

# **B.E. (Biomedical Engineering)**

## **2022 Regulations, Curriculum & Syllabi**



### **BANNARI AMMAN INSTITUTE OF TECHNOLOGY**

An Autonomous Institution Affiliated to Anna University – Chennai • Approved by AICTE • Accredited by NAAC with "A+" Grade

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## **VISION OF THE DEPARTMENT**

Department of Biomedical Engineering envisages to propel creative engineering knowledge and advancements in biomedical technology to improve the healthcare conditions for the benefit of mankind.

## **MISSION OF THE DEPARTMENT**

1. To focus on healthcare engineering that includes the study and understanding of biological systems.
2. To emphasize quantitative analysis and directly tying concepts with healthcare and diagnostics.
3. To encourage entrepreneurship in Biomedical Engineering fostering innovations in healthcare.
4. To inculcate interdisciplinary work and focus on research and development in Biomedical Engineering.

## **PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**

- I. Engage in professional development or post-graduate education for continuing self-development in biomedical engineering or other related fields.
- II. Pursue a wide range of career options, including those in industry, academia, and medicine.
- III. Practice professionally as biomedical engineers and/or biomedical scientists in the, field of health care sector for the wellbeing of humankind.
- IV. Build careers addressing human health problems within a multidisciplinary, global industry.

## PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem Analysis:** Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/ Development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct Investigations of Complex Problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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

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

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

### **PROGRAMME SPECIFIC OUTCOMES (PSOs)**

13. Apply knowledge on foundation in Life Science, engineering, mathematics and current biomedical engineering practices with an ability to demonstrate advanced knowledge of a selected area within Biomedical Engineering.

14. Critically analyse the current healthcare systems and develop innovative solutions effectively through problem specific design and development using modern hardware and software tools.

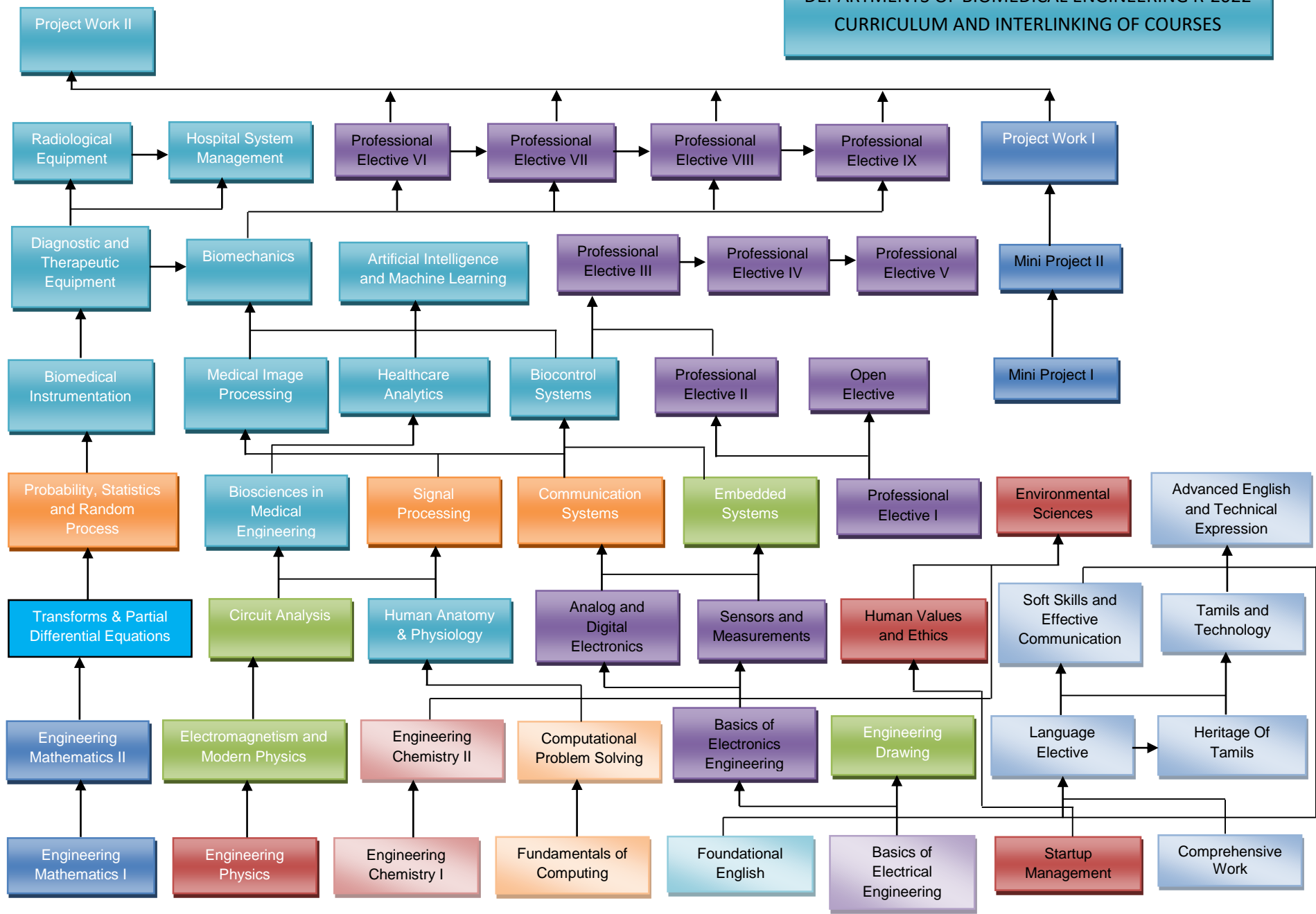
15. Hands-on knowledge on cutting edge hardware and software tools to acquire real time data, model and simulate physiological processes and analyse limitations on real time implementations.

**MAPPING OF PEOs AND POs**

<b>POs</b>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
<b>PEO1</b>	X						X					X	X		
<b>PEO2</b>						X	X	X	X	X					X
<b>PEO3</b>		X	X	X	X								X	X	
<b>PEO4</b>						X			X		X			X	X

DEPARTMENTS OF BIOMEDICAL ENGINEERING R-2022  
CURRICULUM AND INTERLINKING OF COURSES

- S8
- S7
- S6
- S5
- S4
- S3
- S2
- S1



DEPARTMENT OF BIOMEDICAL ENGINEERING											
Minimum Credits to be Earned : 163											
I SEMESTER											
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category	
							CA	ESE	Total		
22MA101	Engineering Mathematics I	3	1	0	4	4	40	60	100	BS	
22PH102	Engineering Physics	2	0	2	3	4	50	50	100	BS	
22CH103	Engineering Chemistry I	2	0	2	3	4	50	50	100	BS	
22GE001	Fundamentals of Computing	3	0	0	3	3	40	60	100	ES	
22HS001	Foundational English	1	0	2	2	3	100	0	100	HSS	
22GE003	Basics of Electrical Engineering	2	0	2	3	4	50	50	100	ES	
22HS002	Startup Management	1	0	2	2	3	100	0	100	EEC	
*22HS003	தமிழர்மரபு / Heritage Of Tamils	1	0	0	1	1	100	0	100	HSS	
<b>Total</b>		<b>15</b>	<b>1</b>	<b>10</b>	<b>21</b>	<b>26</b>	-	-	-	-	
II SEMESTER											
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category	
							CA	ESE	Total		
22MA201	Engineering Mathematics II	3	1	0	4	4	40	60	100	BS	
22PH202	Electromagnetism and Modern Physics	2	0	2	3	4	50	50	100	BS	
22CH203	Engineering Chemistry II	2	0	2	3	4	50	50	100	BS	
22GE002	Computational Problem Solving	3	0	0	3	3	40	60	100	ES	
22GE004	Basics of Electronics Engineering	2	0	2	3	4	50	50	100	ES	
22GE005	Engineering Drawing	1	0	2	2	3	100	0	100	ES	
	Language Elective	1	0	2	2	3	100	0	100	HSS	
*22HS006	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	1	0	0	1	1	100	0	100	HSS	
<b>Total</b>		<b>15</b>	<b>1</b>	<b>10</b>	<b>21</b>	<b>26</b>	-	-	-	-	

\* The lateral entry students have to complete these courses during III and IV semester.



III SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
22BM301	Transforms and Partial Differential Equations	3	1	0	4	4	40	60	100	BS
22BM302	Circuit Analysis	3	1	0	4	4	40	60	100	ES
22BM303	Human Anatomy and Physiology	3	0	2	4	5	50	50	100	PC
22BM304	Analog and Digital Electronics	3	0	2	4	5	50	50	100	PC
22BM305	Sensors and Measurements	3	0	2	4	5	50	50	100	PC
22HS004	Human Values and Ethics	2	0	0	2	2	100	0	100	HSS
22HS005	Soft Skills and Effective Communication	0	0	2	1	2	100	0	100	HSS
<b>Total</b>		<b>17</b>	<b>2</b>	<b>8</b>	<b>23</b>	<b>27</b>	-	-	-	-
IV SEMESTER										
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category
							CA	ESE	Total	
22BM401	Probability, Statistics and Random Process	3	1	0	4	4	40	60	100	BS
22BM402	Biosciences in Medical Engineering	3	0	2	4	5	50	50	100	ES
22BM403	Signal Processing	3	1	0	4	4	40	60	100	PC
22BM404	Communication Systems	3	0	0	3	3	40	60	100	PC
22BM405	Embedded Systems	3	0	2	4	5	50	50	100	PC
	Professional Elective I	3	0	0	3	3	40	60	100	PE
22HS007	Environmental Science	2	0	0	-	2	100	0	100	HSS
22HS008	Advanced English and Technical Expression	0	0	2	1	2	100	0	100	HSS
<b>Total</b>		<b>20</b>	<b>2</b>	<b>6</b>	<b>23</b>	<b>28</b>	-	-	-	-

V SEMESTER											
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category	
							CA	ESE	Total		
22BM501	Biomedical Instrumentation	3	0	2	4	5	50	50	100	PC	
22BM502	Medical Image Processing	3	0	2	4	5	50	50	100	PC	
22BM503	Healthcare Analytics	3	0	0	3	3	40	60	100	PC	
22BM504	Bio Control Systems	3	1	0	4	4	40	60	100	PC	
	Professional Elective II	3	0	0	3	3	40	60	100	PE	
	Open Elective	3	0	0	3	3	40	60	100	PE	
22BM507	Mini Project I	0	0	2	1	2	100	0	100	EEC	
<b>Total</b>		<b>18</b>	<b>1</b>	<b>6</b>	<b>22</b>	<b>25</b>	-	-	-	-	
VI SEMESTER											
Code No.	Course	L	T	P	C	Hours/ Week	Maximum Marks			Category	
							CA	ESE	Total		
22BM601	Diagnostic and Therapeutic Equipment	3	0	2	4	5	50	50	100	PC	
22BM602	Biomechanics	3	0	2	4	5	50	50	100	PC	
22BM603	Artificial Intelligence and Machine Learning	3	0	2	4	5	50	50	100	PC	
	Professional Elective III	3	0	0	3	3	40	60	100	PE	
	Professional Elective IV	3	0	0	3	3	40	60	100	PE	
	Professional Elective V	3	0	0	3	3	40	60	100	PE	
22BM607	Mini Project II	0	0	2	1	2	100	0	100	EEC	
<b>Total</b>		<b>18</b>	<b>0</b>	<b>8</b>	<b>22</b>	<b>26</b>	-	-	-	-	

<b>VII SEMESTER</b>											
<b>Code No.</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>Hours/ Week</b>	<b>Maximum Marks</b>			<b>Category</b>	
							<b>CA</b>	<b>ESE</b>	<b>Total</b>		
22BM701	Radiological Equipment	3	0	0	3	3	40	60	100	PC	
22BM702	Hospital System Management	3	0	2	4	5	50	50	100	PC	
	Professional Elective VI	3	0	0	3	3	40	60	100	PE	
	Professional Elective VII	3	0	0	3	3	40	60	100	PE	
	Professional Elective VIII	3	0	0	3	3	40	60	100	PE	
	Professional Elective IX	3	0	0	3	3	40	60	100	PE	
22BM707	Project Work I	0	0	4	2	4	60	40	100	EEC	
<b>Total</b>		<b>18</b>	<b>0</b>	<b>6</b>	<b>21</b>	<b>24</b>	-	-	-	-	
<b>VIII SEMESTER</b>											
<b>Code No.</b>	<b>Course</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>	<b>Hours/ Week</b>	<b>Maximum Marks</b>			<b>Category</b>	
							<b>CA</b>	<b>ESE</b>	<b>Total</b>		
22BM801	Project Work II	0	0	20	10	20	60	40	100	EEC	
<b>Total</b>		<b>0</b>	<b>0</b>	<b>20</b>	<b>10</b>	<b>20</b>	-	-	-	-	

<b>ELECTIVES</b>										
<b>LANGUAGE ELECTIVES</b>										
Code No.	Course	L	T	P	C	Hours /Week	Maximum Marks			Category
							CA	ES	Total	
22HS201	Communicative English II	1	0	2	2	3	100	0	100	HSS
22HSH01	Hindi	1	0	2	2	3	100	0	100	HSS
22HSG01	German	1	0	2	2	3	100	0	100	HSS
22HSJ01	Japanese	1	0	2	2	3	100	0	100	HSS
22HSF01	French	1	0	2	2	3	100	0	100	HSS

<b>PROFESSIONAL ELECTIVES</b>										
<b>VERTICAL I - SIGNALS AND IMAGE PROCESSING</b>										
22BM001	Speech and Audio Signal Processing	3	0	0	3	3	40	60	100	PE
22BM002	Biometric Systems	3	0	0	3	3	40	60	100	PE
22BM003	Pattern Recognition Techniques	3	0	0	3	3	40	60	100	PE
22BM004	Brain Computer Interface	3	0	0	3	3	40	60	100	PE
22BM005	Advanced Medical Image Analysis	3	0	0	3	3	40	60	100	PE
22BM006	Machine Vision	3	0	0	3	3	40	60	100	PE
22BM007	Deep Learning Techniques	3	0	0	3	3	40	60	100	PE
<b>VERTICAL II -ADVANCE HEALTHCARE DEVICES</b>										
22BM008	Biomaterials and Assistive Devices	3	0	0	3	3	40	60	100	PE
22BM009	Bio Mems and Nano Technology	3	0	0	3	3	40	60	100	PE
22BM010	Virtual Instrumentation	3	0	0	3	3	40	60	100	PE
22BM011	Rehabilitation and Robotics Engineering	3	0	0	3	3	40	60	100	PE
22BM012	Critical Care Equipment	3	0	0	3	3	40	60	100	PE
22BM013	Nuclear Medicine	3	0	0	3	3	40	60	100	PE
<b>VERTICAL III -TECHNOLOGY IN BIOMEDICINE</b>										
22BM014	Cell Biology	3	0	0	3	3	40	60	100	PE
22BM015	Tissue Engineering	3	0	0	3	3	40	60	100	PE

