formulae nodes, Arrays, Clusters, Waveform Chart and graph, XY Graph, Strings, Tables, File I/O functions.	
UNIT III - DATA ACQUISITION	9
Introduction to PC based data acquisition-typical plug-in data acquisition board-multiplexing of analog inputs-single ended and differential inputs-different strategy for sampling of multi-channel analog inputs. Concept of universal data acquisition card-use of timers/counters.	
UNIT IV – INSTRUMENT INTERFACES	9
Current loop, RS 232C/RS 485, General Purpose Interface Bus, System basics, interface basics networking basics for office & industrial application, Virtual Instrument Software Architecture & Interchangeable Virtual Instrument, image acquisition & processing, Motion Control. Analog to digital conversion, digital to analog conversion, Digital input and output, Digital multi meter, waveform generator.	
UNIT V - ANALYSIS TOOLS AND APPLICATION	9
Fourier Transforms, Power spectrum, Correlation methods, Major equipment - Oscilloscope, Digital Multimeter, temperature data acquisition system, Multi-channel data acquisition using LABVIEW, ECG acquisition, Electrodes and sensor for ECG signal acquisition, Denoising ECG signal, effect of oversampling and under sampling, windowing, heart rate calculation using VI.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Explain the fundamental principles of virtual instrumentation (VI) and differentiate it from conventional programming environments.
- Apply core VI programming techniques to develop modular and structured VI applications.
- Analyze the architecture and functionality of various data acquisition (DAQ) systems used in biomedical applications.
- Demonstrate the operation and integration of instrument interfaces for biomedical hardware communication.
- Design and implement real-time biomedical applications using LabVIEW and related VI tools.

TEXT BOOKS:

1. Gary Johnson, LABVIEW Graphical Programming, 2nd Edition, McGraw Hill, 1997.
2. Lisa K. Wells and Jeffrey Travis, LABVIEW for Everyone, PHI, 1997.
3. Skolkoff, Basic concepts of LABVIEW 4, PHI, 1998.

REFERENCES:

1. Kevin James, PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control, Newnes, 2000.
2. S. Gupta, J.P. Gupta, PC Interfacing for Data Acquisition and Process Control, ISA, 2nd Edition, 1994.
3. Technical Manuals for DAS Modules of Advantech and National Instruments.
4. Jerome, Virtual Instrumentation Using LabView, PHI, 2010.
5. Virtual Bio-Instrumentation: Biomedical, Clinical, and Healthcare Applications in LabVIEW BY By Jon B. Olansen, Eric Rosow, 2001

WEB REFERENCES:

- https://www.halvorsen.blog/documents/teaching/courses/labview_automation/labview_basic.php
- https://wwwusers.ts.infn.it/~rui/univ/Acquisizione_Dati/Lezioni/VIII%20-%20Labview%20-%20Introduction/LabVIEW%20Introduction-SixHour.pdf
- <https://nptel.ac.in/courses/111/104/111104100/>
- https://onlinecourses.nptel.ac.in/noc21_ma37/preview/

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	–	–	1	–	–	2	2	1
CO2	2	2	2	1	3	–	–	2	1	–	2	2	1
CO3	2	3	2	3	3	–	–	1	–	–	2	3	2
CO4	2	2	2	2	3	1	–	3	2	1	2	3	2
CO5	1	2	3	3	3	1	–	3	2	2	3	3	3
AVG	2	2.2	2	2	2.8	1	–	2	1.66	1.5	2.2	2.6	1.8

JBM2013	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To familiarize with concepts of Artificial Intelligence.
- To introduce and use the idea of Neural networks for pattern classification.
- To explain the algorithm and techniques of Pattern association and competition based neural networks.
- To demonstrate the implementation of fuzzy systems.
- To impart knowledge on the various supervised and unsupervised techniques for pattern classification and clustering.

UNIT I - ARTIFICIAL INTELLIGENCE Introduction to Artificial Intelligence (AI), Various types and characteristics of production systems, AI Search algorithm-breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies. Knowledge representation issues, Semantic networks-frames, Prepositional and predicate logic, monotonic and non-monotonic reasoning, forward Reasoning, backward reasoning.	9
UNIT II – NEURAL NETWORK FOR PATTERN CLASSIFICATION Structure and Function of a single neuron: Biological neuron, artificial neuron, definition of ANN, Taxonomy of neural net, characteristic and applications of ANN, single layer network, Multilayer network.	9
UNIT III - PATTERN ASSOCIATION AND NEURAL NETWORKS Fixed weight Competitive nets, Kohonen Self-organizing maps, Counter propagation network, LVQ, Back Propagation network.	9
UNIT IV – FUZZY LOGIC AND SYSTEMS Fuzzy set theory, Fuzzy set versus crisp set, Crisp relation & fuzzy relations, Fuzzy systems: crisp logic, fuzzy logic, introduction & features of membership functions. Fuzzy rule base system: Fuzzy propositions, formation, decomposition & aggregation of fuzzy Rules, fuzzy reasoning, fuzzy inference systems, fuzzy decision making & Applications of fuzzy logic, Adaptive networks based Fuzzy interfaces- Classification and Representation trees.	9
UNIT V - PATTERN RECOGNITION AND CLUSTERING TECHNIQUES 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. Unsupervised learning- Hierarchical clustering- Similarity measures, Single-linkage Algorithm, Complete - linkage Algorithm, Average-linkage algorithm and Ward's method. Partitional clustering, Forgy's Algorithm, k-means algorithm.	9

TOTAL:45 PERIODS

COURSE OUTCOMES:**At the end of the course student will be able to:**

- Explain and implement the concepts of Artificial Intelligence.
- Apply the idea of Neural networks for pattern classification.
- Explain and implement the algorithm and techniques of Pattern association and competition based neural networks.
- Demonstrate the implementation of fuzzy systems.
- Apply various supervised and unsupervised techniques for pattern classification and clustering

TEXT BOOKS:

1. Rich E, Knight K, Artificial Intelligence, TMH, 3rd Edition, 2012.
2. S.N.Sivanandam, “Introduction to Artificial Neural Networks using MATLAB 6.0”, Tata McGraw hill Publication, 2016.
3. Earl Gose, Richard Johnsonbaugh, Steve Jost, “Pattern Recognition and Image Analysis”, Pearson India Education, 2015.

REFERENCES:

1. S.N. Sivanandam & S.N. Deepa, Principles of Soft Computing, Wiley Publications, 2nd Edition, 2011.
2. S. Rajasekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic & Genetic Algorithms, Synthesis & applications, PHI Publication, 1st Edition, 2009.
3. Bart Kosko, Neural Network & Fuzzy System, PHI Publication, 1st Edition, 2009.

WEB REFERENCES:

- <https://www.coursera.org/learn/neural-networks-deep-learning>
- <https://www.classcentral.com/course/neuralnets-398>
- <http://neuralnetworksanddeeplearning.com/chap1.html>
- <https://online-learning.harvard.edu/subject/neural-networks>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	–	1	2	–	2	2	–
CO2	3	3	3	2	3	1	–	2	2	–	2	3	–
CO3	3	3	3	2	3	1	–	2	2	–	2	3	–
CO4	3	2	2	2	3	1	–	2	2	–	2	3	–
CO5	3	3	3	2	3	2	–	2	2	–	2	3	–
AVG	3	2.6	2.6	1.8	2.8	1.2	–	1.8	2	–	2	2.8	–

JBM2014	BRAIN COMPUTER INTERFACE TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the theories behind brain computer interaction.
- To introduce the basic concepts of brain computer interface system
- To study the various approaches and models in structure of BCI.
- To study the signal processing and classification methods used in BCI.
- To gain knowledge on various BCI technology applications in medicine.

UNIT I - HUMAN COMPUTER INTERACTION	9
Theories within cognitive and perceptual psychology, human decision making and actions in computer supported situations, Interaction between human and computerized technical systems, Concept of Brain Computer Interface (BCI).	
UNIT II – STRUCTURE OF BCI	9
Design and construction of Brain Computer Interface system, Invasive and Non-invasive Types of BCI, EEG Standards, Signal Features, Spectral Components, EEG Data Acquisition, Pre-processing, Hardware and Software, Artifacts, Methods to Remove artifacts, Near Infrared BCI	
UNIT III - BCI APPROACHES AND MODELS	9
Movement Related EEG Potentials, Mental States, Visual Evoked Potential. P300 virtual platform, EEG Feature Extraction Methods - Time/Space Methods, Fourier Transform, Wavelets, AR models, Band pass filtering, PCA, Laplacian Filters, Linear and Non-linear Features, EEG Feature Translation Methods- LDA, Regression, Memory Based Vector Quantization, Gaussian Mixture Modeling, Hidden Markov Modeling.	
UNIT IV – BCI DATA ANALYSIS AND CLASSIFICATION	9
Classification techniques–Binary classification, Ensemble classification, Multiclass Classification, Regression - Linear, Polynomial, Multilayer neural networks, Support vector machine.	
UNIT V - BCI CONTROLLED APPLICATIONS	9
Brain Computer Interface for Motor rehabilitation, Neuro-prosthetics, Mediating interaction in Virtual reality and augmented reality, Haptics, BCI Controlled Robots, Brain Actuated Control applications, Therapeutic applications of BCI technologies, Ethical issues in BCI research.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At end of the course the students will be able to:

- Explain the theories, cognitive foundations, and human–computer interaction principles relevant to Brain-Computer Interface (BCI) systems.
- Describe the structure, components, standards, and signal acquisition methods used in invasive and non-invasive BCI systems.
- Apply BCI approaches, feature extraction techniques, and modeling methods for interpreting EEG signals.
- Analyze signal processing, feature selection, and classification algorithms used in BCI applications.
- Evaluate and apply BCI-based technologies for rehabilitation, neuro-prosthetics, and clinical applications while considering ethical issues.

TEXT BOOKS:

1. Rajesh P. N. Rao, “Brain-Computer Interfacing: An Introduction”, First Edition, Cambridge University Press, 2019.
2. Fabien Lotte, Chang S. Nam, Anton Nijholt, “Brain–Computer Interfaces Handbook: Technological and Theoretical Advances”, CRC Press, UK. 2018.

REFERENCES:

1. Elizabeth Winter Wolpaw, Jonathan Wolpaw, “Brain Computer Interfaces: Principles and Practices”, First Edition, Oxford University Press, 2014.
2. Ella Hassanien, Ahmad Taher Azar, “Brain-Computer Interfaces: Current Trends and Applications”, Springer International Publishing, 2016.
3. Christoph Guger, Brendan Allison, Gernot Müller-Putz, “Brain-Computer Interface Research A State-of-the-Art Summary”, Springer International Publishing, 2015.
4. Dennis J. McFarland, Guido Dornhege, Jose del R. Millan, Klaus-Robert Müller, Thilo Hinterberger, “Toward Brain-computer Interfacing”, MIT Press, 2007.

WEB REFERENCES:

- <http://learn.neurotechedu.com/>
- <https://www.geeksforgeeks.org/brain-machine-interface-bmi/>
- <https://www.frontiersin.org/articles/10.3389/fnsys.2021.578875/full>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3497935/>
- <https://www.techtarget.com/whatis/definition/brain-computer-interface-BCI>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO-I	PSO-II
CO1	3	2	1	1	1	1	–	–	–	–	2	1	–
CO2	3	3	2	2	2	1	–	–	–	–	2	2	–
CO3	3	3	3	2	3	1	–	–	–	–	2	3	1
CO4	3	3	3	3	3	1	–	–	–	–	3	3	1
CO5	2	2	3	2	2	2	2	–	1	–	3	3	2
AVG	2.8	2.6	2.4	2	2.2	1.2	2	–	1	–	2.4	2.4	1.33

*** END OF VERTICAL 2 ***

VERTICAL III - MEDICAL DEVICE INNOVATION & DEVELOPMENT

JBM2015	BIOMEDICAL ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn fundamentals of entrepreneurship and its scope in Biomedical field.
- To learn the theories of entrepreneurial motivation for startup.
- To learn about the assistance and support available for Entrepreneurship.
- To gain knowledge on the regulatory and legislations in Entrepreneurship.
- To learn to assess the venture and globalization strategies.

UNIT I - SCOPE FOR ENTREPRENEURSHIP	9
Introduction to Entrepreneurship, Factors influencing entrepreneurship, Characteristics of an entrepreneur, Types of entrepreneurs - According to Type of Business, According to Use of Technology, According to Motivation, According to Growth, According to Stages. Advancements in biomedical field, Supporting societies and professional activities. Impact of innovation in medical devices.	
UNIT II - ENTREPRENEURIAL MOTIVATION	9
Motivation - Maslow's theory, Herzberg's theory, McGregor's Theory, McClelland's Need – Achievement Theory, Culture and Society, Values / Ethics. Risk taking behaviour, Creativity in Entrepreneurship, Innovation and inventions, Legal Protection of innovation, Skills of an Entrepreneur for Decision making and Problem Solving	
UNIT III – ORGANISATION ASSISTANCE	9
Identify and organize support for product development, funding agencies, collaborative initiatives, and angel investors. New Ventures, MSME Act Small Scale Industries, Carry on Business license, Environmental Clearance, National Small Industries Corporation, Government Stores Purchase scheme, Excise exemptions and concession, Quality Standards with special reference to ISO, Export oriented units, Incentives and facilities to exports entrepreneurs.	
UNIT IV – RULES, REGULATIONS AND LEGISLATION	9
Applicability of Legislation, Industries Development Act, 1951, Factories Act, 1948, The Industrial Employment Act, 1946, Suspension, Stoppage of work, Termination of employment, Environment Act, 1986, The sale of Goods Act, 1950, Industrial Dispute Act 1947, Directorate General of Supplies and Disposals, Certification, ISI, CE, UL, NABL and FDA regulations, ISO:13485, ISO:14791, risk management, Environmental regulation.	
UNIT V – VENTURE AND IMPACT OF GLOBALIZATION	9
Assessing the venture, establish venture invention, market research, presenting the business plan, medical product manufacturing and marketing, leadership, quality management, safety, safe disposal, preventing pollution and health hazards. Case study.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Describe the role of Biomedical Engineers in entrepreneurship.
- Interpret the background for biomedical engineers in entrepreneurship.
- Acquire the skills and techniques required towards innovation.
- Categorize the resources and funding agencies.
- Judge the right product based on market needs, Compile and quantify the opportunities and challenges

TEXT BOOKS:

1. O.P. Gupta, “Fundamentals of Entrepreneurship”, Reprint Edition, SBPD Publishing House, 2021.
2. Jen-Shih Lee “Biomedical Engineering Entrepreneurship”, World Scientific Publishing, USA. 2010.

REFERENCES:

1. S. Anil Kumar, “Entrepreneurship Development”, New Age International Publishers, 2008.
2. Brant Cooper, Patrick Vlaskovits, “The Lean Entrepreneur”, Wiley, 2nd edition, New Jersey, 2016.
3. Nathan Furr, Jeff Dyer, “The Innovator's Method: Bringing the Lean Start-up into Your Organization”, Harvard Business Press, Boston, 2014.

WEB REFERENCES:

- <https://msme.gov.in>
- www.gktoday.in/topic/national-policy-guidelines-on-bio-medical-innovation-and-entrepreneurship/
- www.worldscientific.com/doi/10.1142/9789813270435_0008
- www.coursera.org/specializations/wharton-entrepreneurship
- <https://swayam.gov.in/explorer?searchText=entrepreneurship>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO-I	PSO-II
CO1	1	3	3	2	-	1	-	-	-	2	2	2	1
CO2	1	-	1	-	-	1	-	-	-	2	2	2	1
CO3	-	-	1	1	-	1	-	-	-	2	2	3	-
CO4	-	-	1	1	-	1	-	-	-	2	2	2	1
CO5	1	1	1	1	-	1	-	-	-	2	2	3	1
AVG	1	2	1.4	1.25	-	1	-	-	-	2	2	2.4	1

JBM2016	CRITICAL CARE EQUIPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the role and importance of machines that are used for diagnosis in ICUs
- To study various imaging and intervening devices used in ICU
- To learn the various feeding, suction equipment and their accessories used in Intensive care unit.
- To understand the operational procedure of various therapeutic, life-saving equipment and accessories of a critical care unit.
- To learn the role and importance of machines that are used in neonatal, pediatric Critical care units.

UNIT I - MONITORING EQUIPMENT AND ACCESORIES	9
Intensive care unit – Overview and Importance, Classification, ICU Bed, Medical Stretcher, Patient Monitoring systems, continuous vital sign monitoring – Oscillometric blood pressure, capnometer, temperature, SpO ₂ , Holter monitor; Video laryngoscopes, Endoscopes, Glucometer, uric acid meter, pressure gauge, pressure monitoring line, monitoring lamps, Retractor set.	
UNIT II - CRITICAL CARE IMAGING AND INTERVENTION	9
Ultrasound Machine, Endoscopic imaging, laparoscopic imaging, laparoscopic clip applicator, electronic morcellator, laparoscopic endo-trainer set, electrosurgical unit vessel sealing system, stainless steel surgical instruments	
UNIT III – FEEDING AND SUCTION EQUIPMENT	9
Syringe Pump, Infusion Pump, Enteral Feeding Pumps, Lines - Arterial line, central line, vascath, Peripherally Inserted Central Catheter (PICC), Breathing tubes - Endotracheal (ET) tube, laryngectomy tube, intubation tube, Tracheostomy tube; tracheostomy mask, endotracheal tube holder, Inhalers; Suction catheters and machine.	
UNIT IV – LIFE SAVING EQUIPMENT	9
Oxygen supply – central line, portable oxygen cylinders; Sequential Compression Device, Ventilator – CPAP, BiPAP machine: mask, headgear, tube and filters, HME filter, nebulizer kit, Bains circuit, respiratory humidifier, Resuscitators, Blood warmer, Defibrillator, oxygen concentrator – Nasal cannula, oxygen mask, Dialysis machine, Anaesthesia machine, vaporiser, alarms.	
UNIT V – NEONATAL AND PAEDIATRIC EQUIPMENT	9
Baby Warmer, Neonatal Ventilator, Baby Incubator, Pediatric Laryngoscope, Mucus Extractor, Baby Resuscitation Unit, Enteral Feeding Pump, Baby Thermometer, Pediatric Suction Machine, Baby Measuring Mat, lumbar puncture set, breast pump electric, Refrigerator for feed and medicine, Neonatal Monitors, Arterial blood gas analyzers, Neonatal echocardiogram.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Explain the functions and clinical importance of monitoring equipment and accessories used in intensive care units.
- Describe the working principles and applications of critical care imaging and interventional devices.
- Interpret the operation and clinical use of feeding systems, suction equipment, and airway management devices in ICU settings.
- Explain the procedures, components, and applications of therapeutic and life-saving equipment used in critical care units.
- Describe the role, functioning, and significance of neonatal and pediatric critical care equipment.

TEXT BOOKS:

1. R.K.V. Murugan, "Hospital Medical Equipment Made Easy-Intensive care and Pediatric Intensive Care", First Edition, Notion Press publication, January 2020.
2. Yatin Mehta, "Textbook of Critical Care", Second Edition, Jaypee Brothers Medical Publishers, 2022.

REFERENCES:

1. Bikram Kumar Gupta, "Critical Care Medicine Bench to Bedside", First Edition, Jaypee Brothers Medical Publishers, 2022.
2. Kler Neelam, "Handbook on Neonatal ICU", First Edition, Jaypee Brothers Medical Publishers, 2020.
3. C. William Hanson, "Procedures in Critical Care", McGraw Hill LLC Publishers, 2008.
4. Daniel Aston, Angus Rivers and Asela Dharmadasa, "Equipment in Anesthesia and Critical Care", Scion Publishing, 2013.

WEB REFERENCES:

- <https://aci.health.nsw.gov.au/>
- <https://www.narang.com/>
- <https://intensivecarehotline.com/>
- <https://patient.uwhealth.org/>
- <https://www.kogland.com/>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	2	-	-	-	-	2	3	2
CO2	3	2	3	2	2	2	-	-	-	-	2	3	2
CO3	3	1	2	1	2	2	-	-	-	-	1	2	2
CO4	3	2	3	2	2	3	-	-	-	-	2	3	3
CO5	3	2	2	1	2	3	-	-	-	-	2	3	3
AVG	3	1.8	2.4	1.4	2	2.4	-	-	-	-	1.8	2.8	2.4

JBM2017	MEDICAL DEVICE DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand about need and scope in areas of medical device design.
- To understand standards and regulatory requirements in developing a medical device.
- To introduce the processes of design, construction of medical device.
- To learn technology of inclusion of hardware and software technology
- To understand procedures involved in patenting the developed medical device design.