22BM016	Genetic Engineering	3	0	0	3	3	40	60	100	PE
22BM017	Cancer Biology	3	0	0	3	3	40	60	100	PE
22BM018	Bio Computational Techniques	3	0	0	3	3	40	60	100	PE
22BM019	Neuroscience	3	0	0	3	3	40	60	100	PE
<b>VERTICAL IV -BIOMECHANICS</b>										
22BM020	Cardiovascular Engineering	3	0	0	3	3	40	60	100	PE
22BM021	Physiological Modelling	3	0	0	3	3	40	60	100	PE
22BM022	Prosthetic and Orthotic Devices	3	0	0	3	3	40	60	100	PE
22BM023	Regenerative Medicine and Ergonomics	3	0	0	3	3	40	60	100	PE
22BM024	Finite Element Analysis	3	0	0	3	3	40	60	100	PE
22BM025	Haptics	3	0	0	3	3	40	60	100	PE
<b>VERTICAL V -COMMUNICATION IN HEALTHCARE</b>										
22BM026	Medical Textiles	3	0	0	3	3	40	60	100	PE
22BM027	Wearable Systems and Body Area Networks	3	0	0	3	3	40	60	100	PE
22BM028	Telemedicine and IoT	3	0	0	3	3	40	60	100	PE
22BM029	Bioinformatics	3	0	0	3	3	40	60	100	PE
22BM030	Virtual and Augmented Reality in Healthcare	3	0	0	3	3	40	60	100	PE
22BM031	Medical Optics	3	0	0	3	3	40	60	100	PE
<b>VERTICAL VI -HEALTHCARE MANAGEMENT</b>										
22BM032	Medical Waste Management	3	0	0	3	3	40	60	100	PE
22BM033	Medical Ethics	3	0	0	3	3	40	60	100	PE
22BM034	Patient Safety and Standards	3	0	0	3	3	40	60	100	PE
22BM035	Medical Device Regulations	3	0	0	3	3	40	60	100	PE
22BM036	Forensic Science in Healthcare	3	0	0	3	3	40	60	100	PE
22BM037	Clinical Engineering	3	0	0	3	3	40	60	100	PE
<b>VERTICAL VII -MEDICAL DEVICE DESIGN AND DEVELOPMENT</b>										
22BM038	Medical Device Design	3	0	0	3	3	40	60	100	PE

22BM039	Medical Equipment Maintenance and Troubleshooting	3	0	0	3	3	40	60	100	PE
22BM040	Advanced Biosensors	3	0	0	3	3	40	60	100	PE
22BM041	Drug Delivery System	3	0	0	3	3	40	60	100	PE
22BM042	Electromagnetic Interference and Compatibility	3	0	0	3	3	40	60	100	PE
22BM043	Interventional and Diagnostic Radiology	3	0	0	3	3	40	60	100	PE
<b>OPEN ELECTIVES</b>										
22OCE01	Energy Conservation and Management	3	0	0	3	3	40	60	100	OE
22OCS01	Object Oriented Programming	3	0	0	3	3	40	60	100	OE
22OCS02	JAVA Fundamentals	3	0	0	3	3	40	60	100	OE
22OCS03	Knowledge Discovery in Databases	3	0	0	3	3	40	60	100	OE
22OCS04	E-Learning Techniques	3	0	0	3	3	40	60	100	OE
22OCS05	Social Text and Media Analytics	3	0	0	3	3	40	60	100	OE
22OEC04	Principles of Computer Communication and Networks	3	0	0	3	3	40	60	100	OE
22OEI01	Programmable Logic Controller	3	0	0	3	3	40	60	100	OE
22OME01	Digital Manufacturing	3	0	0	3	3	40	60	100	OE
22OME02	Industrial Process Engineering	3	0	0	3	3	40	60	100	OE
22OME03	Maintenance Engineering	3	0	0	3	3	40	60	100	OE
22OBT01	Biofuels	3	0	0	3	3	40	60	100	OE
22OFD01	Traditional Foods	3	0	0	3	3	40	60	100	OE
22OFD02	Food Laws and Regulations	3	0	0	3	3	40	60	100	OE
22OFD03	Post Harvest Technology of Fruits and Vegetables	3	0	0	3	3	40	60	100	OE
22OFD04	Cereal, Pulses and Oil Seed Technology	3	0	0	3	3	40	60	100	OE
22OFT01	Fashion Craftsmanship	3	0	0	3	3	40	60	100	OE
22OFT02	Interior Design in Fashion	3	0	0	3	3	40	60	100	OE
22OFT03	Surface Ornamentation	3	0	0	3	3	40	60	100	OE
22OPH05	Physics of Soft Matter	3	0	0	3	3	40	60	100	OE

22OCH01	Corrosion Science and Engineering	3	0	0	3	3	40	60	100	OE
22OCH02	Polymer Science	3	0	0	3	3	40	60	100	OE
22OCH03	Energy Storing Devices	3	0	0	3	3	40	60	100	OE
22OMA01	Graph Theory and Combinatorics	3	0	0	3	3	40	60	100	OE
22OGE01	Principles of Management	3	0	0	3	3	40	60	100	OE
22OGE02	Entrepreneurship Development I	3	0	0	3	3	40	60	100	OE
22OGE03	Entrepreneurship Development II	3	0	0	3	3	40	60	100	OE
22OGE04	Nation building: Leadership and Social Responsibility	3	0	0	3	3	40	60	100	OE
<b>ONE CREDIT COURSE</b>										
22BM0XA	Real Time Biosensors Interfacing	1	0	0	1	1	100	-	100	EEC
<b>OPEN ELECTIVES (For other than BME Students)</b>										
22BM0YA	Occupational Safety And Health In Public Health Emergencies	3	0	0	3	3	40	60	100	OE
22BM0YB	Ambulance And Emergency Medical Service Management	3	0	0	3	3	40	60	100	OE
22BM0YC	Hospital Automation	3	0	0	3	3	40	60	100	OE

**SUMMARY OF CREDIT DISTRIBUTION**

S.No	CATEGORY	CREDITS PER SEMESTER								TOTAL CREDIT	CREDITS in %	Range of Total Credits	
		I	II	III	IV	V	VI	VII	VIII			Min	Max
1	BS	10	10	4	4	-	-	-	-	28	17	15%	20%
2	ES	6	8	4	4	-	-	-	-	22	14	15%	20%
3	HSS	3	3	3	1	-	-	-	-	10	6	5%	10%
4	PC	-	-	12	11	15	12	7	-	57	35	35%	45%
5	PE	-	-	-	3	6	9	12	-	30	18	15%	20%
6	EEC	2	-	-	-	1	1	2	10	16	10	5%	10%
Total		21	21	23	23	22	22	21	10	163	100	-	-