UNIT I - SCOPE OF MEDICAL DEVICE DESIGN	9
Need for innovation in medical device design, Strategy for device design-problem identification, prior art searches, strategy planning and concept generation; estimation, sketching, sketch modelling, design elements, testing and prototyping.	
UNIT II – REGULATORY REQUIREMENTS	9
Medical device classification, bioethics, bio-compatibility and privacy issues in conceptualization, design of clinical trials, Specifications, control and regulatory requirements of design of: medical diagnostics (In-vitro, in-vivo diagnostics and Imaging), minimally invasive devices, surgical tools and implants.	
UNIT III - DEVELOPMENT STRATEGY AND PLANNING	9
Intellectual property strategy – research and development strategy – clinical strategy – regulatory strategy – quality and process management – reimbursement strategy – marketing and stakeholder strategy – sales and distribution strategy – competitive advantage and business strategy.	
UNIT IV - HARDWARE AND SOFTWARE DESIGN	9
Hardware risk analysis, Design and project merits, Design for six sigma, software risk analysis, licensing; Medical Device Rules, 2017: Implications on medical devices. Labelling, Inspection and IVD establishments, Clinical investigation; ISO 14971 (Medical devices: Application of risk management to medical devices). Regulatory requirements of biocompatibility of medical devices and ISO 10993; regulation of investigational medical devices.	
UNIT V - DESIGN TRANSFER AND IPR	9
Transfer to manufacturing, documents and deliverables. Standard-ISO, Intellectual Property – Indian Economic Services, Patents, Copy rights, Trademarks, Trade secrets; Regulations and standards involved in the design – CE mark and FDA, Regulatory bodies in India, ISO 14155 standards for clinical investigations, Steps for getting FDA approval, Function and role of ethical committee, Medical ethics proposed by ICMR.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Understand about need and scope in areas of medical device design.
- Gain knowledge on the standards and regulatory requirements in developing a medical device.
- Explain the basics processes of design, construction and development of medical device.
- Understand the technology of inclusion of hardware and software technology in medical device design.
- Explain the procedures involved in patenting the developed medical device design

TEXT BOOKS:

1. Vikki Hazelwood, “Foundations and Strategies for Medical Device Design”, e-book, McGraw Hill LLC, 2021.
2. Jose Justiniano and Venky Gopalaswamy, “Six Sigma for Medical Device Design”, First Edition, CRC Press, 2004.

REFERENCES:

1. Matthew Bret Weinger, Michael E. Wiklund, Daryle Jean Gardner-Bonneau ‘Handbook of Human Factors in Medical Device Design’, CRC press, 2010.
2. Peter J. Ogrodnik, “Medical Device Design: Innovation from Concept to Market”, Academic Press Inc; 1st Edition, 2012.
3. Paul H. King, Richard C. Fries, Arthur T. Johnson, “Design of Biomedical Devices and Systems”, Third Edition, 2014.
4. Stefanos Zenios, Josh Makower, Paul Yock, Todd J. Brinton, Uday N. Kumar, Lyn Denend, Thomas M. Krummel, “Biodesign: The Process of Innovating Medical Technologies”, Cambridge University Press; 1 edition, 2009.

WEB REFERENCES:

- www.sciencedirect.com/science/article/pii/S0921344917302094
- <https://www.researchgate.net/publication/319445657>
- <https://www.strategy2market.com/>
- www.jabil.com/blog/medical-device-industry.html
- www.insightregulatory.com/design-and-development

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO-I	PSO-II
CO1	3	3	3	3	3	1	-	-	-	1	3	3	1
CO2	3	3	2	3	3	1	-	-	-	-	3	3	2
CO3	3	3	2	3	3	1	-	-	-	-	3	3	2
CO4	3	3	2	2	3	1	-	-	-	-	3	3	2
CO5	3	3	2	2	3	1	-	-	-	-	3	3	1
AVG	3	3	2	2.6	3	1	-	-	-	-	3	3	1.6

JBM2018	BIOPHOTONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To obtain knowledge about optical properties of the tissues and its utilization on medical photonic diagnostic and therapeutic procedures.
- To understand the principle of Laser technology and other Instrumentation in medical photonics used in diagnosis and therapy.
- To understand the various medical applications of laser.
- To understand the principle of various diagnostic imaging modalities and monitoring equipment using photonics.
- To understand the various photonic intervention and treatment techniques

UNIT I - LIGHT - TISSUE INTERACTIONS	9
Fundamental Properties of light, Optical properties of tissues, Photobiology: Light induced cellular processes, Light induced processes in tissues: Radiative - Photo emission (Fluorescence and speckles), Non-Radiative - Photo chemical, Photo thermal and Photo disruption, Photo ablation, In-vivo Photoexcitation of tissues - Optical Biopsy.	
UNIT II - INSTRUMENTATION APPLIED IN MEDICAL PHOTONICS	9
Instrumentation for absorption, Scattering and emission measurements, Principle of Optical Biosensing, Optical Biosensors, Excitation light sources, Optical Waveguides, coupling devices and tips, Optical filters, polarizers, Optical detectors – Single Channel and Multichannel detectors, Time resolved and phase resolved detection techniques, Image intensifiers.	
UNIT III - LASERS IN THERAPEUTIC MEDICINE	9
Laser Characteristics as applied to medicine, Lasers for therapeutic applications in the field of Ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Gastroenterology, Neurology, Laser Safety Procedures.	
UNIT IV - PHOTONIC DETECTION AND IMAGING TECHNIQUES	9
Wave fronts, interference patterns, Principle of Hologram and its applications, Optical Coherence Tomography, Optical Elastography, Laser Induced Fluorescence Imaging (FLIM) Laser Doppler Perfusion Monitoring and Imaging, Flow Cytometry, Near field imaging of biological structures, Multispectral Imaging.	
UNIT V - PHOTONIC INTERVENTION AND TREATMENT TECHNIQUES	9
Phototherapy, Photodynamic therapy (PDT) - Principle and mechanism - Oncological and non-oncological applications of PDT – Bio-stimulation effect, Tissue Engineering with light, Overview of Bio-nano photonics.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Explain about Optical properties of the tissues and their light interaction mechanisms.
- Elaborate on the Principle of Laser technology and other Instrumentation in medical photonics used in diagnosis and therapy.
- Explain the various medical applications of laser.
- Explain the principle of various Diagnostic photonic Imaging modalities.
- Describe the Therapeutic applications of photonics.

TEXT BOOKS:

1. Tuan Vo Dirh, "Biomedical Photonics – Handbook", CRC Press, Boca Raton, 2003. **(Unit I, II, III)**
2. Paras N. Prasad, "Introduction to Biophotonics", A. John Wiley and Sons, Inc. Publications, 2003. **(Unit IV, V)**

REFERENCES:

1. Abraham Katzir, "Lasers and Optical Fibers in Medicine", Academic Press Edition, 1998.
2. Markolf H.Niemz, "Laser-Tissue Interaction Fundamentals and Applications", Springer, 2007
3. David A. Boas, Constantinos Pitris, Nimmi Ramanujam, "Handbook of Biomedical Optics", CRC Press, Taylor and Francis Group, 2011.
4. R. Splinter, B.A. Cooper, "An Introduction to Biomedical optics", Taylor and Francis, 2007.

WEB REFERENCES:

- <https://www.vumc.org/periop-services/laser-tissue-interaction>
- <https://www.ipen.br/biblioteca/2007/eventos/14658.pdf>
- <https://www.cancer.gov/about-cancer/treatment/types/photodynamic-therapy>
- <https://www.fda.gov/radiation-emitting-products/surgical-and-therapeutic-products/medical-lasers>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	-	-	1	-	-	-	-	2	-	3	1
CO2	3	1	2	1	3	1	-	-	-	2	-	3	2
CO3	3	-	-	-	2	1	-	-	-	2	-	3	2
CO4	3	-	2	1	2	1	-	-	-	2	-	3	2
CO5	1	1	2	1	1	1	-	-	-	2	-	3	2
AVG	2.2	1	2	1	1.8	1	-	-	-	2	-	3	1.8

JBM2019	REGULATORY PERSPECTIVES OF MEDICAL DEVICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand hazards and safety aspects of medical devices and hospital environment.
- To understand the need for quality management in hospital sector.
- To describe the Hospital safety and accreditation standards.
- To describe medical equipment safety standards.
- To explain the medical ethics.

UNIT I - HAZARDS IN HEALTHCARE SERVICES	9
Physiological effects of electrical current/shock, leakage current, electrical and chemical causes of fire, smoke and explosion, Occupational hazards - <i>hazardous agents</i> , ergonomic hazards, physical hazards and psychological hazards, Effects of radiation Exposure.	
UNIT II - STANDARDIZATION AND QUALITY MANAGEMENT	9
Need for Standardization, Quality Management, QM in Healthcare Organization-Quality assurance methods, Quality management system for medical devices (ISO 9001 and ISO13485), safety and standardization for risk management (ISO 14971), FDA guidelines for medical devices approval and classification based on risk assessment, measures for Quality Control, Safety and Testing of Medical devices.	
UNIT III - HOSPITAL SAFETY AND ACCREDITATION STANDARDS	9
Life Safety Standards- Protecting Occupants, Protecting the Hospital and individual from Fire, Smoke, and Heat, Systems for Extinguishing Fires, Managing Hazardous Material and Waste, Testing, Maintaining, and Inspecting Medical Equipment. Accreditation- JCI Accreditation and its Policies, Patient Organization management standards, NABH, NABL standards.	
UNIT IV - MEDICAL EQUIPMENT STANDARDS	9
General requirements for basic safety and essential performance of medical equipment, IEC 60601 standards, Electrical Safety of Medical Equipment and Patient, classification of medical devices and their safety standards, Bioeffects of Radiation, Safety Codes for Electromedical Equipment, Electrical Safety Analyser, Radiation Safety Instruments, Radiation Monitoring Instruments, radiation protection.	
UNIT V - MEDICAL ETHICS	9
Introduction to medical law and ethics, Consent to Treatment, Confidentiality and Clinical Negligence, Types of mental health, ethics of abortion, Reproductive Technology and surrogacy, The law in relation to end of life issues and Research. Maintaining standards and regulation, Presenting evidence and reports, The Coroner's court, The General Medical Council, Doctors rights: Employment and other rights of doctors.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Analyze the physiological, electrical, chemical, and radiation hazards in healthcare environments.
- Apply quality management systems, standardization procedures, and regulatory guidelines for medical devices.
- Evaluate hospital safety protocols, accreditation standards, and risk management measures.
- Demonstrate compliance with medical equipment safety standards, testing, and radiation protection procedures.
- Illustrate the principles of medical ethics, legal responsibilities, and patient rights in clinical practice.

TEXT BOOKS:

1. Olinda Timms, “Biomedical Ethics”, First Edition, Reed Elsevier India Pvt. Ltd., 2016.
2. Marcia A. Lewis and Carol D. Tamparo, “Medical Law, Ethics, and Bioethics for the Health Professions”, F. A. Davis Company, 6TH Edition, 2007.

REFERENCES:

1. Domiel A Vallero, Biomedical Ethics for Engineers, Elsevier Pub.1st edition, 2007.
2. C.M. Baxter, “The practical guide to Medical ethics and Law”, Second Edition. Pastest Publisher, 2005.
3. Johnna Fisher, Biomedical Ethics: A Canadian Focus, Oxford University Press, 2009.
4. Robert M Veatch, The Basics of Bio Ethics, 3rd Edition. Routledge, 2011.
5. Joint Commission Accreditation Standards for Hospitals, 6th Edition 2018.
6. Ben Mephram, Bioethics-An Introduction for the biosciences, 2nd Edition, Oxford University Press, 2008.
7. Nils Hoppe, Jose Miola, “Medical law and Medical Ethics”, Cambridge University Press, 2014.

WEB REFERENCES:

1. <https://vtethicsnetwork.org/>
2. www.intechopen.com/chapters/74571
3. www.karger.com/Article/FullText/509119
4. www.themedicportal.com/application-guide/medical-school-interview/medical-ethics/
5. www.ohchr.org/en/instruments-mechanisms/instruments/principles-medical-ethics-relevant-role-health-personnel

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	3	–	1	2	–	2	1	–
CO2	3	3	2	2	3	2	–	2	2	2	2	2	2
CO3	3	3	3	2	2	3	–	2	2	2	2	2	2
CO4	3	2	3	2	3	2	–	2	2	–	2	3	3
CO5	3	2	2	1	2	2	3	2	3	–	2	–	–
AVG	3	2.6	2.4	1.8	2.4	2.4	3	1.8	2.2	2	2	2	2.33

JBM2020	HUMAN ASSIST DEVICE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the role and importance of machines that takes over the functions of the heart.
- To study the role and importance of machines that takes over the functions of the lungs.
- To learn the functioning of the artificial unit which does the clearance function of kidney.
- To understand the devices developed for orthopedic assistance.
- To learn the assistive devices that augments and alternates sensory responses.

UNIT I - CARDIAC ASSIST DEVICES	9
Cardiac cycle, cardiac output, Principle of External counter pulsation techniques, left ventricular assist device, a right ventricular assist device, biventricular assist device, Muscle-powered VADs, intra-aortic balloon pump, Auxiliary ventricle, Short-term Circulatory Support Extracorporeal membrane oxygenation, prosthetic cardio valves, Artificial Heart, Pacemakers, case study.	
UNIT II - RESPIRATORY ASSIST DEVICES	9
Respiratory function, lungs gaseous exchange/transport, Ventilators, Non-invasive positive pressure respiratory assistance, PAP, Continuous Positive Airway Pressure Device, CPAP-machine, Bi-Level Positive Airway Pressure Device machine, Electronic IPPB unit with monitoring for all respiratory parameters, Phrenic nerve stimulator, vertical expandable prosthetic titanium rib, High frequency chest wall oscillation – Smart vest, Heart Lung machine, oxygenators, blood pumps. Case study.	
UNIT III - RENAL ASSIST DEVICES	9
Peritoneal dialysis, Artificial kidney, Dialysis principle, Hemodialysis Machine, Portable kidney machine, Dialyzers, functional parameters of hemodialyzer, Material and maintenance of dialyzers, Pelvic nerve stimulator, Case study.	
UNIT IV - ORTHOPAEDIC ASSIST DEVICES	9
Classification of amputation types, Upper limb orthotics: different types of models, externally powered limb, myoelectric systems, Lower limb orthotics: Foot Orthoses (FO), Ankle Knee Foot Orthoses (AFO), Knee Ankle Foot Orthoses (KAFO), Spinal Orthoses, Crutches and Calipers, Design considerations of Wheelchairs, Case study	
UNIT V - SENSORY ASSIST DEVICES	9
Types of deafness, Auditory augmentation and substitution - hearing aids, Cochlear implants, Voice synthesizer, Speech trainer, Speech synthesizer, mobility aids for visually impaired - Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually challenged, Text voice converter, screen readers, Case study.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At the end of this course the students will be able to:**

- Analyze the principles and construction of artificial hearts and associated circulatory assist devices.
- Discuss the functioning and clinical significance of oxygenation and ventilation equipment.
- Apply the techniques of extracorporeal blood purification using hemodialysis machines.
- Analyze the development, design, and utility of orthopedic assistive devices used in rehabilitation.
- Describe the concepts, operation, and applications of sensory augmentation and assistive technologies

TEXT BOOKS:

1. Dr. S. Sunder, "Rehabilitation Medicine", 3rd Edition, Jaypee Medical Publication, 2019.
2. Albert M. Cook, Janice Miller Polgar, "Essentials of Assistive Technologies", Elsevier Health Sciences, 2014.
3. Rory A, Cooper, Hisaichi Ohnabe, Douglas A, Hodson, "An Introduction to Rehabilitation Engineering", CRC Press, First edition, 2006.

REFERENCES:

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006.
2. Suzanne Robitaille, "The illustrated guide to Assistive technology and devices–Tools and gadgets for living independently", Demos Health New York, First edition, 2010.
3. Michael Lysaght and Thomas Webster, "Biomaterials for artificial Organs", Woodhead Publishing series in biomaterials, 2010.
4. John B. Park Joseph D. Bronzino, "Biomaterials - Principles and Applications" CRC Press, 4th edition, 2003.
5. Design of Artificial Human Joints and Organs, Subrata Pal, Springer New York, 2016.

WEB REFERENCES:

1. www.ncbi.nlm.nih.gov/pmc/articles/PMC6466092
2. <https://www.nichd.nih.gov/health/topics/rehabtech/conditioninfo/device>
3. <https://www.who.int/news-room/fact-sheets/detail/assistive-technology>
4. <https://www.thenationaltrust.gov.in/content/innerpage/aids-and-assistive-devices>

Mapping of CO with PO/PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO 1	PSO 2
CO1	3	3	3	2	2	3	-	1	1	-	2	2	3
CO2	3	3	2	1	2	3	-	1	1	-	2	2	3
CO3	3	3	2	2	3	3	-	1	1	-	2	2	3
CO4	3	3	2	1	3	3	-	1	1	-	2	2	3
CO5	3	3	2	1	3	3	-	1	1	-	2	2	3
AVG	3	3	2.2	1.4	2.6	3	-	1	1	-	2	2	3

JBM2021	PATIENT SAFETY STANDARDS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the framework and implications of patient safety
- To gain knowledge about the Medication Safety Standards
- To understand the various radiation and fire safety standards
- To gain knowledge on the surgical and infection control standards
- To be acquainted with the different clinical trial and medical data records standards

UNIT I - PATIENT SAFETY FRAMEWORK	9
Patient Safety, problematic areas of patients identified by the Joint Commission on Accreditation of Healthcare Organizations, International Patient Safety Goals - Joint Commission International Accreditation Standards for Hospitals, Ministry of Health and Family Welfare.	
UNIT II - MEDICATION SAFETY STANDARDS	9
Primary aims of medication safety standards - 5R's of medication safety, protocols for medication safety assessment, medication management processes, Governance and systems for medication safety, Medication Without Harm, Drugs and Therapeutics Committee, National Safety and Quality Health Service Medication safety standard.	
UNIT III - RADIATION AND FIRE SAFETY STANDARDS	9
Regulatory framework for Ionizing radiation sources, patient exposures in medical applicative, Atomic energy Radiation Protection Act, Rule and Safety codes for Radiotherapy, Nuclear Medicine and Diagnostic Radiology, Recognition of potential fire hazards in healthcare facility and aspects of fire safety, NABH - Facility Management and Safety Standard.	
UNIT IV - SURGICAL AND INFECTION CONTROL STANDARDS	9
Joint Commission's Universal Protocol for Preventing Wrong Site, Wrong Procedure, and Wrong Person Surgery, World Health Organization Surgical Safety Checklist, Patient safety in robotic surgery, Health care-associated infections, Joint Commission infection control standards, WHO - Infection prevention and control, Association for Professionals in Infection Control and Epidemiology's strategic goals	
UNIT V - CLINICAL TRIAL AND ELECTRONIC RECORDS STANDARDS	9
FDA's regulations on good clinical practice and clinical trials, ISO 14155:2020, Institutional Review Board, data safety and monitoring committees, Indian Council of Medical Research, ethics committee, Indian Good Clinical Practice Guideline, Digital Information Security in Healthcare Act of 2018, National Digital Health Authority, Digital Personal Data Protection Act, 2023.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At the end of the course, the student should be able to:**

- Describe the principles of patient safety frameworks and international safety goals applicable to healthcare organizations.
- Interpret medication safety standards, protocols, and governance processes used to ensure safe medication practices.
- Summarize radiation and fire safety regulations, protection standards, and facility safety requirements in healthcare.
- Explain surgical safety protocols and infection control standards enforced by global and national healthcare bodies.
- Outline clinical trial regulations, ethical guidelines, and digital health data protection standards followed in healthcare practice.

TEXT BOOKS:

1. Sharon Myers, Patient Safety and Hospital Accreditation, Springer Publishing Company, 2011.
2. Patient Safety, Joint Commission on Accreditation of Healthcare Organizations.

REFERENCES:

1. Dr. Zuber M. Shaik, Hospital Commissioning and Operations standards, KY Publications, 2021.
2. Charles Vincent, Patient Safety, BMJ Books, Second Edition, 2010.
3. Kimberly A. Galt, Karen A. Paschal, Patient Safety for Health Professionals, Jones and Barlette Publishers, 2010.
4. World Health Organization, Patient Safety Toolkit, 2016.