- BS - Basic Sciences  
ES - Engineering Sciences  
HSS - Humanities and Social Sciences  
PC - Professional Core  
PE - Professional Elective  
EEC - Employability Enhancement Course  
CA - Continuous Assessment  
ES - End Semester Examination



**22MA101 ENGINEERING MATHEMATICS I**

**3 1 0 4**

**Course Objectives**

- To impart mathematical modeling to describe and explore real-world phenomena and data.
- To provide basic understanding on Linear, quadratic, power and polynomial, exponential, and multi variable models
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of polynomial equations

**Course Outcomes (COs)**

1. Implement the concepts of mathematical modeling based on linear functions in Engineering.
2. Formulate the real-world problems as a quadratic function model
3. Demonstrate the real-world phenomena and data into Power and Polynomial functions
4. Apply the concept of mathematical modeling of exponential functions in Engineering
5. Develop the identification of multivariable functions in the physical dynamical problems

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3													
2	2	3													
3	2	3													
4	3	3													
5	1	3													

**UNIT I**

**9 Hours**

**MATHEMATICS MODELING OF LINEAR FUNCTIONS**

The geometry of linear equations - Formation of linear equations: Method of least squares and method of regression - Vector spaces: Basic concepts with examples - Linear combination - Eigen values and vectors

**UNIT II**

**9 Hours**

**MATHEMATICAL MODELING OF QUADRATIC FUNCTIONS**

General form of a quadratic function - Basic relationships between the equation and graph of a quadratic function - Sum of squares error and the quadratic function of best fit - Quadratic forms: Matrix form - Orthogonality - Canonical form and its nature

**UNIT III**

**9 Hours**

**MATHEMATICAL MODELING OF POWER AND POLYNOMIAL FUNCTIONS**

Characteristics of the graphs of power and polynomial functions - Fitting of power and polynomial functions using the method of least squares - Local maxima and local minima of power and polynomial functions - Power series of functions with real variables, Taylors series, radius and interval of convergence - Tests of convergence for series of positive terms - comparison test, ratio test

**UNIT IV**

**9 Hours**

**MATHEMATICAL MODELING OF EXPONENTIAL FUNCTIONS**

Concept of exponential growth - Graphs of exponential functions - Relationship between the growth factor and exponential growth or decline - Exponential equations have a variable as an exponent and take the form  $y = abx$  through least square approximation - Calculus of exponential functions - Exponential series - Characteristics

**UNIT V**

**9 Hours**

**MATHEMATICAL MODELING OF MULTIVARIABLE FUNCTIONS**

Graphing of functions of two variables - Partial derivatives - Total derivatives - Jacobians - Optimization of multivariable functions with constraints - Optimization of multivariable functions without constraints

**Total: 60 Hours**

**Reference(s)**

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi 2016
2. B. S. Grewal, Numerical Methods in Engineering & Science: With Programs in C, C++ & MATLAB, Khanna, 2014
3. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons 2020
4. Thomas and Finney, Calculus and analytic Geometry, Fourteenth Edition, By Pearson Paperback, 2018

**22PH102 ENGINEERING PHYSICS****2023****Course Objectives**

- Understand the concept and principle of energy possessed by mechanical system
- Exemplify the propagation and exchange of energy
- Identify the properties of materials based on the energy possession

**Course Outcomes (COs)**

1. Illustrate the concept and principles of energy to understand mechanical systems
2. Exemplify the types of mechanical oscillations based on vibrational energy
3. Infer the concept of propagation of energy as transverse and longitudinal waves
4. Analyze the exchange of energy and work between the systems using thermodynamic principles
5. Apply the concept of energy and entropy to understand the mechanical properties of materials

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1						2							
2	2	1						2							
3	2	1						2	2						
4	2	1						2							
5	2	1						2							

**UNIT I****6 Hours****CONSERVATION OF ENERGY**

Concept of energy - types of energy - conservation of energy Mechanical energy: - translation - rotation - vibration - Kinetic and potential energies - conservation - work and energy - laws of motion - minimization of potential energy - equilibrium - dissipative systems - friction

**UNIT II****5 Hours****VIBRATIONAL ENERGY**

Periodic Motion - Simple Harmonic Motion - Energy of the SHM - Pendulum types - Damped oscillations - forced oscillations - natural frequency - resonance

**UNIT III****6 Hours****PROPAGATION OF ENERGY**

Transfer of energy - material medium - Transverse wave - Longitudinal wave - standing wave - interference - Doppler effect. Sound waves and its types - characteristics - human voice - reflection - refraction - beats

**UNIT IV****7 Hours****EXCHANGE OF ENERGY**

Energy in transit - heat - Temperature - measurement - specific heat capacity and water - thermal expansion - Heat transfer processes. Thermodynamics: Thermodynamic systems and processes - Laws of thermodynamics - Entropy - entropy on a microscopic scale - maximization of entropy

**UNIT V** **6 Hours**

**ENERGY IN MATERIALS**

Elastic energy - Structure and bonding - Stress - strain - Tension and compression - elastic limit - Elastic Modulus - Stress - strain diagram - ductility - brittleness - rubber elasticity and entropy

**1** **5 Hours**

**EXPERIMENT 1**

Determination of resultant of system of concurrent coplanar forces - Parallelogram law of forces

**2** **5 Hours**

**EXPERIMENT 2**

Determination of moment of inertia - Torsional pendulum

**3** **5 Hours**

**EXPERIMENT 3**

Determination of thickness of a thin wire using interference of light - Air wedge method

**4** **4 Hours**

**EXPERIMENT 4**

Determination of AC frequency using Melde's apparatus

**5** **3 Hours**

**EXPERIMENT 5**

Determination of thermal conductivity of a bad conductor using Lees disc method

**6** **4 Hours**

**EXPERIMENT 6**

Wavelength of ultrasonics in a liquid medium

(ii) velocity of ultrasonic waves in the given liquid

(iii) compressibility of the given liquid using ultrasonic interferometer

**7** **4 Hours**

**EXPERIMENT 7**

Determination of Young's modulus of a given material- Non uniform bending method

**Total: 60 Hours**

**Reference(s)**

1. C J Fischer, The energy of Physics Part I: Classical Mechanics and Thermodynamics, Cognella Academic Publishing, 2019.
2. P G Hewitt, Conceptual Physics, Pearson education, 2017
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017

**22CH103 ENGINEERING CHEMISTRY I****2023****Course Objectives**

- Understand the origin of elements from the universe
- Outline the properties of elements in the periodic table
- Analyse the different types of bond formed during chemical reactions and its reaction thermodynamics
- Summarize different states of matter based on atomic arrangement

**Course Outcomes (COs)**

1. Understand nuclear transmutation reactions that lead to the formation of elements in the universe
2. Illustrate atomic structure of elements in the periodic table and interpret the periodic trends in properties of elements with its anomaly
3. Apply the conditions for the formation of different types of chemical bonds and predict the minimum energy required for a reaction to occur
4. Analyse endothermic and exothermic processes and exchange of energy during chemical reactions
5. Analyse whether the given matter is a solid, liquid, gas, or plasma and interpret the arrangement of atoms