WEB REFERENCES:

- <https://hci.care/>
- <https://qps.nhsrindia.org/>
- <https://www.who.int/>
- <https://www.safetyandquality.gov.au/standards/nsqhs-standards/medication-safetystandard#:~:text=The%20Medication%20Safety%20Standard%20aims,own%20medicine%20needs%20and%20risks>
- <https://www.jointcommission.org/standards/national-patient-safety-goals/>
- https://main.mohfw.gov.in/sites/default/files/national%20patient%20safety%20implimentation_for%20web.pdf

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	1	-	1	-	-	-	2	1	2
CO2	3	3	2	1	1	-	2	-	-	-	2	2	2
CO3	3	2	2	2	2	-	2	-	-	-	2	2	3
CO4	3	2	2	2	2	-	2	-	-	-	2	2	3
CO5	2	2	1	1	1	-	1	-	-	-	3	2	2
AVG	2.8	2.2	1.6	1.4	1.4	-	1.6	-	-	-	2.2	1.8	2.4

***** END OF VERTICAL 3 *****

VERTICAL IV - BIO-ENGINEERING

JBM2022	GENETIC ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic concepts in rDNA technology.
- To explain the importance and creation of recombinant molecules in rDNA technology.
- To outline the concepts involved in gene library construction and differentiate between different gene libraries.
- To explain about the different types of PCR, the main concept in gene sequencing.
- To understand the vast applications of rDNA technology in diverse fields.

PREREQUISITE:

- Molecular Biology

UNIT I - RECOMBINANT DNA TECHNOLOGY	9
Role of genes within cells, genetic elements that control gene expression, Isolation and separation of genomic and plasmid DNA, restriction and modifying enzymes, safety guidelines of recombinant DNA research.	
UNIT II - CREATION OF RECOMBINANT MOLECULES	9
Restriction mapping, design of linkers and adaptors, Cloning and expression vectors based on plasmid and bacteriophage, Vectors for insect, yeast and mammalian system, Introduction of Recombinant DNA into host cells, Selection of Recombinants.	
UNIT III - CONSTRUCTION OF GENE LIBRARIES	9
Construction of cDNA and genomic libraries. Screening of libraries with DNA probes and with antisera. Cloning: Characterization of recombinant clones by southern, Northern, western and PCR analysis, factors affecting foreign gene expression, over expression and purification of recombinant proteins.	
UNIT IV - SEQUENCING AND AMPLIFICATION OF DNA	9
Polymerase chain reaction: Inverse PCR, Nested PCR, Taqman assay, RT - PCR, RACE PCR, RAPD, RFLP, site directed mutagenesis (Kunkel's Method), nucleic acid sequencing- Sangers method, Maxam Gilbert sequencing and automated sequencing method.	
UNIT V - APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY	9
Production of recombinant proteins - insulin, Human growth hormone HGH, DNA vaccines, Transgenic animals, gene silencing, gene therapy, molecular pharming.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At the end of the course, the student should be able to:**

- Explain the fundamentals of recombinant DNA (rDNA) technology.
- Describe the applications of recombinant molecules in research and development.
- Construct gene libraries and perform blotting techniques.
- Execute PCR experiments and analyze DNA sequencing methods.
- Evaluate the role of rDNA technology in cloning, gene therapy, and related applications.

TEXT BOOKS:

1. Old RW, Primrose SB, “Principles of Gene Manipulation, An Introduction to Genetic Engineering “, Blackwell Science Publications, 1993.
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, 3rd Ed. (Blackwell Publishing)
3. T.A. Brown, “Gene Cloning and DNA Analysis: An Introduction, Fifth Edition (2006) Wiley Blackwell, UK.

REFERENCES:

1. Ansubel. F.M., Brent. R., Kingston. R.E. and Moore D.D. (2003). “Current Protocols in Molecular Biology”, Greene Publishing Associates.
2. M. Innis, T. White and J.J. Sninsky, “PCR Protocols: A Guide to Methods and Applications”, First Edition (1990), Academic Press.
3. S. Ying, “Generation of cDNA Libraries: Methods and Protocols”, First Edition (2003) Humana Press.
4. Lodge, J., Lund, P., and Minchin, S., Gene Cloning, Taylor & Francis Group ISBN: 0-7487-6534-4, 2007.
5. Glick B.R. and Pasternak J.J. “Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3 rd Edition. ASM Press, 2003.
6. Krishnarao Appasani. “Genome Editing and Engineering” Cambridge University press 2018

WEB REFERENCES:

- <https://iastate.pressbooks.pub/genagbiotech/chapter/genetic-engineering/>
- <https://www.genome.gov/genetics-glossary/Genetic-Engineering>
- <https://www.sathyabama.ac.in/course-materials/genetic-engineering>
- https://onlinecourses.nptel.ac.in/noc19_bt15/preview
- <https://gdchoysang.ac.in/About/droid/uploads/Biotech5thSemGE.pdf>
- [https://study.com/academy/lesson/what-is-genetic-engineering-definition-benefits- issues.html](https://study.com/academy/lesson/what-is-genetic-engineering-definition-benefits-issues.html)

Mapping of CO with PO/PSO

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	–	1	2	–	2	3	–
CO2	3	2	2	1	2	2	–	2	2	–	2	3	–
CO3	3	3	3	3	3	2	–	2	2	–	3	3	2
CO4	3	3	3	3	3	2	–	2	2	–	3	3	2
CO5	3	3	3	2	2	2	–	2	2	–	3	3	2
AVG	3	2.6	2.6	2	2.4	1.8	-	1.8	2	-	2.6	3	2

JBM2023	BIOPRINTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To create organs and transplantable tissues that can be safely placed in humans.
- To understand the basic concepts of 3D Printing technology.
- To create problem solving ability among students for creating 3D Printing solutions.
- To design novel 3D Printing approaches for different CAD Models.
- To prepare students for Entrepreneurship in the field of 3D Printing technology.

UNIT I - DESIGN PROCESS OVERVIEW	9
Fusion 360, CAD environment, CAD - best practices, common files types, cad libraries, a short history of digital manufacturing: design for 3D print, fusion 360 modeling, sketching, extruding, collaborating on files, process flow: fusion 360 sculpting, moving between environments, matching imported geometry.	
UNIT II - 3D PRINTING AND ITS PROCESS	9
3D printing Business Case: working with Meshes, Scanning Tools, Editing Scanned Files, Fixing Scan Bugs, Printing in Plastic: Optimizing for Print, Printing, Stanford Print, De-Bugging, Printing in Metal: making assemblies, moving and aligning, Parts Joints.	
UNIT III - BIOPRINTING APPROACHES	9
Printing in glass, wood, concrete: Prototype II, fasteners, finishes, advanced modeling tools, bioprinting: Working with Service Providers, Optimizing Files for different methods, debugging prints, ethics: CAD Rendering, Mechanical Drawings, Photographing Parts.	
UNIT IV - 3D BIOPRINTING AND BIOFABRICATION	9
Problem identification, Applications in Lab-on-chip and Organ-on-chip (Brain-on-chip, Artery-on-a-chip, Lung-on-a-chip, Bone-on-a-chip, Liver-on-a-chip, Gut-on-a-Chip, etc.), Applications in prosthetics (Robohand) – implants - innovative bioactive research - regenerative medicine.	
UNIT V - DEVELOPMENTS IN BIOPRINTING	9
Stereolithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), Digital Light Process (DLP), Multi Jet Fusion (MJF), Polyjet. Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM).	

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At the end of this course the students will be able to:**

- Identify the four major steps in bioprinting a 3D structure and explain how bioprinting can be used to address medical needs.
- Differentiate the advantages and limitations of 3D modelling software for bioprinting
- Identify the ethical and regulatory issues involved in new medical treatments and the future of 3D bioprinting.
- Evaluate the nature and variation of materials for prosthetics and structural supports used in 3D bioprinting.
- Apply the 3D printing process to case studies of biomaterials enhancing lives.

TEXT BOOKS:

1. Atala et al., Essentials of 3D Biofabrication and Translation, 1st edition, ISBN-13: 978-0128009727.
2. Zhang et al., 3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine. 1st edition, ISBN 9780128005477.
3. Forgacs et al., Biofabrication - Micro- and Nano-fabrication, Printing, Patterning and Assemblies, 1st Edition, ISBN 9781455728527,

REFERENCES:

1. Hod Lipson, Melba Kurman., M, “Fabricated: The new world of 3D printing”. John Wiley and Sons, 2013.
2. France, A. K, “Make: 3D printing: the essential guide to 3D printers”, Maker Media, Inc., 2013.

WEB REFERENCES:

1. https://onlinecourses.nptel.ac.in/noc22_bt61/preview
2. <https://www.coursera.org/lecture/3d-printing-applications/bioprinting-V6WNO>
3. <https://www.sciencedirect.com/journal/bioprinting>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	2	-	2	3	2	3	2	1	1	2	3	3
CO2	1	1	2	1	2	1	-	1	1	2	2	2	1
CO3	1	3	2	2	2	3	1	3	1	2	2	1	2
CO4	1	3	1	1	3	3	2	1	-	3	2	3	3
CO5	1	2	1	3	1	2	1	1	3	3	2	2	1
AVG	1	2.2	1.5	1.8	2.2	2.2	1.75	1.6	1.5	2.2	2	2.2	2

JBM2024	BioMEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To aware the students about the fundamental principles of microsystems.
- To provide the concepts essential for designing lab-on-a-chip and Point-of-care devices
- To provide the concept of Biosensors, uses, design, and development for advanced research level so that students would be comfortable in higher studies.
- To Hands-on experience in in-house microfabrication and Hands-on experience in fabricating simple microfluidic devices.
- To learn and design about various biosensors and its applications.

UNIT I - MICROSYSTEMS	9
Overview of MEMS and BioMEMS, Silicon microfabrication: materials for MEMS, Emergence, device and applications, Scaling issues.	
UNIT II - MICROFABRICATION TECHNOLOGY	9
Microfabrication concept, types of microfabrication: Thin film deposition, Lithography, E-Beam Lithography, X-ray Lithography, Photolithography, Soft lithography Etching, Wafer Bonding, Bulk Micromachining, Surface Micromachining, and LIGA process.	
UNIT III – MICROFLUIDICS	9
Basic principles in microfluidics, design principles for microfluidic devices, device fabrication procedures, components of microfluidic devices utility of microfluidic devices in various biological, chemical, and optical sensing applications, opto-fluidics, Inertial-microfluidics, droplet-microfluidics, microfluidics based-flow cytometry.	
UNIT IV - LAB-ON-A-CHIP DEVICES	9
Concept of ‘Lab on a chip’, Components of lab-on-a chip: micropump, microvalve, micromixer, microsensor, lenses, heaters, sensors, etc. Field flow fractionation (FFF), Microfluidic PCR, Microfluidic cell sorter, Lab-on-chip array for biomolecules, Minimally invasive biomedical microdevices, and Microfluidics Future prospects.	
UNIT V - BIOSENSORS AND ITS TYPES	9
Introduction to Overview of Biosensors, components of a biosensor, design considerations. Biosensors for Health: Biosensors for diabetes, cardiovascular diseases, and cancer applications. Ion exchange membrane electrodes, enzyme electrodes, glucose sensors, immunosensors, Basic principles of MOSFET biosensors.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Apply fabrication techniques for biosensors and analyse their applications in healthcare.
- Discuss the basic design requirements for microfabrication-based devices.
- Analyse the hands-on skills in building and fabricating simple microfluidic devices.
- Differentiate lab-on-a-chip concepts, design approaches, and modes of operation.
- Describe the performance, advantages, and limitations of various point-of-care diagnostic devices.

TEXT BOOKS:

1. Tai Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata McGraw Hill, 2001.
2. Wanjun Wang, Stephen A.Soper, “BioMEMS: Technologies and Applications”, CRC Press, 2006.
3. Mohamed Gad-el-Hale, “MEMS Applications”, CRC Press, 2006.

REFERENCES:

1. Madou, M. J., “Fundamentals of microfabrication and nanotechnology”, three-volume set. CRC Press, 2018
2. Gerald A. Urban, “BioMEMS”, Springer, 2010.
3. Steven S Saliterman, “Fundamentals of BioMEMS and Medical Microdevices”, SPIE, 2008.

WEB REFERENCES:

1. <https://archive.nptel.ac.in/noc/courses/noc15/SEM1/noc15-me01/>
2. <https://pll.harvard.edu/course/introduction-mems-and-biomems>
3. <https://link.springer.com/book/10.1007/978-1-4757-3534-5>

Mapping of CO with PO/PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	3	2	3	2	3	2	1	2	1	1	1
CO2	2	1	2	1	-	1	-	1	1	2	2	2	1
CO3	3	2	2	2	2	-	-	3	1	2	1	2	2
CO4	1	3	3	2	3	3	2	1	-	1	1	3	3
CO5	3	2	1	3	1	1	1	2	3	3	3	2	1
AVG	2.4	2	2.2	2	2.25	1.75	2	1.8	1.5	2	1.6	2	1.6

JBM2025	NANOTECHNOLOGY AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide a broad view of the nascent field of nanoscience and nanotechnology to undergraduates
- To make them acquaint with the fabrication and characteristics of nanomaterials
- To make them learn the methods and techniques for analysis and synthesis of nanoparticles
- To make them learn about the shapes, structure and properties of nanoparticles
- To make them understand various applications of nanoparticles in different sectors

UNIT I - INTRODUCTION TO NANOTECHNOLOGY	9
Basic Structure of Nanoparticles, History of Nanotechnology-Opportunity at the nano scale-length and time scale in structures-energy landscapes-Inter dynamic aspects of inter molecular forces nanoclusters of metals and semiconductors.	
UNIT II - FABRICATION OF NANOMATERIALS	9
Physical Vapor Deposition (PVD), pulsed laser deposition, Magnetron sputtering, Multi Beam Epitaxy, Chemical Vapor Deposition (CVD), Atomic Layer Deposition (ALD), Microlithography, Dip-pen and Electron beam lithography, thin film deposition; Electrospinning; Bio-synthesis of nanomaterials	
UNIT III - PROPERTIES AND MEASUREMENT OF NANOMATERIALS	9
Influence of Nano structuring on Mechanical, optical, electronic, magnetic and chemical properties, Electronic and optoelectronic properties of molecular materials, Microscopy measurements: Scanning electron microscopy, transmission electron microscopy, Atomic force microscopy, scanning tunnelling microscopy.	
UNIT IV - NANOSTRUCTURES	9
Nanocrystals, Dendrimers, Buckyballs, Carbon Nanotubes, Fullerenes, Nanowires, Micelles, Quantum Dots, Giant magnetoresistance Applications of nanostructures- Reinforcement in Ceramics, Drug delivery.	
UNIT V - BIONANOPHOTONICS	9
Semiconductor (metal) nanoparticles, nucleic acid and protein-based recognition groups– Application in optical detection methods – Nanoparticles as carrier for genetic material–. Designer proteins, Peptide nucleic acids, Nanomedicine, DNA computing, Molecular design using biological selection, Hybrid materials, Biosensors. Other general applications- Nanotechnology in agriculture – Fertilizer and pesticides.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Analyze the basic of nanomedicine and key properties of nanomaterial in contrast biological relevance.
- Determine the potential advantages of nanostructure materials as drug carriers
- Apply their learned knowledge to develop Nanocarriers.
- Compare the surface area and volume in nano systems with microsystems
- Develop the nanocarriers in various drug delivery systems.

TEXT BOOKS:

1. Vladimir P.T., “Nanoparticulates as Drug Carriers”, Imperial College Press, 2006.
2. Christ of M. Niemeyer, “Nano bio-technology: Concepts, Applications and Perspectives”, Wiley, 2014.
3. Dong Kee Yi, Georgia C. Papaefthymiou, “Nanobiomaterials: Development and Applications”, CRC Press, 2013.

REFERENCES:

1. Reza.A., Kentus. L., “Smart Nanoparticles in Nanomedicine”, Kentus Books, 2015.
2. Robert.W.Kelsall, Ian.W.Hamley, Mark Geoghegan, “Nano Scale Science And Technology”, John Wiley and son, ltd., 2011.
3. Mick Wilson Kamali Kannangara Geooff Smith Michelle, Simmons Urkhard Raguse, “Nano Technology”, Overseas India private Ltd., 2005.
4. S. M Lindsay, “Introduction to Nanoscience”, Oxford (2010).
5. Parag D., and Ashish., “Nano Medicines”, Pentagon Press, 2006.
6. K.K.Jain, “Nano Biotechnology”, Horizons Biosciences, 2008.

WEB REFERENCES:

- <https://nptel.ac.in/courses/115/106/115106066/>
- <https://nptel.ac.in/courses/122/106/122106034/>
- <https://nptel.ac.in/courses/112/105/112105123/>
- <https://nptel.ac.in/courses/115/105/115105099/>

Mapping of CO with PO/PSO:

	Program Outcomes												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	3	-	-	1	1	3	2	3	1
CO2	3	3	3	2	3	3	-	2	2	1	3	3	3	2
CO3	-	-	3	3	3	3	-	1	1	1	3	3	2	1
CO4	2	3	2	2	2	-	2	1	1	1	-	2	2	1
CO5	3	3	3	2	3	3	1	1	1	1	2	2	3	1
AVG	2.2	2.2	2.6	2.4	2.6	3	1.5	1.25	1.2	1	2.75	2.4	2.6	1.2

JBM2026	MEDICAL IMPLANTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To describe the principles of implant design with a case study.
- To study the implant design parameters and various blood interfacing implants.
- To study about soft tissue replacement and hard tissue replacement.
- To learn about the different kinds of implant materials and its uses.
- To understand the implants in patients and its ethical principles.

UNIT I - PRINCIPLES OF IMPLANT DESIGN	9
Clinical Problems Requiring Implants for Solution, Principles of Implant Design/Design Parameters: Permanent versus Absorbable Devices, The Missing Organ and its Replacement, Criteria for Materials Selection, Tissue Engineering-Scaffolds and Cells and Regulators.	
UNIT II - DESIGN PARAMETERS	9
Design Specifications, Biocompatibility: Local and Systemic Effects, Tissue Bonding and Modulus Matching, Degradation of Devices: Natural and Synthetic Polymers, Corrosion and Wear, Biocompatibility: Scar Formation and Contraction, Federal Regulation of Devices.	
UNIT III - DESIGN SOLUTIONS	9
Scaffolds for Cartilage Repair, Implants for Bone, Implants for Plastic Surgery, Cardiovascular Prostheses: Heart Valves and Blood Vessels, Devices for Nerve Regeneration, Musculoskeletal Soft Tissues: Meniscus, Intervertebral Disk, Dental and Otologic Implants.	
UNIT IV - IMPLANT MATERIALS	9
Implant Materials: Metallic implant materials, Stainless steels, Co based alloys, Ti-based alloys, Ceramic implant materials, Aluminium oxides, Hydroxyapatite, Glass ceramics, Carbons, nanocomposites in healing abutment and anti-microbial activity.	
UNIT V - IMPLANTS PRACTICAL ASPECTS	9
Case studies – bone, cartilage, joints (knee and hip joints) and neural tissue regenerative devices, Ethical and Safety Issues, Implant and Device Failure, Implant Retrieval and Evaluation.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Explain the principles of implant design and the clinical problems that require implant-based solutions.
- Analyze implant design parameters including biocompatibility, degradation, tissue bonding, and regulatory considerations.
- Evaluate appropriate design solutions for cartilage, bone, cardiovascular, dental, neural, and soft-tissue implants.
- Compare different classes of implant materials and justify their selection based on properties and biomedical applications.
- Assess practical aspects of implants through case studies, focusing on device failure, ethical issues, and retrieval analysis.

TEXT BOOKS:

1. Paul H. King, Richard C. Fries, Arthur T. Johnson, "Design of Biomedical Devices and Systems", Third Edition, ISBN 9781466569133, 2018.
2. Peter J. Ogrodnik, "Medical Device Design: Innovation from Concept to Market", Academic Press Inc, 1st edition, ISBN-10: 0123919428, 2012.
3. Stefanos Zenios, Josh Makower, Paul Yock, Todd J. Brinton, Uday N. Kumar, Lyn Denend, Thomas M. Krummel, Biodesign: "The Process of Innovating Medical Technologies", Cambridge University Press, 1st edition, ISBN-10: 0521517427, 2009.

REFERENCES:

1. Martin Culjat, Rahul Singh, Hua Lee, "Medical Devices: Surgical and Image-Guided Technologies", 2012
2. Reinaldo perez, "Design of medical electronic device", Elsevier science, 2002.
3. Theodore R, Kucklick, "The Medical Device Ramp-D Handbook", Taylor and Francis Group LLC", 3rd edition 2013.
4. David Prutchi, Michael Norris, "Design and Development of Medical Electronic Instrumentation: A Practical perspective of the design, construction and test of medical devices", John Wiley and Sons, 2005.
5. J. E. Ellingsen, S. Petter Lyngstadaas, "Bio-Implant Interface: Improving Biomaterials and Tissue Reactions", CRC Press, 2003.