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1													
2	2	1													
3	2	1													
4	2	1													
5	2	1													

**UNIT I****5 Hours****ORIGIN OF ELEMENTS**

Hydrogen - Elements and Sun - fusion - hypernova - supernova - dying stars - man-made elements

**UNIT II****7 Hours****ATOMIC STRUCTURE AND PERIODICITY**

Atomic Structure - Electronic configuration - Periodic Table - Periodic trends in properties of elements - Anomalous behaviour in periodicity

**UNIT III****6 Hours****CHEMICAL BONDING**

Octet rule &amp; its limitations - types of chemical bonds - bond energy - bond cleavage - activation energy of reactions

<b>UNIT IV</b>	<b>6 Hours</b>
<b>REACTION THERMODYNAMICS</b> Conservation of energy - Endothermic reactions & exothermic reactions - Exchange of energy involved in chemical reactions	
<b>UNIT V</b>	<b>6 Hours</b>
<b>STATES OF MATTER</b> Solid - liquid - gas - plasma - quantum dots - arrangement of atoms/ions/molecules in different phases	
<b>1</b>	<b>2 Hours</b>
<b>EXPERIMENT 1</b> Lab safety rules and guidelines for students - OSHA Guidelines	
<b>2</b>	<b>3 Hours</b>
<b>EXPERIMENT 2</b> Estimation of dissolved oxygen content in water sample(s) by Winkler's method	
<b>3</b>	<b>4 Hours</b>
<b>EXPERIMENT 3</b> Determination of Fe(II) in a sample using spectrophotometer	
<b>4</b>	<b>3 Hours</b>
<b>EXPERIMENT 4</b> Estimation of chromium content in water sample by volumetric analysis	
<b>5</b>	<b>3 Hours</b>
<b>EXPERIMENT 5</b> Estimation of chloride present in the given water sample by argentometric method	
<b>6</b>	<b>3 Hours</b>
<b>EXPERIMENT 6</b> Conductometric titration of mixture of acids	
<b>7</b>	<b>4 Hours</b>
<b>EXPERIMENT 7</b> Estimation of magnesium ions in given solution by EDTA method	
<b>8</b>	<b>4 Hours</b>
<b>EXPERIMENT 8</b> Preparation of salt of fatty acid by saponification process	
<b>9</b>	<b>4 Hours</b>
<b>EXPERIMENT 9</b> Recrystallization of aspirin from water/ethanol	
	<b>Total: 60 Hours</b>

**Reference(s)**

1. Peter Atkins, Physical Chemistry, Oxford university press, 2019
2. Rose Marie Gallagher and Author Paul Ingram, Complete Chemistry Cambridge IGCSE, Oxford university press, 2020
3. P L Soni, Text book of inorganic chemistry, Chand publishers, New Delhi, 2017
4. J.D. Lee, Concise inorganic chemistry, Blackman Science Ltd, France, Wiley-India, 5th edition (Reprint), 2016
5. Gareth Price, Thermodynamics of chemical processes, Oxford university press, 2019
6. D Tabor, Gases, liquids and solids and other states of matter, Oxford University press, 2018

**22GE001 FUNDAMENTALS OF COMPUTING****3 0 0 3****Course Objectives**

- Understand the fundamental digital logics behind computations of computer systems.
- Develop simple assembly language programs with respect to arithmetic operations.
- Understand the program execution process and basics of software development methodologies.

**Course Outcomes (COs)**

1. Infer the hidden languages and inner structures of computer hardware and software through codes and combinations.
2. Interpret the organizational and architectural issues of a digital computer with concepts of various data transfer techniques in digital computers and the I/O interfaces.
3. Analyze programming problems and apply assembly instructions to solve simple problems.
4. Infer the fundamentals of operating system and System programs basics.
5. Apply the software development methodologies to various real life scenarios.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1	1	1											
2	3	3	3	1											
3	2	2	2	1											
4	2	2	2	1											
5	2	2	2	1											

**UNIT I****8 Hours****CODES AND COMBINATIONS**

Communication using Mores and Braille binary codes - Digitizing letters, numbers and objects using binary codes - Performing simple operations: addition through binary codes.

**UNIT II****9 Hours****COMPUTATION USING COMPUTER**

Communication to computing devices through various input sources - Computational operation - flow, functions and controls - communication to output devices - Basic communication protocol.

**UNIT III****11 Hours****ASSEMBLY LANGUAGE PROGRAMMING**

Little Man Computing (LMC) Model - Instruction Set - Labels - Calculation -Branching - Input - Output - Loops - Simple programs.

**UNIT IV****9 Hours****OPERATING SYSTEM AND APPLICATION GENERATION**

BIOS - Device Drivers - Resources - Scheduler - Applications Generation and Creation - Stages of Compilation - Linkers, Loaders and Libraries.



**UNIT V**

**8 Hours**

**SOFTWARE DEVELOPMENT**

Phases of application life cycle management - Software Development Methodologies - Web Page development.

**Total: 45 Hours**

**Reference(s)**

1. Charles Petzold, "Code: The Hidden Language of Computer Hardware and Software", Microsoft Press books, 2009.
2. David D. Riley, Kenya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
3. Andrew Eliasz, "Little Man Computer Programming: For The Perplexed From The Ground Up", The Internet Technical Bookshop; 1st edition, 2016.
4. Abraham Silberschatz, "Peter Baer Galvin and Greg Gagne, Operating System Concepts", 9th Edition, John Wiley & Sons Pvt. Ltd, 2015.
5. Roger S. Pressman, "Software Engineering: A Practitioner's Approach", McGraw Hill International edition, Seventh edition, 2010

**22HS001 FOUNDATIONAL ENGLISH****1 0 2 2****Course Objectives**

- Heighten awareness of grammar in oral and written expression
- Improve speaking potential in formal and informal contexts
- Improve reading fluency and increased vocabulary
- Prowess in interpreting complex texts
- Fluency and comprehensibility in self-expression
- Develop abilities as critical readers and writers
- Improve ability to summarize information from longer text, and distinguish between primary and supporting ideas

**Course Outcomes (COs)**

1. Express themselves in a professional manner using error-free language
2. Express in both descriptive and narrative formats
3. Understand and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1									2	3		2			
2									2	3		2			
3									2	3		2			
4									2	3		2			
5									2	3		2			

**UNIT I****15 Hours****SELF-EXPRESSION**

Self-Introduction - Recreating Interview Scenarios (with a focus on verbal communication) - Subject Verb Concord - Tenses - Common Errors in verbal communication  
 Be-verbs - Self-Introduction - Recreating interview scenarios - Haptics - Gestures - Proxemics - Facial expressions - Paralinguistics/ Vocalics - Body Language - Appearance - Eye Contact - Artefacts  
 Self-Introduction - Powerful openings and closings at the interview - Effective stock phrases - Modified for spontaneity and individuality-Question tags, framing questions including WH Questions - Prepositions - Listening to Ted talks-Listening for specific information