WEB REFERENCES:

- <https://www.mayoclinic.org/patient-care-and-health-information>
- <https://biodesign.stanford.edu/>
- <https://piib.gov.in/newsite/printrelease.aspx?relid=157955>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	1	1	1	—	-	—	1	2	1
CO2	3	3	3	2	2	1	2	—	—	—	1	2	1
CO3	3	3	3	3	2	2	1	1	1	1	1	3	2
CO4	3	2	2	1	2	1	—	—	—	—	1	3	1
CO5	2	2	1	3	1	3	3	-	-	2	1	2	2
AVG	2.8	2.4	2.2	2	1.6	1.6	1.75	1	1	1.5	1	2.4	1.4

JBM2027	ARTIFICIAL ORGANS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To have an overview of artificial organs and transplants
- To describe the principles of cardiac implants and its design.
- To study about implants of blood and cochlea.
- To describe about artificial skin and its substitutes.
- To study about physical parameters for concept design of artificial pancreas and lungs.

UNIT I - ARTIFICIAL ORGANS AND TRANSPLANTS	9
Artificial Organs: Basic physiology of human organs, Introduction, outlook for organ replacements, design consideration, evaluation process, Biomaterials used in artificial organs and prostheses. Transplants: Overview, Immunological considerations, Blood transfusions, individual organs – kidney, liver, heart and lung, bone marrow, cornea.	
UNIT II - CIRCULATORY ASSIST DEVICES	9
Engineering Design of artificial Heart and Circulatory Assist Devices, Detailed Design to execute the plant, HeartAssist Technology, Blood Pumps, Prosthetic Heart Valves.	
UNIT III - ARTIFICIAL BLOOD AND COCHLEAR IMPLANTS	9
Blood components and characteristics, Oxygen carrying plasma expanders, Blood substitutes, Crystalloid and colloid solutions as volume expanders, Artificial oxygen carriers, Fluorocarbons, Hemoglobin based artificial blood. Cochlear Implant: Introduction, candidates for implant, the auditory system, the auditory periphery, theory of operation, evaluation of cochlear prosthesis, benefits and risks of implantation, the cost of implantation, the future of cochlear prosthesis.	
UNIT IV - ARTIFICIAL SKIN	9
Structure and functions of skin, Characteristics and clinical use of skin substitutes, two conceptual stages in the treatment of massive skin loss, Skin substitutes: characteristics and uses, types of skin substitutes.	
UNIT V - ARTIFICIAL PANCREAS AND ARTIFICIAL LUNGS	9
Parenteral Structure and function of Pancreas, Endocrine pancreas and insulin secretion, Diabetes, Insulin therapy, Insulin administration systems, Insulin production systems. Artificial Lungs: Gas exchange systems, Cardiopulmonary Bypass, Oxygen and CO₂ transport, coupling of oxygen and CO₂ exchange, Shear-Induced Transport Augmentation and Devices for Improved Gas Transport.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At the end of this course the students will be able to:**

- Elaborate the principle and biology underlying the design of implants and artificial organs.
- Differentiate classes of materials used in medicine.
- Discuss the application of cardiac assist devices.
- Discuss concept of biocompatibility and the design of artificial skin.
- Discuss the design process in artificial pancreas and lungs.

TEXT BOOKS:

1. Bronzino, J. D, "The Biomedical Engineering Handbook", Germany: CRC Press, 2000.
2. Gerardo Catapano and Gijsbertus Jacob Verkerke, "Artificial Organs", IGI Global Publishers, 2012.

REFERENCES:

1. Miller, G. E., "Artificial Organs", United States: Morgan and Claypool Publishers, 2006.
2. Schoen, F. J., Ratner, B. D., Hoffman, A. S., Lemons, J. E., "Biomaterials Science: An Introduction to Materials in Medicine", Elsevier, 2003.
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, "Clinical Engineering", CRC Press, 1st edition, 2010.
4. Yannas, I. V, "Tissue and Organ Regeneration in Adults", New York, NY: Springer, ISBN: 9780387952147, 2001.

WEB REFERENCES:

- https://onlinecourses.nptel.ac.in/noc20_bt12/preview
- <https://aabme.asme.org/posts/innovations-in-artificial-organs>
- <https://onlinelibrary.wiley.com/journal/15251594>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	3	3	1	1	-	1	1	1	2	1	1
CO2	3	1	2	2	2	1	-	-	-	1	1	2	1
CO3	2	2	2	2	2	2	-	-	1	2	1	2	2
CO4	3	2	1	1	3	2	1	-	1	1	3	3	3
CO5	2	1	2	1	1	1	-	-	2	-	-	2	3
AVG	2.6	1.5	2	1.8	1.8	1.4	1	1	1.25	1.25	1.75	2	2

JBM2028	NEURAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To discuss the physiological concepts of nerve impulse generation and Electromyography
- To discuss about neuronal disorder.
- To Explore Evoked potentials and its importance in medicine
- To introduce various techniques to study central and peripheral nerve function
- To discuss the electrophysiological evaluation in special situations

UNIT I - NERVE EXCITABILITY AND ELECTROMYOGRAPHY	9
Nerve Excitability, Nerve excitability findings in Neurologic diseases: Chemotherapy induced neurotoxicity, Porphyric Neuropathy, Inflammatory Neuropathy and its Treatment, Spinal Cord Injury; Nerve conduction studies, Microneurography, Clinical and Quantitative EMG, Electrophysiological evaluation of movement disorders, Evaluation of autonomic nervous system.	
UNIT II – 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 III - EVOKED POTENTIALS	9
Evoked Potentials: Visual Evoked potentials (VEPs), Electroretinography and other diagnostic approaches to the Visual System, VEPs in infants and children, Brainstem Auditory Evoked Potentials (AEPs), Brainstem AEPs in infants and children, Somatosensory evoked potentials, Diagnostic and therapeutic role of Magnetic stimulation in neurology.	
UNIT IV - FUNCTIONAL NEUROIMAGING AND COGNITION	9
Historical and physiological perspective, Functional neuro imaging methods: PET and fMRI, Network analyses, Functional neuro imaging of: Attention, Visual recognition, Semantic memory, Language, Episodic memory, Working memory, Cognitive aging, Neuro-psychologically impaired patients.	
UNIT V - ELECTROPHYSIOLOGICAL EVALUATION	9
Nerve graft, Neural tissue engineering, Cognitive & neurobehavioral rehabilitation, Electrophysiological evaluation of sacral function, Vestibular laboratory testing, Polysomnographic evaluation of sleep disorders, Electrophysiologic evaluation of brain death, Robotics and virtual reality in physical therapy, Transcranial magnetic stimulation.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):**At end of the course the students will be able to:**

- Explain the physiology underlying the generation of nerve impulses.
- Describe various techniques used to evaluate the functioning of the nervous system.
- Differentiate between normal and abnormal signals from healthy and diseased nervous systems.
- Analyze functional neuroimaging data and interpret cognitive processes.
- Demonstrate understanding of electrophysiological methods and their applications.

TEXT BOOKS:

1. Michael J. Aminoff, et.al., “Electrodiagnosis in Clinical Neurology”, Sixth Edition, Elsevier Saunders, 2012. **(Unit I, II, III)**
2. Rajesh. P.N. Rao, “Brain-Computer Interfacing: An Introduction”, First edition, Cambridge University Press, 2013. **(Unit IV, V)**

REFERENCES:

1. Kim E. Barette, Scott Boitano et. al., “Ganong’s review of Medical Physiology”, 23 Edition, Mc Graw Hill Medical, 2010.
2. Eric R.Kandel et. al., “Principles of Neural Science”, McGraw-Hill, New York, 2012.
3. R.Cooper, et.al, “Techniques in Clinical Neurophysiology: A Practical Manual”, Elsevier, Amsterdam, The Netherlands, 2005.
4. Ella Hassianien. A and Azar. A. T, “Brain-Computer Interfaces Current Trends and Applications”, Springer 2015.
5. Holodny, Andrei I., et al, “Functional neuro imaging: a clinical approach”. Informa Health Care, 2008.

WEB REFERENCES:

- <https://centerforneurotech.uw.edu/education-k-12-resources-teachers/introduction- neural-engineering>
- https://onlinecourses.nptel.ac.in/noc22_bt14/preview
- <http://acl.digimat.in/nptel/courses/video/108108188/L52.html>
- <https://iopscience.iop.org/journal/1741-2552>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	2	–	1	2	–	2	3	–
CO2	3	3	2	3	3	2	–	2	2	–	2	3	2
CO3	3	3	3	3	3	2	–	2	2	–	2	3	2
CO4	3	3	3	3	3	2	–	2	2	–	2	3	–
CO5	3	2	3	3	3	2	–	2	2	–	2	3	2
AVG	3	2.6	2.6	2.8	2.8	2	-	1.8	2	-	2	3	2

***** END OF VERTICAL 4 *****

VERTICAL V – COMMUNICATION SYSTEMS IN MEDICINE

JBM2029	VIRTUAL REALITY IN MEDICINE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To get knowledge about the various component and benefits of virtual reality
- To introduce the relevance to the existing technology through I/O devices
- To implement case studies and applications with a futuristic vision along with socio-economic impact and issues
- To understand virtual reality, augmented reality and using them to build Biomedical engineering applications
- To know the intricacies of these platform to develop PDA applications with better optimality

UNIT I - COMPONENTS OF VR	9
The three I's of virtual reality-commercial VR technology and the five classic components of a VR system – real time computer graphics, virtual environment requirement, benefits of virtual reality, historical development of VR, scientific landmark.	
UNIT II - INPUT AND OUTPUT DEVICES	9
Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays and haptic feedback.	
UNIT III - CONTENT CREATION CONSIDERATIONS	9
Methodology and terminology - user performance studies - VR health and safety issues - Usability of virtual reality system - cyber sickness - side effects of exposures to virtual reality environment.	
UNIT IV - VR ON THE WEB AND MOBILE	9
JS - pros and cons - building blocks (WebVR, WebGL, Three.js, device orientation events) - frameworks (A-frame, React VR) - Google VR for Android - scripts, mobile device configuration, building to android - cameras and interaction - teleporting - spatial audio -assessing human parameters - device development and drivers - Design haptics.	
UNIT V - APPLICATIONS	9
Medical applications – robotics applications – Advanced Real time tracking other applications, games, movies, simulations, therapy, case studies.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Discuss the various components of VR
- Analyze and design a system or process to meet given specifications with realistic engineering constraints.
- Analyze the problem statements and function as a member of an engineering design team.
- Evaluate the technical resources
- Develop technical documents and give technical oral presentations related to design mini project results.

TEXT BOOKS:

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. C.Burdea and Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley and Sons, Inc., 2008.
4. Jason Jerald, "The VR Book: Human-Centered Design for Virtual Reality", Association for Computing Machinery and Morgan and Claypool, 2015.

REFERENCES:

1. Steve Aukstakalnis, "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability)", Addison-Wesley Professional; first edition, 2016.
2. Tony Parisi, O'Reilly Media, "Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile", first edition, 2015.

WEB REFERENCES:

- <https://archive.nptel.ac.in/courses/106/106/106106138/>
- <https://vrvisiongroup.com/virtual-reality-development/apps/>
- <https://www.smashingmagazine.com/2017/09/guide-virtual-reality-web-developers/>

Mapping of CO with PO/PSO:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	-	2	1	1	1	3	1	3	2
CO2	3	2	2	1	2	2	2	1	2	1	2	3	2
CO3	3	2	2	1	2	2	2	1	2	2	2	3	2
CO4	3	3	2	1	2	2	1	1	1	2	1	3	2
CO5	3	2	2	1	-	2	1	2	1	1	1	3	2
AVG	3	2.2	2	1	2	2	1.4	1.2	1.4	1.8	1.4	3	2

JBM2030	BODY AREA NETWORK	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study about working of Body Area Network
- To learn about body area networks and different hardware related to it
- To understand the healthcare devices of BAN
- To describe the need and methods of communication network
- To provide knowledge in the applications of Body area Network

UNIT I - BODY AREA NETWORKS	9
Need for wireless monitoring, Body area networks 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 - HEALTHCARE DEVICES	9
Wearable system for ECG monitoring, Evaluation of night time performance, smart phone-based healthcare monitoring system, Phone based fall risk prediction, RFID based personal mobile medical assistance.	
UNIT IV - WEARABLE SENSORS IN COMMUNICATION	9
Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wireless personal Area Network Technologies-IEEE 802.15.1, IEEE 802.15.3, IEEE 802.15.4, Zigbee.	
UNIT V - BAN APPLICATIONS AND CHALLENGES	9
Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics, Electronic pill, Hardware centric and human centric challenges.	

TOTAL: 45 PERIODS

COURSE COUTCOMES:

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

- Analyze the working of Body area network
- Analyze the mobile based healthcare devices
- Apply the body area network in wireless health systems
- Apply the sensors and communication techniques in BAN
- Discuss the applications of BAN

TEXT BOOKS:

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011. (UNIT I, IV, V)
2. Sandeep Gupta, Tridib Mukherjee, Krishna Kumar Venkatasubramanian, "Body Area Networks Safety, Security and Sustainability", Cambridge University Press, 2013.

REFERENCES:

1. Hang, Yuan Ting, "Wearable medical sensors and systems", Springer-2013
2. Mehmet R. Yuce, Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore, 2012
3. Guang-Zhong Yang (Ed.), "Body Sensor Networks", Springer, 2017
4. Nilanjan Dey, Amira S. Ashour, Simon James Fong, "U-Healthcare Monitoring Systems: Volume 1: Design and Applications", United Kingdom, Elsevier Science, 2018.

WEB REFERENCES:

- <https://www.nist.gov/publications/application-link-adaptation-body-area-networks>
- <https://www.sciencedirect.com/science/article/pii/S187705091630299X>
- <https://www.lairdconnect.com/resources/white-papers/overview-of-medical-body-area-networks>

Mapping of CO with PO/PSO:

	Program Outcomes												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	1	2	1	2	1	1	2	3	2
CO2	3	2	1	1	2	1	2	1	1	2	1	2	3	2
CO3	3	2	1	1	2	2	2	1	1	2	1	2	3	2
CO4	3	3	1	1	2	2	2	1	1	2	2	2	3	2
CO5	3	2	3	1	-	3	3	2	3	2	3	2	3	2
AVG	3	2.4	1.4	1	2	1.8	2.4	1.2	1.6	1.8	1.6	2	3	2

JBM2031	PRINCIPLES OF COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To know about analog communication and its types
- To learn data and pulse communication techniques.
- To gain knowledge on digital communication techniques
- To know the different types of bio-telemetry system
- To know the fundamental concepts of picture archiving and communication system

UNIT I - ANALOG COMMUNICATION	9
Introduction to Communication Systems - Modulation - Types - Need for Modulation. Theory of Amplitude Modulation - Modulation and demodulation Techniques - Theory of Frequency and Phase Modulation - Comparison of Analog Communication Systems (AM, FM, PM).	
UNIT II - PULSE AND DATA COMMUNICATION	9
Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM), Pulse code Modulation (PCM) - Comparison of various Pulse Communication System (PAM, PTM, PCM), Data Communication: History of Data Communication - Standards Organizations for Data Communication- Data Communication Circuits - Data Communication Codes - Data communication Hardware - serial and parallel interfaces.	
UNIT III - DIGITAL COMMUNICATION	9
Amplitude Shift Keying (ASK) - Frequency Shift Keying (FSK) - Phase Shift Keying (PSK), BPSK - QPSK - Quadrature Amplitude Modulation (QAM) - 8 QAM - 16 QAM - Bandwidth Efficiency - Comparison of various Digital Communication System (ASK, FSK, PSK, QAM).	
UNIT IV – BIO-TELEMETRY SYSTEM	9
Components of telemetry system, Bio-telemetry and its importance, Single and multi-channel biotelemetry, ECG telemetry system, Temperature telemetry system, Telemetry of ECG and Respiration, Sports telemetry, Multi-patient telemetry, Ambulatory patient monitoring, Implantable telemetry systems.	
UNIT V - PICTURE ARCHIVING AND COMMUNICATION SYSTEMS	9
History of Picture archiving and communication system (PACS): Computer network development and data storage technology history - Establishment of standards for image exchange in medicine - PACS server, Benefits of a PACS Server, Cloud-based PACS, PACS With Radiology Information Systems (RIS) - Applications of PACS, PACS software, implementation of a picture archiving and communication system in a prototype application.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At the end of the course, the students will be able to:**

- Apply analog and digital communication techniques.
- Analyze the data and pulse communication techniques.
- Examine different Digital Communication Technique
- Elucidate on biotelemetry system and its components
- Describe the applications of PACS in hospital communication

TEXT BOOKS:

1. Wayne Tomasi, “Advanced Electronic Communication Systems”, 6th Edition, Pearson Education, 2009.
2. R S Khandpur, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, 2003.
3. Yu Liu, Jihong Wang, “PACS and Digital Medicine: Essential Principles and Modern Practice”, CRC Press, 2010.

REFERENCES:

1. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley and Sons, 2004
2. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, 2007.
3. H.Taub, D L Schilling and G Saha, “Principles of Communication”, 3rd Edition, Pearson Education, 2007.

WEB REFERENCES:

- <https://electronicspost.com/explain-the-need-for-modulation-in-a-communication-system/>
- <https://www.postdicom.com/en/blog/cloud-based-pacs>
- <https://science.jrank.org/pages/6722/Telemetry-System-components.html>
- <https://blog.peekmed.com/pacs-systems/>

Mapping of CO with PO/PSO:

	Program Outcomes												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	2	2	2	1	1	1	1	2	2
CO2	3	3	3	3	1	3	3	3	1	1	1	1	1	2
CO3	3	3	3	3	1	2	2	3	1	1	1	1	2	2
CO4	3	3	3	3	1	3	3	3	1	1	1	2	2	1
CO5	3	3	3	3	2	3	2	3	2	2	2	2	1	1
AVG	3	3	3	2.8	1.2	2.6	2.6	2.8	1.2	1.2	1.2	1.4	1.6	1.6

JBM2032	TELEHEALTH TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the key principles for telemedicine in health
- To apply multimedia technologies in medicine
- To understand legal issues and legal aspects of telemedicine
- To know about various telemedical standards
- To know about mobile telemedicine and its application.

UNIT I - FUNDAMENTALS OF TELEMEDICINE History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, tele medicine systems, benefits and limitations of telemedicine.	9
UNIT II - TELEMEDICINE TECHNOLOGIES Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.	9
UNIT III - ETHICAL AND LEGAL ASPECTS Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection and security, jurisdictional issues, intellectual property rights. constraints for the wide spread use of telemedicine, social acceptance	9
UNIT IV - PICTURE ARCHIVING AND COMMUNICATION SYSTEM Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture	9
UNIT V - APPLICATIONS OF TELEMEDICINE Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e-Health and Cyber Medicine.	9

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At the end of the course, the student will be able to:**

- Describe the fundamentals, evolution, scope, benefits, and limitations of telemedicine systems.
- Differentiate various telemedicine technologies, communication modes, and network infrastructures used in healthcare.
- Evaluate ethical, legal, confidentiality, consent, and data protection issues in telemedicine practice.
- Interpret the components, standards, and architecture of PACS, DICOM, and radiology information systems.
- Assess diverse telemedicine applications such as teleradiology, telepathology, telecardiology, telesurgery, and e-health systems.

TEXT BOOKS:

1. Norris A C, "Essentials of Telemedicine and Telecare", John Wiley, New York 2002.
2. H K Huang, "PACS and imaging Informatics: Basic Principles and Applications", Wiley, New Jersey, 2010.

REFERENCES:

1. Jung Hee Seo, Vijay Vedula, Theodore Abraham and ajat Mittal, "Multiphysics Computational models for cardiac low and virtual cardiography", Int.J.Numer. Meth. Biomed. Engg, Published online in Wiley Online Library, 2013.
2. Lee Waite, Jerry Fine, "Applied Biofluid Mechanics", McGraw Hill, 2007.
3. John K-J Li, "Dynamics of Vascular System", World Scientific, 2004.
4. C.Ross Ethier, Craig A Simmons, "Introduction to Biomechanics - From Cells to Organisms", Cambridge Texts in Biomedical Engineering, 2007.

WEB REFERENCES:

- https://www.physio-pedia.com/Fundamentals_of_Telehealth_Technology
- <https://catalyst.nejm.org/doi/full/10.1056/CAT.18.0268>
- <https://www.healthit.gov/faq/what-telehealth-how-telehealth-different-telemedicine>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	2	1	–	–	–	–	1	1	1
CO2	3	3	2	1	3	1	–	–	–	–	1	2	2
CO3	2	2	1	2	2	3	3	–	–	–	1	1	1
CO4	3	2	2	2	3	1	–	–	–	–	1	3	2
CO5	2	2	2	1	2	2	–	–	–	–	2	3	3
AVG	2.6	2.4	1.8	1.4	2.4	1.6	3	–	–	–	1.2	2	1.8

JBM2033	ROBOTICS IN MEDICINE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand concepts of robots and types of robots, manipulators, actuators and grippers.
- To understand the basics of Inverse Kinematics.
- To explore various kinematic motion planning solutions for Robotic configurations.
- To design techniques used for planning and decision-making in robotics and examine case studies.
- To explore various applications of Robots in Medicine

UNIT I - MEDICAL ROBOTICS	9
Automation and Robots, Classification, Application, Specification, Notations, Direct Kinematics Dot and cross products, Coordinate frames, Rotations, Homogeneous coordinates Link coordination arm equation - 5-axis robot, 4-axis robot, 6-axis robot, Dynamic stabilization.	
UNIT II – KINEMATICS	9
General properties of solutions tool configuration, Workspace analysis and trajectory planning work envelope, workspace fixtures, Pick and place operations, Continuous path and Interpolated motion, Straight-line motion.	
UNIT III - ROBOT VISION	9
Robot Vision Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation - Thresholding, region labeling, Shrink operators, Swell operators, Euler numbers, Perspective transformation, Structured illumination, Camera calibration.	
UNIT IV - PLANNING	9
Task Planning, Task level programming, Planning Representations: Symbolic Representation Uncertainty, Configuration, Space, Gross motion, Grasp Planning, Fine-motion planning, Simulation of planar motion, Source and Goal scenes, Task Planner simulation. Case-Study: Planning for Mobile Manipulators and Legged Robots, Minimax Formulation, Partially-Observable Markov Decision Processes.	
UNIT V – APPLICATIONS	9
Bio Engineering Biologically Inspired Robots - Rehabilitation - Interactive Therapy, Bionic Arm, Clinical and Surgical Gynecology, Orthopedics, Neurosurgery, Cardiac, Pediatric, abdominal, and urologic procedures with teleoperated robots - Prostate interventions with manual robots, Image guided robotic systems for focal ultrasound based surgical applications.	

TOTAL: 45 PERIODS

COURSE COUTCOMES:**At the end of the course student will be able to:**

- Describe the fundamentals, classification, and kinematic modeling of industrial and medical robots.
- Analyze robot workspace, trajectory planning, and motion configurations for automation tasks.
- Apply robot vision techniques including image processing, segmentation, and camera calibration for object recognition.
- Apply task and motion planning methods for mobile manipulators and legged robots using simulation techniques
- Discuss the biomedical applications of robotic systems including rehabilitation and surgical interventions.

TEXT BOOKS:

1. J.J.Craig, "Introduction to Robotics", Pearson Education, 2014.
2. Achim Schweikard, Floris Ernst, "Medical Robotics", 2015.
3. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, First edition, 2003.
4. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008.

REFERENCES:

1. Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, "Robot Modeling and Control", WileyPublishers, 2020.
2. Paula Gomes, "Medical robotics- Minimally Invasive surgery", Woodhead, 2012.
3. Daniel Faust, "Medical Robots", Rosen Publishers, 2016.
4. K.S.Fu, R.C. Gonzales and C. S.G. Lee, "Robotics", McGrawHill, 2008.
5. Mikell P Groover and Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012

WEB REFERENCES:

- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6625162/>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	1	1	1	3	-	-	-	-	1	1	1
CO2	3	3	2	2	2	1	-	-	-	-	2	2	2
CO3	3	2	2	3	3	3	-	-	-	-	2	3	2
CO4	3	2	2	3	3	3	-	-	-	-	1	3	2
CO5	2	2	1	2	2	3	-	-	-	-	1	3	2
AVG	2.8	2	1.6	2.2	2.2	2.6	-	-	-	-	1.4	2.4	1.8

JBM2034	WEARABLE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the functioning of sensors for force and movement
- To learn processing of bio-signals in wearable sensor
- To study about energy harvesting for wearable devices
- To know about the health systems in wireless
- To elucidate the applications of wearable systems

UNIT I - SENSORS	9
Need for wearable systems, wearable sensors, Inertia movement sensors, Respiration activity sensor, Inductive, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, Radiant thermal sensor, Wearable motion sensors, CMOS Based Biosensors, e-Textiles.	
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, Data mining.	
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, Wireless communication techniques.	
UNIT V - APPLICATIONS OF WEARABLE SYSTEMS	9
Medical Diagnostics, Medical Monitoring, Patients with chronic disease, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):**At end of the course the students will be able to:**

- Describe the types, working principles, and applications of wearable sensors for biomedical monitoring.
- Analyze signal acquisition, processing techniques, and challenges in wearable sensor systems.
- Describe the energy harvesting methods including solar, thermal, vibration, and hybrid approaches for wearable devices.
- Discuss the architecture, communication techniques, and security considerations of wireless body area networks (BAN) in healthcare.
- Discuss the biomedical and healthcare applications of wearable systems, including diagnostics, monitoring, and sports medicine.

TEXT BOOKS:

1. Annalisa Bonfiglio, Danilo De Rossi, 'Wearable Monitoring Systems', Springer, 2011 **(Unit I, II, III, V)**
2. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar V, 'Body Area Networks Safety, Security and Sustainability', Cambridge University Press, 2013 **(Unit IV)**

REFERENCES:

1. Hang, Yuan-Ting, "wearable medical sensors and systems", Springer, 2013
2. Mehmet R. Yuce, Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd, Singapore, 2012
3. Guang-Zhong Yang (Ed.), "Body Sensor Networks, "Springer, 2006
4. Andreas Lymberis, Danilo de Rossi, 'Wearable eHealth systems for Personalised Health Management - State of the art and future challenges' IOS press, The Netherlands, 2004

WEB REFERENCES:

- <https://www.mdpi.com/1424-8220/23/5/2479>
- <https://www.techtarget.com/searchmobilecomputing/definition/wearable-technology>
- <https://dl.acm.org/doi/10.1145/3648469>
- <https://jneuroengrehab.biomedcentral.com/articles/10.1186/s12984-017-0229-y>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	1	3	-	-	-	-	1	3	1
CO2	2	3	2	2	2	2	-	-	-	-	1	3	1
CO3	2	1	1	1	1	2	-	-	-	-	2	2	1
CO4	3	1	1	2	1	1	-	-	-	-	2	2	2
CO5	2	1	1	2	1	1	-	-	-	-	2	2	1
AVG	2.2	1.4	1.2	1.6	1.2	1.8	-	-	-	-	1.6	2.4	1.2

JBM2035	NEURAL NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the differences between biological and artificial neurons
- To understand the need for supervised learning
- To describe the classification of images
- To describe the medical image restoration
- To explain the ability to self-learn and adapt

UNIT I – ARTIFICIAL NEURAL NETWORK	9
Elementary neurophysiology and Neurotransmitters, Neuron to ANS, Adaline and Madaline – Architecture and Applications, Learning Algorithms, Error correction and Gradient Descent Rules, Artificial Neural Model, Types of activation functions.	
UNIT II – SUPERVISED LEARNING	9
Perceptron, Least Mean Square Learning, Steepest Descent Search, Application of LMS to Noise Cancelling, Multi-layered Network Architecture, Backpropagation Learning Algorithm, Practical consideration of BP algorithm, generalized delta rule.	
UNIT III - SUPPORT VECTOR MACHINES	9
Learning from Examples, Statistical Learning Theory, Support Vector Machines, SVM application to Image Classification.	
UNIT IV - ATTRACTOR NEURAL NETWORKS	9
Associative Learning Attractor Associative Memory, Linear Associative memory, Hopfield Network, application of Hopfield Network, Brain State in a Box (BSB) neural Network, Simulated Annealing, Boltzmann Machine, Bidirectional Associative Memory.	
UNIT V - SELF ORGANIZATION FEATURE MAP	9
Generalized Learning Laws, Vector Quantization, Self-organization Feature Maps, Adaptive Resonance Theory, Application of SOM, Growing Neural Gas (GNG), Neocognitron – architecture and data processing.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):**At end of the course the students will be able to:**

- Explain the fundamentals of artificial neural networks, including neuronal models, activation functions, and learning rules.
- Apply supervised learning techniques such as perceptron, LMS, and backpropagation algorithms to solve computational problems.
- Analyze support vector machine principles and demonstrate their application in classification tasks.
- Compare various attractor neural network models and evaluate their applications in associative memory.
- Apply self-organization feature maps and illustrate their use in clustering and pattern recognition.

TEXT BOOKS:

1. Freeman J. A., and Skapura B.M, “Neural networks, algorithms, applications and programming techniques”, Addison- Wesley, 2003. **(Unit I, II, III, IV)**
2. Hagan, Demuth and Beale, “Neural Network Design”, Vikas Publishing House Pvt Ltd., New Delhi, 2002. **(Unit V)**

REFERENCES:

1. Laurene Fausett, “Fundamentals of Neural Networks- Architectures, Algorithms and Application”, Prentice Hall, 1994.

WEB REFERENCES:

- <https://www.javatpoint.com/brain-state-in-a-box-network>
- <https://medium.com/@mbakhtiari/system-thinking-4-unleashing-self-organization-in-healthcare-learning-from-the-ants-and-trees-2f8934eb2020>
- <https://www.javatpoint.com/machine-learning-support-vector-machine-algorithm>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	1	2	1	-	-	-	-	1	1	-
CO2	3	2	2	3	3	3	-	-	-	-	1	1	-
CO3	3	3	2	2	2	1	-	-	-	-	1	-	-
CO4	2	2	2	2	2	1	-	-	-	-	1	-	-
CO5	3	2	3	3	3	3	-	-	-	-	2	-	-
AVG	2.6	2.2	2	2.2	2.4	1.8	-	-	-	-	1.2	1	-

***** END OF VERTICAL 5 *****

VERTICAL VI – MECHANICS AND MODELLING

JBM2036	MEDICAL HAPTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic principles, theories, and concepts of haptics.
- To know different types of haptic feedback, including force feedback, tactile feedback, and thermal feedback.
- To learn current trends and challenges in haptic rendering research, including the development of new haptic devices, new haptic rendering algorithms, and new applications.
- To adapt to current trends and challenges in haptic rendering research, including the development of new haptic devices and haptic rendering algorithms.
- To understand critical thinking and problem-solving skills related to haptic interaction research and its applications.

UNIT I – MECHANICS OF TOUCH	9
The sense of touch and its receptors, Anatomy of the skin and other tactile organs, Types of touch and their neural pathways – sensory processing, Overview of haptics, Types of receptors and their functions, Haptic perception and the brain, sensing and actuation.	
UNIT II – HAPTIC RENDERING	9
Types of haptic feedback - vibrotactile, force feedback, thermal feedback; Human subjects experiments and statistics, Kinematics of haptic devices, Virtual coupling, Proxy-based haptic rendering, Texture and surface rendering, Multi-finger haptic rendering, Haptic rendering in teleoperation and remote manipulation.	
UNIT III – HAPTIC DESIGN PRINCIPLES	9
PHANToM, Human factors considerations in haptic design, Design principles for effective haptic interfaces, Human haptic perception, Surface haptic devices, Tactile displays, design of Motion simulators, Haptics in human-machine interactions, Haptic design principles and guidelines. Haptic interfaces in medicine.	
UNIT IV – HAPTIC INTERACTIONS	9
Human haptic sensing, Haptic interaction techniques, Haptic communication, Perception of haptic feedback, Evaluation of haptic devices and interfaces, Psychophysics of wearable haptic and tactile perception in a multisensory context.	
UNIT V – HEALTHCARE APPLICATIONS	9
Surgical training, robotic surgery, haptics in rehabilitation and prosthetics, training and education of haptic technology, pain management and therapy using haptic devices, telemedicine and remote healthcare, haptic enabled models in medical education.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At the end of the course student will be able to:**

- Apply fundamental concepts of physiology of touch, haptic perception, and haptic feedback in various applications.
- Develop different types of haptic feedback devices, including grounded and ungrounded force feedback devices, tactile feedback devices, and hybrid devices
- Analyze the experiment rendering algorithms, including point-based and model-based rendering into virtual environments
- Analyze and solve the challenges, limitations of haptic technology, including device resolution, latency, and stability and how to overcome issues.
- Evaluate the effectiveness of haptic technology in different applications, using metrics such as user performance, user satisfaction, and usability.

TEXT BOOKS:

1. Lynette A. Jones, "Haptics", The MIT press essential knowledge series, 2018.
2. Mark Paterson, "The senses of touch –haptics, affects and technologies", Bloomsbury Publishing, 2007.

REFERENCES:

1. Troy McDaniel and Sethuraman Panchanathan, "Haptics interfaces for accessibility, health, and enhanced quality of life", Springer Publications, 2019.
2. Christian Hatzfeld, Thorsten A. Kern, "Engineering Haptic Devices A Beginner's Guide", Springer London, 2014.

WEB REFERENCES:

- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4003673/>
- <https://healthcare-in-europe.com/en/news/haptic-technology-will-change-healthcare.html>
- <https://www.frontiersin.org/articles/10.3389/frobt.2021.612949/full>

Mapping of CO with PO/PSO:

	Program Outcomes												PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	1	1	1	1	-	2	2	1	1	1	1
CO2	2	2	2	1	1	1	1	-	2	1	1	1	1	1
CO3	2	2	1	2	1	2	1	-	2	1	2	2	1	1
CO4	1	2	1	3	1	2	2	-	1	2	3	2	2	2
CO5	1	1	2	2	2	3	3	-	2	3	2	1	3	2
AVG	1.4	1.8	1.8	1.8	1.2	1.8	1.6	-	1.8	1.8	1.8	1.4	1.6	1.4

JBM2037	NEUROMECHANICS OF HUMAN MOVEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic principles of neuromechanics and how they apply to human movement.
- To describe the physiological processes involved in muscle contraction and relaxation
- To understand neural control of movement, including the role of reflexes and higher-level control centres.
- To understand the principles of motor learning and development, and how they apply to skill acquisition.
- To apply neuromechanics principles to rehabilitation and sport science contexts

UNIT I – REVIEW OF NERVOUS SYSTEM	9
General organization of the nervous system, neurons and glial cells, action potential, synaptic transmission, significance of sensory systems – vision, hearing, taste, smell and proprioception, motor systems, homeostasis, neuroplasticity.	
UNIT II – MUSCLE PHYSIOLOGY	9
Muscle moment arms and lever systems, Muscle work, power, and efficiency, Muscle tissue properties, strengthening muscle, injury to skeletal muscle, combined movement characteristics of muscle, Muscle injury and repair, Muscle weakness and atrophy, Muscle function in athletic performance, Muscle adaptation to training.	
UNIT III – NEURAL CONTROL OF MOVEMENT	9
Forms of motion, joint movement terminology, spatial reference systems, structure of the motoneuron, neural control of force output, sensory receptors and reflexes, effect of training and exercise, Qualitative analysis of human movement, neural communication, Synaptic transmission, Somatic and autonomic nervous systems, Motor pathways and control, Reflexes and movements.	
UNIT IV – MOTOR LEARNING AND DEVELOPMENT	9
Basic principles of motor control, Historical and current theories of motor learning, Stages of Motor Development, Types of feedback and their effects on learning, Use of technology in feedback delivery, Types of practice and their effects on learning, Transfer of learning, Factors that influence practice effectiveness, Factors that influence practice effectiveness, Applications of motor learning in different types of rehabilitation.	
UNIT V – APPLICATIONS	9
Historical and current theories of neuromechanics in sports medicine, Techniques for reducing injury risk through neuromechanical approaches, Neuromechanical approaches to injury prevention in different types of sports, Neuromechanical approaches to improving injury diagnosis in sports medicine, Ethical considerations in neuromechanics research in sports medicine.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course student will be able to:

- Explain the organization and functions of the nervous system, including sensory, motor, and neuroplastic mechanisms.
- Describe the physiological properties of skeletal muscle and analyze factors influencing muscle performance, adaptation, and injury.
- Analyze the neural control of human movement and interpret the role of sensory feedback, reflexes, and motor pathways.
- Evaluate principles and theories of motor learning and apply them to rehabilitation and skill development.
- Discuss neuromechanical approaches used in sports medicine for injury prevention, diagnosis, and performance enhancement.

TEXT BOOKS:

1. Enoka, Roger M, “Neuromechanics of human movement”, United States: Human Kinetics, 2015.
2. Joseph Hamill, Kathleen M. Knutzen, “Biomechanical Basis of Human Movement”, Lippincott Williams and Wilkins, 2006.

REFERENCES:

1. Paavo V. Komi, “The Encyclopaedia of Sports Medicine, Neuromuscular Aspects of Sports Performance”, John Wiley and Sons, 2011.
2. Susan J. Hall, “Basic biomechanics”, sixth edition, McGraw Hill publishers, 2007.

WEB REFERENCES:

- <https://www.frontiersin.org/research-topics/18381/neuromechanics-in-movement-and-disease-with-physiological-and-pathophysiological-implications-from-fundamental-experiments-to-bio-inspired-technologies>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4392340/>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	-	2	-	-	-	-	1	3	1
CO2	3	2	2	1	-	-	-	-	-	-	1	3	2
CO3	2	3	3	3	-	2	-	-	-	-	2	3	1
CO4	2	3	3	3	-	2	-	-	-	-	2	3	-
CO5	2	2	1	1	-	-	2	-	-	-	2	3	-
AVG	2.4	2.4	2	1.8	-	2	2	-	-	-	1.6	3	1.33

JBM2038	PHYSIOLOGICAL MODELLING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make the students to understand the system concepts of Physiological models and Vital organs.
- To make them acquaint with couple systems and applications of transfer functions.
- To make them learn methods and techniques for analysis/synthesis of dynamic models.
- To make them learn about the mechanics of internal system that trips away from homeostasis with the help of modelling.
- To make them describe the dynamic models, simulate and visualize, dynamic responses of physiological models.

UNIT I – MATHEMATICAL MODELLING	9
Physiological system modelling basics, generalized system properties, models with combination of system elements, linear models of physiological systems, linear system and superposition principle, impulse response and linear convolution, state space analysis.	
UNIT II – IDENTIFICATION OF PHYSIOLOGICAL SYSTEMS	9
Basic Problems in Physiological System Analysis, nonparametric and Parametric Identification methods, Problems in Parameter Estimation: Identifiability and Input design, Identification of Closed-Loop Systems.	
UNIT III – ANALYSIS OF PHYSIOLOGICAL SYSTEMS	9
Cardiovascular models and controls, respiratory models and controls, neural network for physiological control, methods and tools for identifying physiological system, saccadic eye movement systems, Regulation of Glucose, Hodgkin-Huxley Model.	
UNIT IV – TIME DOMAIN ANALYSIS	9
Linearized Respiratory Mechanics, Open-Loop and Closed-Loop Transient Responses – first order model, Open-Loop versus Closed-Loop Transient Responses, second order model, Dynamic model of neuromuscular reflex motion, model of Cheyne-Stoke's breathing, Physical Significance of under damped responses of post systolic operations in aortic arch.	
UNIT V – FREQUENCY DOMAIN ANALYSIS	9
Steady-State Responses to Sinusoidal Inputs, Graphical Representations of Frequency Response, Frequency Response of a Model of Circulatory control, Frequency Response of a Model of Circulatory system, Review of transient and stability analysis, Analysis of Instrumentation to measure air flow system, Evaluation of Transfer function from frequency response for muscle response modes.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At end of the course the students will be able to:

- Describe the fundamentals of physiological system modeling, including linear models, convolution, and state-space representation.
- Apply parametric and non-parametric identification methods to estimate and analyze physiological system parameters.
- Analyze cardiovascular, respiratory, neural, and other physiological control models using appropriate modelling tools.
- Analyze time-domain responses of physiological systems using first- and second-order models for clinical and diagnostic interpretation.
- Interpret frequency-domain characteristics of physiological systems and assess system stability and performance.

TEXT BOOKS:

1. John D. Enderle, "Model of Horizontal eye movements: Early models of saccades and smooth pursuit", Morgan and Claypool Publishers, 2010.
2. Micheal C.K.Khoo, "Physiological Control System – Analysis, Simulation and Estimation", Prentice Hall of India, New Delhi, 2001.
3. Claudio Cobelli Ewart Carson, "Introduction to Modelling in Physiology and Medicine", second edition, Academic Press, 2019.