**UNIT II****15 Hours****CREATIVE EXPRESSION**

Descriptive Expression - Picture Description and Blog Writing  
 - Vocabulary - One word substitution - Adjectives - Similes, Metaphors, Imagery & Idioms - Link words - Inclusive language  
 Narrative Expression - Travelogue and Minutes of Meeting -Verbal analogy -Sequence & Time order words - Jumbled paragraph, sentences, Sequencing - Text & Paragraph completion - Past tense - Using quotation marks

**UNIT III**

**15 Hours**

**FORMAL EXPRESSION**

Formal Letters and Emails - Writing: E-mails and Letters of apology, Requisition and Explanation, and Letters to Newspapers - Speaking: Tendering verbal apologies, and explanations, persuading a listener/ audience-Hierarchy in Business correspondence- Subject of a mail, Header, Body (Salutation) and Footer of a mail. Conjunctional clause Punctuation - Formal Idioms - Phrases - Articles - Definite & Indefinite - Types of sentences - Modal verbs Precision in comprehension, Summary writing, Selective summary - Reading: Active reading - short paragraphs, excerpts, articles and editorials - Skimming and Scanning Reading comprehension & analysis - Tenses, QP/ PQ approach. Identifying the central themes/ crux-Interpreting tone - formal/informal/semi-formal - Note - taking - Listening: Listening for data, for specific information, for opinion -Active and passive Listening - Transcription - Paraphrasing and summarising information-Agreeing & disagreeing - Note - taking - Writing: Summary writing, selective summary, paraphrasing, note - making, opinion pieces - Finding synonyms in the context Paraphrasing - Sentence Transformation - simple, compound, complex. Sentence substitution - Sentence completion - Interpreting paragraphs

**Total: 45 Hours**

**Reference(s)**

1. Sasikumar, V, et.al. A Course in Listening & Speaking Foundation Books, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010
4. Reynolds, John. Cambridge IGCSE® First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.

**22GE003 BASICS OF ELECTRICAL ENGINEERING****2023****Course Objectives**

- To understand the basic concepts of electrical charge and its properties
- To interpret the formation of electric field due to electric charges
- To illustrate the concept of magnetic fields due to revolving electron
- To illustrate the force on moving charges in electric and magnetic field
- To understand the energy transfer in electro mechanical conversion

**Course Outcomes (COs)**

1. Interpret the behavior of electric charges in different medium using coulombs law.
2. Analyse the electric field due to different charge distributions.
3. Analyse the magnetic field intensity due to long conductor, solenoid, toroid and magnetic dipoles.
4. Analyze the force on conductors due to the moving charges.
5. Interpret the energy conversion concepts in electromagnetic fields.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2	2											2	2
2	2	2	2	3										2	2
3	2	2	1	3										2	2
4	3	2	1	2										2	2
5	2	2												2	2

**UNIT I****5 Hours****ELECTRIC CHARGE**

Properties of charge, additivity of charges, quantization of charge, conservation of charge, Forces between multiple charges, Electric charge in conductors, Drift of Electrons, Charges in Clouds.

**UNIT II****7 Hours****ELECTRIC FIELD**

Electric field due to system of charges, Significance of Electric field line. Electric Dipole and its significance, Continuous charge distribution, Field in infinite long uniform straight conductors, field in uniform charged uniform infinite plane sheet, field due to uniform thin spherical sheet.

**UNIT III****7 Hours****MAGNETIC FIELDS**

Concept of magnetic field, magnetic fields in infinitely long straight wire, straight and toroidal solenoids, Magnetic dipole moment of a revolving electron, Magnetic field intensity due to a magnetic dipole (bar magnet) along its axis and perpendicular to axis, Induced Electric field due to changing Magnetic Field.

**UNIT IV** **6 Hours**

**FORCE ON CHARGES**

Force on a moving charge in uniform magnetic and electric fields, Force on a current carrying conductor in a uniform magnetic field, Force between two parallel current carrying conductors.

**UNIT V** **5 Hours**

**ELECTRO MECHANICAL ENERGY CONVERSION**

Energy transfer in electromagnetic fields, Energy storage in magnetic field, Electromagnetic induction, induced emf, Eddy currents. Self and mutual inductance Linear Momentum and Angular Momentum carried by Electromagnetic Fields.

**1** **15 Hours**

**EXPERIMENT 1**

Analyze and design of Electromechanical energy conversion system.

**2** **15 Hours**

**EXPERIMENT 2**

Develop an electrical machine and analyze its performance with supplied input of AC from 0 V to 230 V.

**Total: 60 Hours**

**Reference(s)**

1. Mathew N. O. Sadiku, Principles of Electromagnetics, 6th Edition, Oxford University 2020
2. William H. Hayt and John A. Buck, Engineering Electromagnetics, McGraw Hill 2020
3. Kraus and Fleisch, Electromagnetics with Applications, McGraw Hill International Editions, 2017
4. S.P.Ghosh, Lipika Datta, Electromagnetic Field Theory, First Edition, McGraw Hill Education(India) Private Limited 2017

**22HS002 STARTUP MANAGEMENT**

**1 0 2 2**

**Course Objectives**

- Promote entrepreneurial spirit and motivate to build startups
- Provide insights on markets and the dynamics of buyer behaviour
- Train to develop prototypes and refine them to a viable market offering
- Support in developing marketing strategies and financial outlay
- Enable to scale up the prototypes to commercial market offering

**Course Outcomes (COs)**

1. Generate valid and feasible business ideas
2. Create Business Model Canvas and formulate positioning statement
3. Invent prototypes that fulfills an unmet market need
4. Formulate business strategies and create pitch decks
5. Choose appropriate strategies for commercialization

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1							1	2	1		1				
2							2	2	1	1	2				
3							3	3	1	2	2				
4							1	3	1	2	2				
5							2	3	2	2	2				

**UNIT I**

**3 Hours**

**BUSINESS MODELS AND IDEATION**

Startups: Introduction, Types of Business Modes for Startups. Ideation: Sources of Ideas, Assessing Ideas, Validating Ideas, Tools for validating ideas, Role of Innovation and Design Thinking

**UNIT II**

**3 Hours**

**UNDERSTANDING CUSTOMERS**

Buyer Decision Process, Buyer Behaviour, Building Buyer Personas, Segmenting, Targeting and Positioning, Value Proposition (Business Model Canvas), Information Sourcing on Markets, Customer Validation

**UNIT III**

**3 Hours**

**DEVELOPING PROTOTYPES**

Prototyping: Methods - Paper and Digital, Customer Involvement in Prototyping, Product Design Sprints, Refining Prototypes

**UNIT IV**

**3 Hours**

**BUSINESS STRATEGIES AND PITCHING**

Design of Marketing Strategies and Campaigns, Go-To-Market Strategy, Financial KPIs Financial Planning and Budgeting, Assessing Funding Alternatives, Pitching, Preparing Pitch Decks