REFERENCES:

1. Willian B. Blesser, "A System Approach to Biomedicine", Mc Graw Hill Book Co., 1969.
2. Richard Skalak and Shu Chien, "Hand Book of Biomedical Engineering", McGraw Hill and Co., 1987.
3. Joseph D, Bronzino, "The Biomedical Engineering Handbook", CRC Press, 3rd edition, 2006.

WEB REFERENCES:

- <https://pubmed.ncbi.nlm.nih.gov/2092991/>
- <https://www.nature.com/articles/ncb3510>
- https://www.cds.caltech.edu/~murray/courses/cds101/fa04/caltech/am04_ch6-3nov04.pdf
- <https://nsec.lab.uconn.edu/home/courses-2/bme-3100-physiological-modeling/>
- <https://www.sciencedirect.com/science/article/abs/pii/S0045794902004819>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	1	1	-	-	-	3	1	1	1
CO2	3	1	2	3	3	3	-	-	-	3	1	1	2
CO3	1	3	1	1	1	-	-	-	-	1	-	1	-
CO4	1	3	1	1	1	-	-	-	-	1	-	1	-
CO5	1	2	1	2	3	-	-	-	-	3	-	1	3
AVG	1.6	2	1.2	1.6	1.8	2	-	-	-	2.2	1	1	2

JBM2039	REHABILITATION ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand and analyse the importance and role of Rehabilitation techniques
- To describe the design specifications, operation and indications of Orthotic and Prosthetic devices.
- To understand the different methods and devices concerned with sensory augmentation and substitution.
- To describe the various Therapeutic Exercises and assistive technology devices that help to restore and strengthen the neuromuscular functional activity.
- To have an overview of physiological, psychological and legal aspects involved in rehabilitation service rendered for the benefit of the impaired population

UNIT I - NEED FOR REHABILITATION	9
Types of disabilities, Activities of daily living, Appropriate Technology, Residual function, Levels of Prevention, Rehabilitation team, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering, Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.	
UNIT II - OCCUPATIONAL REHABILITATION	9
Motor rehabilitation, different types of models for limb prosthetics, Artificial limbs - body powered, externally powered and controlled prosthetics, restoration of standing and walking, Hybrid Assistive Systems (HAS), Bionic arm, Wireless robotic arm, assessment of mobility rehabilitation, Functional Electrical Stimulus for mobility.	
UNIT III - AUDITORY AND SPEECH REHABILITATION	9
Types of deafness, hearing aids, application of DSP in hearing aids, Tactual augmentation and Tactual substitution, Cochlear implants, Voice synthesizer, speech trainer. Brain plasticity, Sensory Substitution systems for auditory and speech impairment.	
UNIT IV - COGNITIVE REHABILITATION	9
Memory aids, Electronic reminder systems, adaptive technology, sensory stimulation tools, neurofeedback training, voice-to-text software, sensory stimulation, AR and VR in cognitive rehabilitation.	
UNIT V - REHABILITATION MEDICINE	9
Architectural design features for motor and visual disability for day-to-day life, Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspects of rehabilitation – Disability evaluation, provision available in education.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Explain the need for rehabilitation, types of disabilities, assistive technology principles, and community-based rehabilitation approaches.
- Describe occupational rehabilitation methods and analyze prosthetic and mobility-assistive systems used for functional restoration.
- Analyze auditory and speech rehabilitation technologies, including hearing aids, cochlear implants, and sensory substitution systems.
- Evaluate cognitive rehabilitation tools and apply adaptive and emerging technologies such as AR and VR for patient support.
- Discuss rehabilitation medicine principles, including physiological, psychological, architectural, and legal considerations.

TEXT BOOKS:

1. Dr.S.Sunder, “Rehabilitation Medicine”, 3rd Edition, Jaypee Medical Publications, New Delhi. 2010
2. Joseph D.Bronzino, “The Biomedical Engineering Handbook”, Third Edition: Three Volume Set, CRC Press, 2006

REFERENCES:

1. Rory A Cooper, “An Introduction to Rehabilitation Engineering”, CRC press, 2006
2. Christian Buhler, Harry Knops, “Assistive Technology on the threshold of the New Millennium”, IOS Press, 2019.
3. Margaret J.Giannini, “Choosing a wheelchair system”, Diane Publishing Co., 1992.

WEB REFERENCES:

- <https://cmasuki.org/introduction-to-movement-analysis/>
- <https://www.mobility-aids.com/advancements-in-mobility-aids.html>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	1	1	-	2	-	-	2	1	3	-
CO2	3	3	2	2	2	-	1	-	-	1	1	3	1
CO3	3	3	2	2	2	-	1	-	-	1	1	3	2
CO4	2	2	3	3	3	-	1	-	-	2	2	3	-
CO5	2	1	2	1	1	-	3	-	-	2	2	3	-
AVG	2.6	2.2	2.25	1.8	1.8	-	1.6	-	-	1.6	1.4	3	1.5

JBM2040	ERGONOMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To get exposed to principles of visual capabilities.
- To learn the mechanics of muscle physiology and significance of rest cycle.
- To learn spatial compatibility and the relation between control orders and control response.
- To know about the measurements and proportions of the human body.
- To be familiar with the mathematical models, analysis and design of biomedical devices using case studies.

UNIT I - ERGONOMICS	9
Objectives and scope of ergonomics, role of an ergonomist, human characteristics and capabilities, human error, team work and ageing, interfaces between job, person and environment, musculoskeletal and nervous – body systems, static and dynamic postures, work physiology, risk to health.	
UNIT II – METHODS AND TECHNIQUES	9
Work place layout and equipment design, ergonomic risk assessment, developing ergonomic strategy at work, perception of risk, signal detection theory and vigilance, work stress – causes, prevention and protective measures, human error, human computer interaction, measurement and information gathering.	
UNIT III - VISUAL AND AUDITORY ERGONOMICS	9
Visual display unit, Visual capabilities, factors affecting visual acuity and contrast sensitivity, human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display, process of hearing, principles of auditory display, Measures for monitoring control and mitigation, noise induced hearing loss.	
UNIT IV - MUSCLE PHYSIOLOGY	9
Muscle physiology – muscle metabolism – joint motion study – measure of physiological inefficiency and energy consumption – work rest cycles – aspects of manual and posture study, material handling (MMH), Bio-mechanical recommended limits of MMH, work related upper limb disorders (WRULD).	
UNIT IV – DESIGN PRINCIPLES AND STANDARDS	9
Anthropometry, anthropometric design principles, Physical work load and energy expenditure, ergonomic implications, thermal environment, reducing accidents by altering behaviour, ISO standards, selection and training, supervision and record, measuring health and illness.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At the end of the course student will be able to:**

- Derive the principles of ergonomic auditory monitors and measure factors affecting mitigation.
- Analyze the significance of posture and measure physiological inefficiency and energy consumption.
- Evaluate movement relationships, control orders, and human limitations in tracking tasks.
- Design control panels and workspaces to reduce accidents and optimize ergonomics.
- Perform case studies on handling electronic instruments and medical equipment.

TEXT BOOKS:

1. Pascale Carayon, "Handbook of Human Factors and Engineering", Second Edition, CRC Press, 2011.
2. Martin Helander, "Guide to Human Factors and Ergonomics", Second Edition, CRC Press, 2005.
3. Benjamin W. Niebel, "Motion and Time Study", Richard, D. Irwin Inc., Seventh Edition, 2002.

REFERENCES:

1. George Kanawaty, "Introduction to work study", ILO, 3rd edition, Oxford and IBH publishing, 2001.
2. Stephen Pheasant, Christine M. Haslegrave, "Bodyspace: Anthropometry, Ergonomics and the Design of Work", CRC Press, 2005.
3. Shrawan Kumar, "Biomechanics in Ergonomics", Second Edition, CRC Press, 2007.
4. Francesca Tosi, "Design for ergonomics", First edition, Springer International Publishing, 2019.

WEB REFERENCES:

- <https://www.hsph.harvard.edu/ecpe/programs/ergonomics-and-human-factors/>
- <https://archive.nptel.ac.in/courses/109/103/109103101/>
- <https://ehs.unc.edu/workplace-safety/ergonomics/>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	3	2	—	1	2	—	2	3	—
CO2	3	3	2	2	3	2	—	1	2	—	2	3	—
CO3	3	3	3	3	3	2	—	2	2	—	2	3	2
CO4	3	3	3	2	3	2	—	2	2	2	2	3	2
CO5	3	2	2	2	3	2	—	2	2	2	2	3	3
AVG	3	2.6	2.4	2.2	3	2	-	1.6	2	2	2	3	2.33

JBM2041	BIOMECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To expose to basic principles of mechanics, fluid and solid mechanics and their property.
- To give knowledge on basic principles of bio fluid mechanics, to learn artificial heart valves types and testing and blood vessel material property for modelling.
- To understand the properties, models, material property for modelling of soft tissues for orthopaedic applications.
- To learn orthopaedic implant design, prosthetic joint, biomaterials characteristics and biocompatibility for design.
- To understand human locomotion, biomechanical analysis using FEA, Gait analysis for modelling and designing.

UNIT I – BASIC MECHANICS	9
Scope of mechanics in medicine, mechanics of bone structure, determination of in-vivo elastic modulus, Bio fluid mechanics, flow properties of blood, free body diagram, Dynamics – Newton’s law of motion, Mechanics of motion, Anthropometry.	
UNIT II - BIOFLUID MECHANICS	9
Fluid mechanics - Euler equations, Bernoulli’s equation and Navier - Stoke’s equations, Hagen-Poiseuille Flow in a Circular Tube, Rheological properties of blood, Viscoelasticity and its models, Bio-viscoelastic fluids, shear stresses in extra-corporeal circuits, material properties and modelling of Blood vessels.	
UNIT III - BIOSOLID MECHANICS	9
Hard Tissues: Bone structure and composition, viscoelasticity and strength of bones, functional adaptation, bone fracture mechanics, Maxwell and Voight models, Kinetics and Kinematics of bones. Soft Tissues: Material properties and Modelling of Soft Tissues, Muscle action, Hills models.	
UNIT IV - BIOMECHANICS OF JOINTS	9
Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, pulse wave velocities in arteries, biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle, Design of orthopaedic implant, specifications for a prosthetic joint.	
UNIT V - MODELLING AND ERGONOMICS	9
Introduction to Finite Element Analysis, occupant response to vehicular vibration, Ergonomic principles contributing to good workplace design, Design of a Computer work station, Mechanics of knee joint during standing and walking.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):**At end of the course the students will be able to:**

- Apply the laws of motion and energy function.
- Study the behaviour of fluids inside the body and its simulation.
- Differentiate and explain the material properties and composition of the tissues.
- Differentiate between the rigid bodies and free body and to characterize biomaterials.
- Design the work station depending upon the ergonomics using finite element analysis

TEXT BOOKS:

1. Duane Knudson, "Fundamentals of Biomechanics", Second Edition, Springer Science and Business Media, 2007.
2. Cees Oomens, Marcel Brekelmans, Sandra Loerakker, Frank Baaijens, "Biomechanics: Concepts and Computation", Cambridge University Press, second edition, 2018.
3. Y.C. Fung, "Bio-Mechanics - Mechanical Properties of Tissues", Springer-Verlag, 1998.

REFERENCES:

1. Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids and Fluids, Analysis and Design", Springer Science Business Media, 2004.
2. Shrawan Kumar, "Biomechanics in Ergonomics", Second Edition, CRC Press, 2007.
3. Bruce M. Koeppen and Bruce A. Stanton, "Berne and Levy Physiology", Mosby, 6th Updated Edition, 2009.
4. Robert L. Huston, "Principles of Biomechanics", CRC Press, 2008.

WEB REFERENCES:

- <https://www.sciencedirect.com/topics/engineering/biofluid-mechanics>
- <https://ep.jhu.edu/courses/535663-biosolid-mechanics/>
- <https://www.frontiersin.org/articles/10.3389/frobt.2020.00013/full>
- <https://ptsmc.com/healthy-workplace-ergonomics>
- <https://www.sciencedirect.com/topics/neuroscience/gait-analysis>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	-	3	3	1	1	-	1	1	1	2	1	1
CO2	3	1	2	2	2	1	-	-	-	1	1	2	1
CO3	2	2	2	2	2	2	-	-	1	2	1	2	2
CO4	3	2	1	1	3	2	1	-	1	1	3	3	3
CO5	2	1	2	1	1	1	-	-	2	-	-	2	3
AVG	2.6	1.5	2	1.8	1.8	1.4	1	1	1.25	1.25	1.75	2	2

JBM2042	BIOFLUIDS AND DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To expose the students to the characteristics of motion of biological fluid
- To make the students learn the viscoelastic properties of the biological fluid
- To learn about the function and metabolism of heart tissues
- To give knowledge on basic concepts of material models from nonlinear elasticity and viscoelasticity
- To help in discovering and potentially optimizing the mechanical stresses experienced by normal, diseased, injured, or surgically treated bones.

UNIT I - BIO-FLUID MECHANICS	9
Newton's laws, derivation of pipe flow, Sheer stress and viscosity Bernoulli equation, Reynolds number, Poiseuille's law, Flow Rate, Womersley number, Relationship between diameter, velocity and pressure of blood flow, Resistance against flow, classification of fluids, Bio-viscoelastic fluid, Response to Harmonic variation, viscoelastic models.	
UNIT II - FLOW PROPERTIES OF BLOOD	9
Rheological properties of blood, Apparent and relative viscosity, types of flow, transition from laminar to turbulent flow, laminar flow annulus, Blood viscosity variation: Effects of shear rate, Casson's equation, Rheology of Blood in Micro-vessels: Fahraeus - Lindquist effect and inverse effect.	
UNIT III - CARDIAC MECHANICS	9
cardiovascular system, Ventricular performance, Pulsality index, Physics of valvular diseases, mechanical properties of blood vessels, Blood flow types, control theory and system analysis, mechanical analysis of circulatory systems, Physics of cardiovascular diseases, myocardial mechanics, fluid dynamics of aortic and mitral valves, index of contractibility.	
UNIT IV - SOFT TISSUE MECHANICS	9
Pseudo elasticity, non-linear stress-strain relationship, Mechanical properties of soft biological tissues, Entropic elasticity-stretching, bending and twisting, persistence length, function and mechanical properties of skin, ligaments and tendons, Finite elasticity, hyper elasticity, poro elasticity, biphasic, Tissue Remodeling	
UNIT V - ORTHOPEDIC MECHANICS	9
Mechanical properties of cartilage, diffusion properties of Articular cartilage, Bone mechanics - mechanical characterization, fracture mechanics, degeneration, Whole bone biomechanics, adaptive nature of bone, kinetics and kinematics of joints, lubrication of joints	

TOTAL: 45 PERIODS

COURSE OUTCOMES:**At end of the course the students will be able to:**

- Analyse how fluid mechanics principles can be applied to blood circulation
- Derive the principles of Blood flow in living body and analyse if the flow is steady or pulsatile
- Analyse the heart pumping functions through various involuntary movements that can be used for diagnosis
- Design and analyse the non-linear stress-strain relationship among various soft tissues
- Apply knowledge on how to potentially optimize the mechanical stresses experienced by normal, diseased, injured, or surgically treated bones and joints

TEXT BOOK:

1. David Rubenstein, Wei Yin, Mary Frame, “Biofluid Mechanics: An introduction to Fluid Mechanics, Macro circulation and Microcirculation”, 2nd edition, Academic press series in biomedical engineering, 2015.
2. JiyuanTu, Kiao Inthavong and Goodarz Ahmadi, “Computational Fluid and Particle Dynamics in the Human Respiratory System”, Springer, 1st edition, 2013.

REFERENCES:

1. Silver Frederick H. “Biomaterials, Medical Devices and Tissue Engineering”, Chapman and Hall publishers, 1994.
2. Nihanth ozkai, Mc Donald, “Biomechanics, Blood flow in arteries”, Edward Arnold, 1998.
3. Philip J Pritchard and John W Mitchell, “Fox and McDonald’s Introduction to fluid Mechanics”, John Wiley, 9th edition, 2012.

WEB REFERENCES:

- <https://www.frontiersin.org/articles/10.3389/fphys.2019.01329/full>
- <https://www.sciencedirect.com/topics/engineering/biofluid-mechanics>

Mapping of CO with PO/PSO:

	Program Outcomes											PSO	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	3	2	—	1	2	—	2	3	—
CO2	3	3	2	2	3	2	—	1	2	—	2	3	—
CO3	3	3	3	3	3	2	—	2	2	—	2	3	2
CO4	3	3	3	3	3	2	—	2	2	2	2	3	2
CO5	3	3	3	3	3	3	—	2	2	2	2	3	2
AVG	3	3	2.6	2.6	3	2.2	-	1.6	2	2	2	3	2

***** END OF VERTICAL 6 *****

JERUSALEM COLLEGE OF ENGINEERING

(An Autonomous Institution, Affiliated to Anna University &

Accredited by NBA & NAAC 'A' Grade)

B.E. - BIOMEDICAL ENGINEERING

OPEN ELECTIVES LIST

(REGULATION - 2023)

S.no	Course Code	Course Title	Category	Contact Period	L	T	P	C
IV Semester								
1	JBM9201	Food & Nutrition	OE	3	3	0	0	3
2	JBM9202	Medical Instrumentation	OE	3	3	0	0	3
3	JBM9203	Biosensors Technology	OE	3	3	0	0	3
V Semester								
4	JBM9204	Introduction to Biometric Systems	OE	3	3	0	0	3
5	JBM9205	Applications of Telemedicine	OE	3	3	0	0	3
6	JBM9206	IoT in Healthcare	OE	3	3	0	0	3
VI Semester								
7	JBM9207	Wearable Technology	OE	3	3	0	0	3
8	JBM9208	Basics of Image Processing	OE	3	3	0	0	3
9	JBM9209	Artificial Intelligence in Healthcare	OE	3	3	0	0	3
VII Semester								
10	JBM9210	Assistive Technology	OE	3	3	0	0	3
11	JBM9211	Basics of Neural Networks	OE	3	3	0	0	3
12	JBM9212	Advancements in Healthcare	OE	3	3	0	0	3

JBM9201	FOOD & NUTRITION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the basic principles of nutrition and summarize the fundamental and applied aspects of Food Science.
- To evaluate the role of macronutrients in the body.
- To evaluate the role of micronutrients in the body.
- To evaluate dietary patterns and recommendations for improving nutritional intake.
- To explain the need of functional foods and analyse the relationship between nutrition and chronic diseases.

UNIT I - FOOD, NUTRITION, HEALTH	9
Food & its relation to health, Energy & forms of energy, units of measurement, physiological fuel values of energy, determination of energy value of foods, BMR - definition, Determination and factors affecting, Factors affecting energy requirements, diet induced thermogenesis.	
UNIT II – MACRONUTRIENTS	9
Classification, functions, Digestion & Absorption, RDA (Recommended Dietary Allowances), sources and deficiencies of Protein Carbohydrate and Fat, Dietary fiber - types and functions.	
UNIT III - MICRONUTRIENTS-VITAMINS AND MINERALS	9
Fat-soluble Vitamins - Function, RDA, sources and deficiency and excess. Water soluble vitamins: Thiamin, Riboflavin, Niacin, B12, Folic acid, Biotin and Vitamin C: functions, RDA, food sources, deficiencies. Macro minerals and Micro Minerals - functions, absorption, RDA, sources and deficiency.	
UNIT IV – DIETARY GUIDELINES AND NUTRITIONAL ASSESSMENT	9
Assessment of nutritional knowledge, Rapid Rural Appraisal (RRA). National and International agencies. Direct nutritional assessment of human groups: Diet survey methods, nutritional anthropometry, Indirect nutritional status vital statistics, health policy indicators, social and economic indicators; coverage by primary health care.	
UNIT V - NUTRACEUTICALS AND NUTRITIONAL PROBLEM	9
Classification of Functional Foods: Probiotics, Prebiotics and Synbiotics; Nutrient vs. Non-nutrient, Magnitude of nutritional problems in India: Protein energy malnutrition, anemia, vitamin A deficiency, Iodine deficiency disorder; over nutrition and chronic degenerative diseases. Strategies for the control of malnutrition.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Explain the basics of food science and its classification.
- Describe the fundamental components and macronutrients present in food products.
- Summarize the types and role of micronutrients in food products.
- Estimate the nutritional and food requirements and the various assessment strategies.
- Explain the basics of functional foods and nutraceuticals, their significance, regulatory standards, and role in disease prevention.