<b>UNIT V</b>	<b>3 Hours</b>
<b>COMMERCIALIZATION</b> Implementation: Prototype to Commercialization, Test Markets, Institutional Support, Registration Process, IP Laws and Protection, Legal Requirements, Type of Ownership, Building and Managing Teams, Defining role of investors	
<b>1</b> <b>EXPERIMENT 1</b> Analysis of various business sectors	<b>1 Hours</b>
<b>2</b> <b>EXPERIMENT 2</b> Developing a Design Thinking Output Chart	<b>2 Hours</b>
<b>3</b> <b>EXPERIMENT 3</b> Creating Buyer Personas	<b>1 Hours</b>
<b>4</b> <b>EXPERIMENT 4</b> Undertake Market Study to understand market needs and assess market potential	<b>3 Hours</b>
<b>5</b> <b>EXPERIMENT 5</b> Preparation of Business Model Canvas	<b>2 Hours</b>
<b>6</b> <b>EXPERIMENT 6</b> Developing Prototypes	<b>15 Hours</b>
<b>7</b> <b>EXPERIMENT 7</b> Organizing Product Design Sprints	<b>2 Hours</b>
<b>8</b> <b>EXPERIMENT 8</b> Preparation of Business Plans	<b>2 Hours</b>
<b>9</b> <b>EXPERIMENT 9</b> Preparation of Pitch Decks	<b>2 Hours</b>
	<b>Total: 45 Hours</b>

**Reference(s)**

1. Rashmi Bansal, Connect the Dots, Westland and Tranquebar Press, 2012
2. Pavan Soni, Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Penguin Random House India, 2020
3. Ronnie Screwvala, Dream with Your Eyes Open: An Entrepreneurial Journey, Rupa Publications, 2015
4. Stephen Carter, The Seed Tree: Money Management and Wealth Building Lessons for Teens, Seed Tree Group, 2021
5. Kotler Philip, Marketing Management, Pearson Education India, 15th Edition
6. Elizabeth Verkey and Jithin Saji Isaac, Intellectual Property, Eastern Book Company, 2nd Edition, 2021



**22HS003 HERITAGE OF TAMILS****1 0 0 1****Course Objectives**

1. Describe the linguistic diversity in India, highlighting Dravidian languages and their features.
2. Summarize the evolution of art, highlighting key transitions from rock art to modern sculptures.
3. Examine the role of sports and games in promoting cultural values and community bonding.
4. Discuss the education and literacy systems during the Sangam Age and their impact.
5. Outline the importance of inscriptions, manuscripts, and the print history of Tamil books in preserving knowledge and culture.

**Course Outcomes (COs)**

1. Understand the concept of language families in India, with a focus on Dravidian languages.
2. Trace the evolution of art from ancient rock art to modern sculptures in Tamil heritage.
3. Identify and differentiate various forms of folk and martial arts in Tamil heritage.
4. Understand the concepts of Flora and Fauna in Tamil culture and literature.
5. Evaluate the contributions of Tamils to the Indian Freedom Struggle.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1									2	3					
2									2	3					
3									2	3					
4									2	3					
5									2	3					

**UNIT I****3 Hours****LANGUAGE AND LITERATURE**

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and 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****3 Hours****HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE**

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****3 Hours****FOLK AND MARTIAL ARTS**

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

**UNIT IV**

**3 Hours**

**THINAI CONCEPT OF TAMILS**

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

**UNIT V**

**3 Hours**

**CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**

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

**Total: 15 Hours**

**Reference(s)**

1. Dr.K.K.Pillay , Social Life of Tamils, A joint publication of TNTB & ESC and RMRL.
2. Dr.S.Singaravelu, Social Life of the Tamils - The Classical Period, International Institute of Tamil Studies.
3. Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu, Historical Heritage of the Tamils, International Institute of Tamil Studies.
4. Dr.M.Valarmathi, The Contributions of the Tamils to Indian Culture, International Institute of Tamil Studies.
5. Keeladi, Sangam City Civilization on the banks of river Vaigai, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
6. Dr.K.K.Pillay, Studies in the History of India with Special Reference to Tamil Nadu.
7. Porunai Civilization, Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu
8. R.Balakrishnan, Journey of Civilization Indus to Vaigai, RMRL.

## 22HS003 - தமிழர் மரபு

1001

**பாடத்திட்டத்தின் நோக்கம்**

1. இந்திய மொழிக்குடும்பத்துள் திராவிட மொழிகள் தனித்து இயங்கும் தன்மையை அதன் சிறப்புகள் வழி அறிதல்.
2. தொன்றுதொட்டு தமிழர், கலையில் அடைந்த வளர்ச்சியை இயம்புதல்.
3. சங்ககால தமிழரின் கற்றல் திறத்தை இலக்கியங்கள் வழி ஆராய்தல்.

**கற்றலின் விளைவு**

1. இந்திய மொழிக்குடும்பத்துள் திராவிட மொழிகள் தனித்து இயங்கும் தன்மையை அதன் சிறப்புகள் வழி அறிதல்.
2. தொன்றுதொட்டு தமிழர், கலையில் அடைந்த வளர்ச்சியை இயம்புதல்.
3. சங்ககால தமிழரின் கற்றல் திறத்தை இலக்கியங்கள் வழி ஆராய்தல்.
4. தமிழ் மொழியின் சிறப்புகளை அதன் படைப்பிலக்கியங்கள் மூலம் அறிந்து கொள்ளுதல்.
5. கற்காலம் தொடங்கி, இக்காலம் வரை சிறப்பக்கலை அடைந்த வளர்ச்சியை கண்டுகொள்ளல் .
6. தமிழர் தம் வாழ்வில் எங்கனம் இயற்கையை வணங்கி போற்றினர் என்பதை திணை கோட்பாட்டின் வழி தெளிதல்.
7. இந்திய விடுதலை போரில் தமிழர் ஆற்றிய பங்கினை தெரிந்து கொள்ளுதல்.

**அலகு I மொழி மற்றும் இலக்கியம்: 3**  
 இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் - பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

**அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை: 3**  
 நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள்- பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளூர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

**அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3**  
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஓயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

**அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3**  
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

**அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: 3**  
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிிகள் - தமிழ்ப் புத்தகங்களின் அச்ச வரலாறு.

**TOTAL : 15 PERIODS**

#### **TEXT-CUM-REFERENCE BOOKS**

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

**22MA201 ENGINEERING MATHEMATICS II**

**3 1 0 4**

**Course Objectives**

- To impart and analyze the concepts of differential equations to describe in real-world phenomena
- To provide basic understanding on differential equation models and vector field models
- Summarize and apply the methodologies involved in framing the real world problems related to fundamental principles of complex functions

**Course Outcomes (COs)**

1. Interpret the concept of differential equations through mathematical modeling and analyze its applications in engineering
2. Formulate the real world problems as second order linear differential equations and give solutions for the same
3. Demonstrate the real-world phenomena with magnitude and direction in the form of vector functions
4. Apply the concept of vector fields and line integrals through mathematical modeling in engineering
5. Determine complex functions and apply them to formulate problems arising in engineering

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	3												
2	2	3												
3	2	3												
4	3	3												
5	3	3												

**UNIT I**

**9 Hours**

**FIRST ORDER LINEAR DIFFERENTIAL EQUATIONS**

Formation of differential equations- Solutions of first order linear ODE: Leibnitzs and method of separation of variables - Cooling/Heating of an object - A falling object - Modeling of electric circuits: RL and RC circuits - Modeling of population dynamics: Exponential growth and decay - Logistic growth model

**UNIT II**

**9 Hours**

**SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS**

Methods of solving second order linear ordinary differential equations - Models for linear oscillators: Simple harmonic motion - Mechanical vibrations with and without damping - Electric circuit system: RLC circuits