TEXT BOOKS:

1. Bamji MS, Krishnaswamy K and Brahman GNV, "Textbook of Human Nutrition", 3rd edition. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, 2012. **(Unit 1)**
2. Wadhwa A and Sharma S, Nutrition in the Community-A Textbook. Elite Publishing House Pvt. Ltd. New Delhi, 2003. **(Unit 2, 3, 4)**
3. Chukwuebuka Egbuna, Genevieve Dable Tupas, "Functional Foods and Nutraceuticals", Springer International Publishing, 25 Aug 2020. **(Unit 5)**

REFERENCES:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter, "Molecular Biology of the Cell", Garland Science, 2014.
2. ICMR, "Dietary Guidelines for Indians – A Manual. National Institute of Nutrition, Indian Council of Medical Research", Hyderabad, 2011.
3. Sunetra Roday, "Food Science and Nutrition", Oxford University Press, New Delhi.
4. Srilakshmi. B, "Food Science", New Age International (P) Ltd. Publishers, Sixth edition, 2016.

WEB REFERENCES:

- <https://eatrightindia.gov.in/dart/>
- <https://www.ncbi.nlm.nih.gov/books/NBK230970/>
- <https://onlinelibrary.wiley.com/doi/book/10.1002/9781119946045>
- <https://foodandnutritionresearch.net/index.php/fnr>
- <https://www.who.int/news-room/fact-sheets/detail/healthy-diet>
- <https://www.nal.usda.gov/programs/fnic>

Mapping of CO with PO/PSO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	-	1	-	-	1	-	-	-	-	1
CO2	2	-	2	-	-	1	-	-	-	-	2
CO3	2	1	1	-	-	3	-	-	-	-	1
CO4	2	1	2	-	2	3	1	2	2	2	2
CO5	2	2	1	2	1	3	2	2	2	2	3
AVG	2	1.33	1.4	2	1.5	2.2	1.5	2	2	2	1.8

JBM9202	MEDICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the origin and propagation of bio potentials.
- To gain knowledge on the measurement of electrical activity across human body
- To study the measurements associated with the vital parameters
- To understand the different techniques used for measurement of non-electrical bio-parameters
- To understand the working of imaging systems to study cross sectional details of organs

UNIT I - ELECTRODES FOR BIOSIGNAL ACQUISITION	9
Origin of bio potential and its propagation. Electrode Configurations and classes, Half-Cell Potential, Electrode-electrolyte interface, electrode–skin interface.	
UNIT II - BIOPOTENTIAL MEASUREMENTS	9
Electrocardiography - Electro conduction system of heart, Electrocardiograph, Electroencephalography - Brain waves, Multichannel EEG system, Electromyography - Muscular contraction, Electromyograph, Electrooculography, Electroretinography, Electrogastrography.	
UNIT III - NON-ELECTRICAL BIO-PARAMETERS MEASUREMENT	9
Blood Pressure: Sphygmomanometer and Ultrasonic method, Respiratory Measurement – Spirometer, Temperature measurement - Thermistor, Thermocouple applications, Oxygen saturation - Pulse oximeter, Auto analyzer, Audiometer, Galvanic skin resistance measurement, Heart rate measurement, Cardiac Output measurement, Respiration rate measurement.	
UNIT IV - PATIENT MONITORING SYSTEMS AND BIOTELEMETRY	9
Patient monitoring systems, ICU/CCU Equipment, Infusion pumps, bed side monitors, Central consoling controls. Radio Telemetry (single, multi), multiplexing of bio-signals- FDM, TDM	
UNIT V - IMAGING SYSTEMS	9
Computed Tomography, Magnetic Resonance imaging, Ultrasonic imaging, Thermography, Endoscopy	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Explain the origin and propagation of Biopotentials
- Describe the measurements of electrical activity of the heart
- Explain on the measurements associated with the vital parameters
- Describe different techniques used for measurement of non-electrical bio-parameters.
- Demonstrate working of imaging systems to study cross sectional details of organs.

TEXT BOOKS:

1. Leslie Cromwell, Biomedical Instrumentation and measurement, 2nd edition, Prentice Hall of India, New Delhi, 2015. **(Unit 1 & 2)**
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004. **(Unit 3 & 4)**
3. Khandpur R.S, Handbook of Biomedical Instrumentation, 3rd edition, Tata McGraw-Hill New Delhi, 2014. **(Unit 5)**

REFERENCES:

1. John G Webster, Medical Instrumentation Application and Design, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.
2. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw-Hill Publisher, 2003.

WEB REFERENCES:

- <https://nptel.ac.in/courses/108105101/>
- <https://www.youtube.com/watch?v=49CWbXNJ3WE&t=35s>
- <https://www.youtube.com/watch?v=zj1teWL9k7A>
- <https://www.youtube.com/watch?v=xJkeLiRQBVU>
- https://www.youtube.com/watch?v=NeiD87Z-kJ8&list=PLXcK6l9b40r_WeJMfo7Wb5RYMdP6brgpj

Mapping of CO with PO/PSO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	-	3	-	-	-	-	-	-	1	-
CO2	-	-	3	-	-	-	-	-	-	2	-
CO3	2	-	3	1	3	1	-	-	-	3	-
CO4	2	-	3	1	3	1	-	-	-	3	-
CO5	2	-	3	1	3	1	-	-	-	3	-
AVG	2	-	3	1	3	1	-	-	-	2.4	-

JBM9203	BIOSENSORS TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To be able to identify different classes of biosensors and describe their functioning principles
- To understand the different biological systems and their working methodology.
- To understand the principles of photo electric measurement.
- To understand electrochemical techniques of biosensors.
- To gain knowledge on application of sensors in various field.

PREREQUISITE:

- Transducers, bioreceptor

UNIT I - BIO SENSORS	9
General configuration of biosensor; Generations of biosensors; Basic principle and instrumentation of different biosensors: electrochemical, optical, acoustic, piezoelectric, and calorimetric biosensors	
UNIT II - BIOLOGICAL RECOGNITION SYSTEMS	9
Biological recognition systems: enzyme, antibody, nucleic acid, cell, and tissue; Properties of ideal materials for biosensors; Classes of materials for biosensors: polymers, material containing metal complex, sol-gel materials, nanomaterials, composite materials, metal oxides, photonic crystals, and zeolite materials.	
UNIT III - PHOTO ELECTRIC SENSORS	9
Phototube, scintillation counter, Photo Multiplier Tube (PMT), photovoltaic, Photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers, Spectro photometric applications of photo electric transducers.	
UNIT IV - ELECTRO CHEMICAL TECHNIQUES	9
Voltammetry and Amperometry, immobilized enzyme-electrodes Active DC electrochemical techniques: Impedance Spectroscopy Potentiometry for small molecule and ion detection Fluorescence and colorimetric biosensors.	
UNIT V - APPLICATION OF BIOSENSORS	9
Noninvasive biosensors in clinical analysis, biosensors based instruments to the bioprocess industry, biochips and their application to genomics, BIA core- an optical biosensors, environment monitoring.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Explain the general configuration, generations, and principles of various biosensors.
- Describe biological recognition systems, properties of ideal materials, and classes of materials used in biosensors.
- Compare different photoelectric sensors and their applications in spectrophotometry.
- Analyze electrochemical techniques including voltammetry, amperometry, potentiometry, and fluorescence/colorimetric biosensors.
- Apply biosensor principles to real-world applications in clinical analysis, bioprocess industry, genomics, and environmental monitoring.

TEXT BOOKS:

1. Biosensors and modern bio-specific analytical techniques, L. Gorton (ed), Elsevier 2005. **(Unit 1 & 2)**
2. Advances in biosensors, B. D. Malhotra & A. P. F. Turner (eds), Volume 5, Elsevier science 2003. **(Unit 3 & 5)**
3. Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996. **(Unit 3, 4, 5)**

REFERENCES:

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

WEB REFERENCES:

- <https://www.youtube.com/watch?v=kQ6CY1qpGjY>
- <https://www.youtube.com/watch?v=VoX85L8zykE>
- <https://www.youtube.com/watch?v=IlO2s-qMzN8>
- https://www.youtube.com/watch?v=Z_BHVFP0Lk
- <https://control.com/technical-articles/introduction-to-photoelectric-sensors/>

Mapping of CO with PO/PSO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	2	1	—	1	2	—	2
CO2	3	2	2	1	2	2	—	1	2	—	2
CO3	3	2	2	2	3	2	—	1	2	—	2
CO4	3	3	3	3	3	2	—	2	2	—	3
CO5	3	3	3	3	3	2	—	2	2	2	3
AVG	3	2.4	2.4	2	2.6	1.8	-	1.4	2	2	2.4

JBM9204	INTRODUCTION TO BIOMETRIC SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To familiarize the fundamental principles of different biometric systems
- To emphasize concepts and design of fingerprint recognition biometric systems.
- To know principles of face and hand geometry recognition systems
- To analyze and understand the principles of multimodal biometric system
- To identify issues in realistic evaluation of biometrics - based authentication systems

PREREQUISITE:

- Pattern Recognition and Neural Networks

UNIT I - BIOMETRIC SYSTEMS AND AUTHENTICATION TECHNOLOGIES	9
Biometrics – Authentication vs. Verification, Biometric characteristics - Types of Biometrics – General Architecture of Biometric System and Functionalities – Biometric applications - Authentication technologies – Need for strong authentication – Protecting privacy and biometrics policy –performance measures.	
UNIT II - FINGERPRINT IDENTIFICATION TECHNOLOGY	9
Biometrics using Fingerprint - General description of fingerprints - Fingerprint Recognition system - fingerprint sensors using RF imaging techniques - Finger print feature processing techniques - Minutiae Extraction – Computer enhancement and modelling of fingerprint images - fingerprint classification – fingerprint matching.	
UNIT III - FACE RECOGNITION AND HAND GESTURE RECOGNITION	9
Introduction to face recognition, Algorithms for face recognition - Neural networks for face recognition – Basics of Hand geometry – Image capturing – Hand Segmentation- Feature Extraction - Adaptive Classifiers - Visual-Based Feature Extraction and Pattern Classification.	
UNIT IV - IRIS AND RETINAL BIOMETRICS	9
Iris Image Acquisition using iris sensors. Iris image pre-processing, segmentation, Iris Localization, Daugman's method, iris code, statistical properties of the iris code. Other iris coding methods. Retina scanning: Technical description, Characteristics, Strengths – Weaknesses, Deployment. Retina vascular pattern.	
UNIT V - MULTIMODAL BIOMETRICS AND PERFORMANCE MEASURES	9
Introduction to Multimodal Biometrics –Biometric Fusion- Two Factor Authentication - Normalization- Multimodal Biometrics using Face and Ear – Characteristics and Advantages of Multimodal Biometrics – AADHAAR: An Application of Multimodal Biometrics. Performance evaluation- Statistical Measures of Biometrics – FAR – FRR – FTE – EER.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Demonstrate knowledge on engineering principles underlying biometric systems.
- Extract the finger print features, and apply for finger print recognition.
- Apply different algorithms for face Recognition and hand geometry in biometric application.
- Apply basic knowledge and skills necessary for the Iris and Retinal biometric recognition.
- Elaborate on various multimodal biometrics and performance evaluation.

TEXT BOOKS:

1. Arun A. Ross, Karthik Nandakumar, A.K.Jain, Handbook of Multi biometrics, Springer, New Delhi, 2006. **(Unit 1 to 4)**
2. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, "Biometric Systems, Technology - Design and Performance Evaluation", Springer, 2005. **(Unit 5)**
3. David D. Zhang, Automated Biometrics: Technologies and Systems, Kluwer Academic Publishers, New Delhi, 2000. **(Unit 1 to 5)**

REFERENCES:

1. Anil K. Jain, Ruud Bolle, Sharath Pankanti, "Biometrics, Personal Identification in Network Security", Springer, 2006.
2. D. Maltoni, D. Maio, Anil K. Jain and Salil Prabhakar "Handbook of Fingerprint Recognition", Springer, 2009.
3. Stan Z. Li and Anil K. Jain "Handbook of Face Recognition", Springer; 2nd ed., 2011.
4. John Chirillo, Scott Blaul, "Implementing Biometric Security", John Wiley, 2003.
5. S.Y. Kung, S.H. Lin, M.W.Mak, "Biometric Authentication: A Machine Learning Approach" Prentice Hall, 2005.

WEB REFERENCES:

- <https://sites.google.com/a/di.uniroma1.it/biometric-systems/home-page/course-material>
- https://link.springer.com/chapter/10.1007/0-387-21685-5_2
- <https://machinelearningmastery.com/face-recognition-using-principal-component-analysis/>

Mapping of CO with PO/PSO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	2	2	3	2	1	2	2	1	3
CO2	3	3	3	3	3	3	1	2	2	1	3
CO3	3	3	3	3	3	2	1	2	2	1	3
CO4	3	3	3	3	3	3	1	2	2	1	3
CO5	2	3	3	2	2	3	1	3	3	1	3
AVG	2.8	3	2.8	2.6	2.8	2.6	1	2.2	2.2	1	3

JBM9205	APPLICATION OF TELEMEDICINE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the key principles for telemedicine, benefits and limitation
- To acquire knowledge on the technology and devices in communication useful in telemedicine.
- To understand the concepts of various standards those are involved in medical data transmission.
- To gain knowledge on the ethical and legal aspects involved in telemedicine.
- To understand the various applications of telemedicine

UNIT I - FUNDAMENTALS OF TELEMEDICINE	9
History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.	
UNIT II - TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE	9
Audio, video, still images, text and data, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare	
UNIT III - PICTURE ARCHIVING AND COMMUNICATION SYSTEM	9
Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.	
UNIT IV - ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE	9
Autonomy & Confidentiality issues in Telemedicine, patient rights and consent, the patient-doctor relationship, data protection & security, licensing, maintenance and access of medical records, continuity of care, jurisdictional issues.	
UNIT V - APPLICATIONS OF TELEMEDICINE	9
Teleradiology, telepathology, telecardiology, tele-oncology, telesurgery, Telerehabilitation, Tele-education, video conferencing.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Explain the fundamentals, scope, and benefits of telemedicine systems.
- Describe the types of information and communication infrastructures used in telemedicine.
- Illustrate the concepts of PACS, DICOM, and radiology information systems for telemedicine applications.
- Analyze the ethical, legal, and patient-rights issues associated with telemedicine practice.
- Apply telemedicine principles to various healthcare applications including teleradiology, telepathology, telecardiology, telesurgery, and tele-education.

TEXT BOOKS:

1. R.S. Khandpur, "Telemedicine - Technology and Applications", PHI Learning Pvt. Ltd., Eastern Economy Edition, 2017. **(Unit 1, 2, 3)**
2. Shashi Gogia, "Fundamentals of Telemedicine and Telehealth", American Press, Elsevier, 2020. **(Unit 4 & 5)**

REFERENCES:

1. Norris AC, "Essentials of Telemedicine and Telecare", John Wiley, New York, 2002.
2. HK Huang, "PACS and Imaging Informatics: Basic Principles and Applications", Wiley, New Jersey, 2010.
3. Olga Ferrer Roca, Marcelo Sosa Iudicissa, "Handbook of Telemedicine", IOS Press, Netherland, 2002.

WEB REFERENCES:

- <https://www.youtube.com/watch?v=KYwbkP9bDZA>
- <https://www.youtube.com/watch?v=HJVOXrPyWIo>
- https://www.youtube.com/watch?v=Ftg7juI5Y_w
- <https://www.youtube.com/watch?v=FI6V8Dl-2tU>
- <https://www.youtube.com/watch?v=Dpts5XTtMhQ>

Mapping of CO with PO/PSO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	2	2	–	1	2	–	2
CO2	3	2	2	1	3	2	–	1	2	–	2
CO3	3	2	3	2	3	2	–	1	2	–	2
CO4	3	3	2	2	2	3	3	2	3	–	2
CO5	3	3	3	3	3	3	2	2	3	2	3
AVG	3	2.4	2.4	1.8	2.6	2.4	2.5	1.4	2.4	2	2.2

JBM9206	IoT IN HEALTHCARE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the student to gain knowledge about the measuring instruments and the methods of measurements
- To know about the types of transducers available and their applications in different fields.
- To understand the Networking and communication protocol using IoT
- To have an understanding about IoT
- To learn Utilization of IoT in Healthcare application

UNIT I - INTRODUCTION OF IOT (INTERNET OF THINGS)	9
Internet of Things Promises, Definition, Scope, Sensors for IoT Applications, Structure of IoT, IoT Map Device, IoT platform	
UNIT II - IoT SENSORS	9
Industrial sensors, First Generation, Advanced Generation, Integrated IoT Sensors, Polytronics Systems, Sensors' Swarm, Printed Electronics, IoT Generation Roadmap - Execution of a medical parameter using think speak module.	
UNIT III - NETWORK & COMMUNICATION ASPECTS	9
Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination - Study of Data logging in think speak and Beagle bone black.	
UNIT IV - IOT CHALLENGES	9
Design challenges, Development challenges, Security challenges, Other challenges, Study and execution of applications using Online Cloud Platforms.	
UNIT V - IOT HEALTHCARE APPLICATIONS	9
Chronic disease management, Remote assisted living (Tele health), Wellness and preventive care (Lifestyle assessment), Remote intervention, Improved drug management, Study and uses of Biomedical Engineering.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Explain the fundamental concepts, architecture, and significance of the IoT in healthcare applications.
- Interpret the operating principles, characteristics, and selection criteria of IoT sensors used in medical and industrial systems.
- Analyze networking and communication protocols relevant to IoT-based healthcare data transmission.
- Evaluate IoT design, development, deployment, and security challenges in real-world healthcare environments.
- Apply IoT platforms and tools to examine and illustrate advanced healthcare applications such as tele-health, diagnostics, and patient monitoring.

TEXT BOOKS:

1. Kumar, Vikas, “Healthcare analytics made simple: techniques in healthcare computing using machine learning and Python”, Packt Publishing Ltd, 2018. **(Unit 1)**
2. Roshak, Michael, “Artificial Intelligence for IoT Cookbook”, Packt Publishing Ltd, 2021. **(Unit 2)**
3. Minter, Andrew, “Analytics for the internet of things (IoT)”, Packt Publishing Ltd, 2017. **(Unit 3,4)**
4. Holler, Jan, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, and David Boyle, “Internet of Things”. Academic Press, 2014. **(Unit 5)**

REFERENCES:

1. Hersent, Olivier, David Boswarthick, and Omar Elloumi. “The internet of things: Key applications and protocols” John Wiley & Sons, 2011.

WEB REFERENCES:

- https://www.aranca.com/assets/uploads/resources/special-reports/Internet-of-Medical-Things-IoMT_Aranca-Special-Report.pdf
- https://www.scirp.org/pdf/jcc_2022082515323190.pdf

Mapping of CO with PO/PSO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	3	1	1	2	—	—	1	—	—	2
CO2	3	2	1	1	3	—	—	1	—	—	2
CO3	3	3	1	2	3	—	—	1	—	—	2
CO4	2	3	2	2	2	1	1	2	1	1	3
CO5	2	3	2	2	3	1	—	3	2	2	3
AVG	2.6	2.8	1.4	1.6	2.6	1	1	1.6	1.5	1.5	2.4

JBM9207	WEARABLE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the functioning of sensors for force and movement
- To learn the signal processing in wearable sensor
- To study about energy harvesting for wearable devices
- To know about the health systems in wireless
- To Elucidate the applications of wearable systems

UNIT I - MEASUREMENTS AND SENSORS	9
Functional Elements of a Measurement System and Instruments, Transducers classification - sensors and actuators, Resistive sensors, capacitive sensors and inductive sensors, Wearable applications: Strain sensor for monitoring Physiological signals, body movement, Body/textile antennas for wireless data transmission.	
UNIT II – MECHANICAL TRANSDUCERS	9
Accelerometers: Characteristics and working principle, Types - Capacitive, Piezoresistive, piezoelectric; Gyroscopes: Characteristics and working principle, Rotor Gyroscope; Diaphragm Pressure Sensor - resistive & capacitive type. Wearable applications: Motion sensors for fall detection, hemiplegic and Parkinson's disease patients.	
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 - SMART SENSORS AND APPLICATIONS	9
Integrated and Smart sensors, IEEE 1451 standard & Transducer Electronic Datasheets (TEDs), Overview of various smart sensors: Digital temperature sensor (DS1621, TMP36GZ), Humidity sensor (DHT11, DHT22, FC28), IR sensor (FC51), Gas sensor (MQ2, MQ8), Pressure sensors (BMP180), Accelerometers (ADXL335), etc; Structural health monitoring sensors, MEMS and Flexible sensors.	
UNIT V - SCOPE OF WEARABLE DEVICES	9
Role of Wearables, Attributes of Wearables, The Meta Wearables - Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study: Google Glass, health monitoring, Wearables: Challenges and Opportunities, Future and Research Roadmap.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Explain the principles and functioning of wearable sensors used for movement, force and physiological monitoring.
- Analyze signal-processing methods used in wearable sensing systems.
- Evaluate energy-harvesting techniques suitable for wearable devices.
- Explain health-monitoring systems used in wireless wearable applications.
- Assess advanced smart-sensor applications and emerging wearable-technology domains.

TEXT BOOKS:

1. B. C. Nakra, K.K. Choudhury, "Instrumentation, Measurement and Analysis", 3rd Edition, Tata McGraw, 2009. **(Unit I, II, IV)**
2. Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 3rd ed., Springer, 2010. **(Unit III)**
3. Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Elsevier, 2014. **(Unit V)**

REFERENCES:

1. Hang, Yuan-Ting, "wearable medical sensors and systems", Springer, 2013
2. A.K. Sawhney, "Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai.
3. Subhas C. Mukhopadhyay, "Wearable Electronics Sensors-For Safe and Healthy Living", Springer International Publishing, 2015.
4. Andreas Lymberis, Danilo de Rossi, 'Wearable eHealth systems for Personalised Health Management - State of the art and future challenges' IOS press, The Netherlands, 2004

WEB REFERENCES:

- <https://www.mdpi.com/1424-8220/23/5/2479>
- <https://www.techtarget.com/searchmobilecomputing/definition/wearable-technology>
- <https://dl.acm.org/doi/10.1145/3648469>
- <https://jneuroengrehab.biomedcentral.com/articles/10.1186/s12984-017-0229-y>

Mapping of CO with PO/PSO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	1	1	–	3	–	–	–	–	–	1
CO2	3	3	2	2	3	–	–	–	–	–	1
CO3	2	2	3	1	2	2	–	–	–	–	–
CO4	2	2	3	1	2	2	–	–	–	–	–
CO5	2	2	2	1	3	–	–	–	–	–	2
AVG	2.2	2	2.2	1.25	2.6	2	–	–	–	–	1.33

JBM9208	BASICS OF IMAGE PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide fundamental knowledge on different levels of Digital Image processing.
- To illustrate various enhancement technique to enhance the visual quality of Image.
- To articulate Image restoration technique to restore the image from degradation.
- To demonstrate use of segmentation methods in Morphological Processing of Image.
- To addresses the compression techniques for effective storage of Image and Classification technique in recognizing Image data.

PREREQUISITE:

- Digital Signal Processing

UNIT I - DIGITAL IMAGE PROCESSING	9
Fundamentals of Digital Image Processing, Components of digital image processing system, Elements of visual perception, Image sensing and acquisition, Sampling and quantization of images, 2-D sampling theory, Relationship between pixels, Representation of digital image.	
UNIT II - IMAGE ENHANCEMENT TECHNIQUES	9
Spatial Domain: Gray level transformations – Histogram processing –Smoothing and Sharpening, Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening -frequency domain filters, Homomorphic filtering.	
UNIT III - IMAGE RESTORATION	9
Image Restoration – degradation model, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering.	
UNIT IV - IMAGE SEGMENTATION	9
Gradient operators: Point, line and edge detection, Thresholding, Region Based segmentation, Edge linking and boundary detection, Hough transform, Watershed segmentation algorithm, Morphological Processing – Erosion, Dilation.	
UNIT V - IMAGE COMPRESSION AND CLASSIFICATION	9
Compression: Need for data compression, Image Compression models – Error Free Compression – Lossy compression– Image Compression standards. Classification: Pixel Based Classification-Unsupervised and Supervised Classification, Object recognition, template matching.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Explain the fundamentals, components, and representation of digital images.
- Apply spatial and frequency domain techniques for image enhancement.
- Analyze image degradation and implement restoration techniques using various filters.
- Demonstrate image segmentation methods including edge detection, thresholding, and morphological processing.
- Implement image compression and classification techniques for efficient storage and analysis.

TEXT BOOKS:

1. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010. **(Unit 1 to 5)**
2. Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011. **(Unit 1 to 5)**

REFERENCES:

1. William K Pratt, “Digital Image Processing”, John Willey, 2002.
2. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, First Edition, PHI
3. J.C. Russ,” The Image Processing Handbook”, CRC, 2006
4. Digital Image Processing, Kenneth R. Castleman, Pearson Education, 2007.

WEB REFERENCES:

- <http://www.imageprocessingplace.com/>
- https://onlinecourses.nptel.ac.in/noc19_ee55/preview
- <https://online.stanford.edu/courses/ee368-digital-image-processing>
- <https://www.geeksforgeeks.org/digital-image-processing-basics/>
- <https://www.javatpoint.com/digital-image-processing-tutorial>

Mapping of CO with PO/PSO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	1	2	1	–	1	2	–	2
CO2	3	2	2	2	3	2	–	1	2	–	2
CO3	3	3	3	3	3	2	–	2	2	–	3
CO4	3	3	3	3	3	2	–	2	2	–	3
CO5	3	3	3	3	3	2	–	2	2	-	3
AVG	3	2.6	2.4	2.4	2.8	1.8	-	1.6	2	-	2.6

JBM9209	ARTIFICIAL INTELLIGENCE IN HEALTHCARE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Study the basic concepts and implementation of AI
- To understand different structure of knowledge and acquisition by humans
- To implement and analysis of AI in healthcare
- To build complex and advanced models using deep network basics
- To study about CNNs learning and regularization

UNIT I - BASICS OF AI	9
General AI Goal, Study of AI, Engineering based AI Goal, Science - based AI Goal. Techniques Intelligent, Describe and match, Goal reduction, Constraint satisfaction, Tree Searching, Generate and test, Rule based systems, Biology - inspired AI techniques, Neural Networks, Genetic Algorithms, Reinforcement learning.	
UNIT II - BRANCHES OF AI	9
Logical AI, Search in AI, Pattern Recognition, Knowledge Representation, Inference, Commonsense knowledge and reasoning, Learning, Planning, Epistemology, Ontology, Heuristics, Genetic programming.	
UNIT III - APPLICATIONS OF AI	9
Game playing, Speech Recognition, Understanding Natural Language, Computer Vision, Expert Systems, Biomedical data using deep learning.	
UNIT IV - DEEP NETWORKS BASICS	9
Scalars, Vectors, Matrices and tensors; Probability Distributions - Gradient based Optimization - Machine Learning Basics: Capacity - Overfitting and underfitting - Hyperparameters and validation sets - Estimators - Bias and variance - Stochastic gradient descent.	
UNIT V - CONVOLUTIONAL NEURAL NETWORKS	9
Convolution Operation - Sparse Interactions - Parameter Sharing - Equivariance - Pooling - Convolution Variants: Stride - Tiled - Transposed and dilated convolutions; CNN Learning: Nonlinearity Functions - Loss Functions - Regularization - Optimizers - Gradient Computation	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Explain the fundamentals, goals, and techniques of Artificial Intelligence.
- Describe the branches of AI including knowledge representation, reasoning, learning, and planning.
- Demonstrate the applications of AI in game playing, natural language processing, computer vision, and biomedical data analysis.
- Analyze the basics of deep networks, machine learning principles, and optimization techniques.
- Apply convolutional neural network concepts including convolutions, pooling, and learning strategies to solve AI problems.

TEXT BOOKS:

1. Goodfellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016. **(Unit-1)**
2. Deshpande, Anand, and Manish Kumar. Artificial intelligence for big data: complete guide to automating big data solutions using artificial intelligence techniques. Packt Publishing Ltd, 2018. **(Unit-2)**
3. Mahajan, Parag. "Artificial intelligence in healthcare: AI, machine learning, and deep and intelligent medicine simplified for everyone." (No Title) (2022). **(Unit-3,4)**
4. Panesar, Arjun. Machine learning and AI for healthcare. Coventry, UK: Apress, 2019. **(Unit-5)**

REFERENCES:

1. Bohr, Adam, and Kaveh Memarzadeh, eds. Artificial intelligence in healthcare. Academic Press, 2020.
2. Gunatilleke, Janak. Artificial Intelligence in Healthcare: Unlocking Its Potential. Publisher unknown, 2022.

WEB REFERENCES:

- https://www.vssut.ac.in/lecture_notes/lecture1428643004.pdf

Mapping of CO with PO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	2	2	–	1	2	–	2
CO2	3	2	2	1	2	2	–	1	2	–	2
CO3	3	3	2	2	3	2	–	2	3	–	2
CO4	3	3	3	3	3	2	–	2	2	–	3
CO5	3	3	3	3	3	2	–	2	2	2	3
AVG	3	2.6	2.4	2	2.6	2	-	1.6	2.2	2	2.4

JBM9210	ASSISTIVE TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain cardiac assistive devices that supports lower chambers of heart
- To learn the functioning of dialyzers to remove excess fluid from body
- To assist spontaneous respiratory efforts during and post-surgery
- To study various assistive devices for deaf and blind
- To elucidate the prosthetics devices for limb replacement

UNIT I - CARDIAC ASSIST DEVICES	9
Principle of External counter pulsation techniques, Extracorporeal membrane oxygenation, Ventricular Bypass Pump, Mechanical Auxiliary ventricle, Intra Aortic Balloon Pumping and Non IABP, non-percutaneous centrifugal pumps, Impella cardiac power model, ventricular assist device, total artificial heart.	
UNIT II – ARTIFICIAL KIDNEY	9
Indication and Principle of Hemodialysis, Membranes and its types, Dialysate, types of hemodialyzer, Monitoring Systems, Peritoneal dialysis, Wearable Artificial Kidney, Bio Artificial Kidney (BAKs), renal replacement, applications of nanotechnology in artificial kidneys.	
UNIT III - RESPIRATORY ASSIST DEVICES	9
Continuous Ventilator, extracorporeal carbon dioxide removal, Intermittent positive pressure, BiPAP, CPAP, Breathing Apparatus Operating Sequence, tracheal intubation, bag valve mask, laryngeal mask airway, endotracheal tubes, IPPB breathing machine, oxygenators.	
UNIT IV - SENSORY ASSIST DEVICES	9
Types of Deafness, Hearing Aids, application of DSP in hearing aids, Cochlear implant, electronic braille, Voice synthesizer, speech trainer, haptics as a substitution of vision, Tactile devices for visually challenged, Text voice converter, Low vision aids.	
UNIT V - PROSTHETIC DEVICES	9
Types of body powered and externally powered limb prosthetics, materials used in prosthesis, different types of models, myo electric powered limb prosthesis.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Explain the principles, working, and applications of cardiac assist devices.
- Describe the types, functioning, and monitoring of artificial kidney systems.
- Illustrate respiratory assist devices including ventilators, oxygenators, and breathing apparatus.
- Analyze sensory assistive devices for hearing and vision, including DSP-based aids and haptic systems.
- Apply knowledge of prosthetic devices to understand different types, materials, and myoelectric-powered prostheses.

TEXT BOOKS:

1. Levine S.N. (ed), "Advances in Bio-medical Engineering and Medical physics", Vol. I, II, IV, Inter university publications, New York, 1968 **(Unit I, IV)**
2. Kopff W.J, "Artificial Organs", John Wiley and sons, New York, 1976 **(Unit II)**
3. Rory A Cooper, An Introduction to Rehabilitation Engineering, CRC press, 2006 **(Unit IV, V)**
4. Albert M.Cook and Webster J.G, "Therapeutic Medical Devices", Prentice Hall Inc., New Jersey, 1982 **(Unit III)**

REFERENCES:

1. Andreas.F. Vonracum, "Hand book of biomaterial evaluation", Mc-Millan publishers, 1980.
2. Gray E Wnek, Gray L Browlin – Encyclopaedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc New York 2004.
3. D.S. Sunder, "Rehabilitation Medicine", 3rd Edition, Jaypee Medical Publication, 2010
4. Hersh, M. (2008). "Assistive Technology for Visually Impaired and Blind People". Germany: Springer London.

WEB REFERENCES:

- <https://www.mayoclinic.org/tests-procedures/ventricular-assist-device/about/pac-20384529>
- <https://www.mdpi.com/2077-0375/11/1/8>
- <https://dth.ac.in/medical/courses/pathology/10/1/index.php>
- <https://nptel.ac.in/courses/103103163>
- https://onlinecourses.swayam2.ac.in/cec22_ed24/preview
- <https://www.thoracic.org/patients/patient-resources/resources/mechanical-ventilation.pdf>
- <https://www.coursera.org/lecture/disability-awareness/assistive-technology>

Mapping of CO with PO:

	Program Outcomes										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	2	1	2	2	–	1	2	–	2
CO2	3	2	2	2	3	2	–	1	2	–	2
CO3	3	2	2	2	3	2	–	1	2	–	2
CO4	3	3	3	3	3	2	–	2	2	–	3
CO5	3	3	3	3	3	2	–	2	2	2	3
AVG	3	2.4	2.4	2.2	2.8	2	-	1.4	2	2	2.4

JBM9211	BASICS OF NEURAL NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To emphasize basic neural network architectures and learning algorithms.
- To understand how ANNs can be designed and trained using special neural nets.
- To illustrate the recent trends in pattern recognition and machine learning theories.
- To develop understanding of computers in decision making.
- To understand different bio inspired technologies

UNIT I - SIMPLE NEURAL NETWORKS	9
Elementary neurophysiology and biological neural network- Artificial neural network- Architecture, biases and thresholds, Hebb net, Perceptron, Adaline and Madaline.	
UNIT II - SPECIAL NEURAL NETWORKS	9
Back propagation network, Bidirectional Associative memory, Hopfield Network, Kohonen Self organizing map, Counter Propagation network	
UNIT III - ADVANCEMENTS AND APPLICATIONS IN NEURAL NETWORKS	9
Introduction to SVM and CNN, Neuro-fuzzy Systems, Application of ANN in Medical Diagnostics, Introduction to Machine Learning- Tensor Flow.	
UNIT IV - COMPUTER ASSISTED MEDICAL DECISION-MAKING	9
Neuro computers and Artificial Neural Networks application, Expert system - General model of CMD, Computer - assisted decision support system-production rule system, cognitive model, semester networks.	
UNIT V - BIO-INSPIRED TECHNOLOGIES	9
Elementary neurophysiology and biological neural network- Artificial neural network- Architecture, biases and thresholds, Perceptron, Adaline and Madaline Networks. DNA as a genetic material- Genetic Algorithms: Introduction to Genetic Algorithms (GA) as optimization tool.	

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able to:

- Explain the fundamental concepts and structures of simple neural networks.
- Distinguish the principles and functions of competition-based neural networks.
- Analyze the applications of ANN, fuzzy logic, and machine-learning techniques for real-time systems.
- Apply computer-assisted techniques for medical decision-making in selected scenarios.
- Describe various bio-inspired technologies used in intelligent system design.

TEXT BOOKS:

1. Freeman J.A., and Skapura B.M, “Neural networks, algorithms, applications and programming techniques”, Addison – Wesley, 2003. **(Unit 1 to 5)**
2. S.N.Sivanandam, “Introduction to Artificial Neural Networks using MATLAB 6.0”, Tata McGraw hill Publication, 2016. **(Unit 3 to 5)**

REFERENCES:

1. Robert Schalkoff, “Pattern recognition, Statistical, Structural and neural approaches” John Wiley and Sons (Asia), pvt., Ltd., Singapore, 2005.
2. Laurene Fausett “Fundamentals of neural networks – Architectures, Algorithms and Applications”, Prentice Hall, 1994.
3. S.Theodoridis and K.Koutroumbas, “Pattern Recognition”, 4th Ed., Academic Press, 2009.
4. C.M.Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
5. S. Haykin, “Neural Networks and Learning Machines”, Prentice Hall of India, 2010.
6. D. E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, 1stEdn, Pearson, 2016.

WEB REFERENCES:

- <https://www.coursera.org/learn/neural-networks-deep-learning>
- <https://www.classcentral.com/course/neuralnets-398>
- <http://neuralnetworksanddeeplearning.com/chap1.html>
- <http://www.deeplearningbook.org/>
- <https://online-learning.harvard.edu/subject/neural-networks>

Mapping of CO with PO:

	Program Outcome										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	2	1	1	2	-	-	-	-	-	2
CO2	3	2	1	1	2	-	-	-	-	-	2
CO3	3	3	2	2	3	1	-	-	1	-	3
CO4	2	2	2	1	3	1	-	-	1	2	2
CO5	3	2	1	1	2	1	-	-	1	-	3
AVG	2.8	2.2	1.4	1.2	2.4	1	-	-	1	2	2.4

JBM9212	ADVANCEMENTS IN HEALTHCARE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the theoretical knowledge, practical skills and methodological competences in Digital Health.
- To explain the modalities and standards in mobile systems.
- To describe to describe the underlying technology of blockchain and big data, evaluate potential use cases for blockchain technology.
- To list the basic methodologies and data processing methods for human activity and cognitive quantification from the perspective of self-care and clinical applications.
- To understand the various approaches of forensic sciences.

UNIT I – DIGITAL HEALTH	9
Fundamentals of Medicine and Computer Science (FMC), International & Global Health (IGH); Health Law & Ethics, Digital Health Fundamentals (DHF): eHealth & Telemedicine, Digital Health Technology (DHT): Data, Information & Communication, Digital Health Coding (DHC): Standards, Contemporary Health Research (CHR): Health Research & Biomedical Statistics.	
UNIT II – MODALITY FOR INTER-OPERABILITY	9
Multimodality registration in daily clinical practice. Mobile healthcare. Selection and Implementation in e-Health project, design of medical equipment based on user needs. Security and privacy in digital health care.	
UNIT III – BLOCKCHAIN AND BIG DATA IN HEALTHCARE	9
Cryptography and Bitcoin, Consensus mechanisms, Smart contracts, Blockchain implications in Healthcare, Future of decentralized technology. Computing for Data Analysis, Database Systems, Data and Visual Analytics, Scalable machine learning algorithms, Hadoop family (Hive, Pig, HBase), Spark and Graph DB.	
UNIT IV - IOMT DEVICES	9
Smart connectivity and Big picture of IoT-smart devices, networks, Wireless technologies and need for data analysis. Evolution of wearable technology, Wearable IoT use cases - Smart watches, Android wear, Smart glasses, fitness trackers, health care devices, cameras, smart clothing. Case studies - Health care, fitness and sports, defense and security.	
UNIT V – FORENSIC APPLICATIONS	9
Forensic Science, Forensic Microscope and Anthropology- Skeletal Determination of Demographic Data from Skeletal Remains, Determining Types of Trauma and Disease From Skeletal Remains, Detection and Identification of Blood Stains, Determination of Species of Origin, Automated Fingerprint Identification Systems (AFIS), Track Marks.	

TOTAL: 45 PERIODS

COURSE OUTCOMES (CO):

At end of the course the students will be able to:

- Analyze various healthcare hazards, accident-causing factors, and corresponding control measures.
- Design appropriate waste-disposal procedures for different categories of biomedical wastes.
- Classify biomedical waste types based on their properties, sources, and environmental impacts.
- Develop safety facility plans and protocols for preventing hazards in hospital environments.
- Recommend applicable regulations and safety norms based on national and international standards.

TEXT BOOKS:

1. Rick Krohn, David Metcalf, Patricia Salber, “Health-e Everything: Wearables and The Internet of Things for Health, 2013. **(Unit 1,2)**
2. Stefane.N.Kabhen, “Healthcare and the Effect of Technology: Developments, Challenges and Advancements”, Medical Information Science Reference, March 2010. **(Units 3 & 4)**
3. S.P. Vyas and R.K. Khar, “Controlled Drug Delivery - concepts and advances”, Vallabh Prakashan, New Delhi, First edition 2002. **(Unit-5)**

REFERENCES:

1. Andreas Lymberis, Danilo de Rossi, “Wearable eHealth systems for Personalized Health Management - State of the art and future challenges” IOS press, The Netherlands, 2004
2. Neha Sharma, Durgesh Srivastava, Deepak Sinwar, “Artificial Intelligence Technology in Healthcare: Security and Privacy Issues”, 1st edition, Springer, 2024.

WEB REFERENCES:

- <https://www.coursera.org/courses?query=healthcare%20technology>
- <https://www.udemy.com/topic/healthcare/>
- <https://www.edx.org/learn/healthcare>
- <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10613744/>
- <https://www.ijpsonline.com/>

Mapping of CO with PO:

	Program Outcome										
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	1	—	2	—	1	—	—	1	2
CO2	2	1	1	1	2	1	—	—	1	2	1
CO3	1	1	1	2	1	2	1	—	1	2	1
CO4	1	1	1	2	3	2	1	—	2	1	1
CO5	2	1	1	3	2	3	1	—	2	1	1
AVG	1.4	1	1	2	2	2	1	—	1.5	1.4	1.2