**UNIT III**

**9 Hours**

**VECTOR DIFFERENTIAL CALCULUS**

Vector and scalar functions - Fields - Derivative of a vector function and geometrical interpretation - Velocity and acceleration - Gradient and its properties - Tangent and normal vectors - Directional derivative - Divergence of a vector field - Curl of a vector field - Projectile motion

**UNIT IV**

**9 Hours**

**VECTOR INTEGRAL CALCULUS**

Line integrals of vector point functions - Surface integral of vector point functions - Applications of line and surface integrals - Greens theorem in a plane - Stokes theorem - Gauss divergence theorem

**UNIT V**

**9 Hours**

**COMPLEX FUNCTIONS**

Basic concepts of Complex numbers Geometrical representation of complex number - Analytic functions and its properties - Construction of Analytic functions: Fluid flow Electric flow - Mapping of complex functions

**Total: 60 Hours**

**Reference(s)**

1. Richard E. Williamson, Introduction to Differential Equations and Dynamical Systems, McGraw Hill Companies. Inc, 1997
2. Michael Greenberg, Advanced Engineering Mathematics, 2/e, Pearson, 2018
3. George B. Thomas, Maurice D. Weir and Joel Hass Thomas Calculus, 13/e, Pearson Publishers, 2013
4. Erwin Kreyszig, Advanced Engineering Mathematics Wiley, 10th editi5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017on ,2015
5. J. Stewart, Essential Calculus, Cengage, 2nd edition, 2017

**22PH202 ELECTROMAGNETISM AND MODERN  
PHYSICS**

2023

**Course Objectives**

- Understand the principles and mechanisms of electricity and magnetism
- Infer the classification of electromagnetic waves
- Analyze the theory of relativity and energy bands

**Course Outcomes (COs)**

1. Understand the principles and mechanism of electrostatics and current
2. Illustrate the principles and mechanism of magneto statics
3. Classify electromagnetic waves and infer the characteristics of visible light
4. Outline the importance of theory of relativity and analyze the wave nature of particles
5. Exemplify the electrical properties of semiconductor based on the band theory

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1							2					
2	2	1							2					
3	2	1							2					
4	2	1												
5	2	1							2					

**UNIT I****6 Hours****ELECTRICITY**

Electric monopoles - Electric field - Electric flux - Electric potential - Electrical energy- Capacitor- Conductors and Insulators - Electric dipole and polarization - Electric current - Voltage sources - Resistance

**UNIT II****6 Hours****MAGNETISM**

Sources of magnetism - Monopoles - Magnetic field and force - magnetic field and current distribution - Magnetic dipole - Magnetic potential energy - Inductor - Electric and magnetic field comparison

**UNIT III****6 Hours****ELECTROMAGNETIC WAVES AND LIGHT**

Electromagnetism: Basic laws - Electromagnetic energy - radiation. Electromagnetic waves: Origin, nature and spectrum - Visible light. Principle of least time - Geometrical optics-Human eye - Diffraction - Interference - Polarization - LASER

**UNIT IV****6 Hours****MODERN PHYSICS**

Special theory of relativity - Simultaneity and time dilation - Length contraction - Relativistic mass variation. Matter waves - De-Broglie hypothesis - Wave nature of particles

**UNIT V** **6 Hours**

**ENERGY BANDS IN SOLIDS**

Band theory of solids - Classification of materials - Semiconductors - Direct and indirect semiconductor - Fermi energy - Intrinsic and extrinsic semiconductor - Carrier concentration - Electrical conductivity

**1** **5 Hours**

**EXPERIMENT 1**

Determination of V-I characteristics of a solar cell

**2** **5 Hours**

**EXPERIMENT 2**

Determination of Hall voltage of a given specimen by Hall Effect method

**3** **5 Hours**

**EXPERIMENT 3**

Determination of wavelength of a given laser source - Grating method

**4** **4 Hours**

**EXPERIMENT 4**

Determination of particle size using diode laser

**5** **3 Hours**

**EXPERIMENT 5**

Determination of refractive index of a given solid medium and liquid medium

**6** **4 Hours**

**EXPERIMENT 6**

Determination of energy loss per cycle of a ferromagnetic material using hysteresis curve

**7** **4 Hours**

**EXPERIMENT 7**

Determination of band gap energy of a given semiconducting material

**Total: 60 Hours**

**Reference(s)**

1. C J Fischer, The energy of Physics Part II: Electricity and Magnetism, Cognella Academic Publishing, 2019
2. P G Hewitt, Conceptual Physics, Pearson education, 2017
3. R A Serway and J W Jewitt, Physics for Scientists and Engineers, Thomson Brooks/Cole, 2019
4. J Walker, D Halliday and R Resnick, Principles of Physics, John Wiley and Sons, Inc, 2018
5. H C Verma, Concepts of Physics (Vol I & II), Bharathi Bhawan Publishers & Distributors, New Delhi, 2017



**22CH203 ENGINEERING CHEMISTRY II****2023****Course Objectives**

- Understand the concept of electrochemistry for determination of electrode potential, pH and applications as energy storage devices
- Outline the chemistry of metal corrosion and analyze the methods of corrosion control
- Understand the role of catalyst in the rate of reaction
- Summarize the variation in properties and reactivity of isotopes.

**Course Outcomes (COs)**

1. Apply the electrochemical concepts to determine the electrode potential of a metal
2. Analyze the working of batteries for the energy storage devices
3. Understand the mechanism of corrosion and suggest a method to control the corrosion
4. Illustrate reaction mechanisms and assess the role of catalyst in a chemical reaction
5. Analyze various types of nuclear transmutation including decay reactions

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2	1												
3	2	1					1							
4	2	1												
5	2	1												

**UNIT I****6 Hours****ELECTROCHEMISTRY**

Origin of potential - Electromotive force - Electrical double layer - Transport of charge within the cell - Cell description - Prediction of cell potentials

**UNIT II****6 Hours****ENERGY STORING DEVICES**

Relation between electrical energy and energy content of a cell - Reversible and irreversible cell - Charging and discharging reactions in a reversible cell - Current challenges in energy storage technologies

**UNIT III****6 Hours****METAL CORROSION AND ITS PREVENTION**

Oxidation of metals: Electrochemical origin of corrosion - Electromigration - Electron transfer in the presence and absence of moisture - Galvanic series. Strategies for corrosion control: Galvanic anode and impressed current.

**UNIT IV****6 Hours****CATALYSIS**

Energy profile diagram for a chemical reaction - activation energy - role of catalyst - homogeneous and heterogeneous catalysis - types

**UNIT V** **6 Hours**

**NUCLEAR REACTIONS**

Radioactive and stable isotopes - Variation in properties between isotopes - Radioactive decay (alpha, beta and gamma) - Half-life period - Nuclear reactions - Radiocarbon dating

**1** **4 Hours**

**EXPERIMENT 1**

Determination of strength of hydrochloric acid in a given solution using pH meter

**2** **4 Hours**

**EXPERIMENT 2**

Application of calomel electrode to determine the redox potential of Fe(II) solution

**3** **4 Hours**

**EXPERIMENT 3**

Construct an electrochemical cell exhibiting valid output and compare its potential with the given standard cell

**4** **5 Hours**

**EXPERIMENT 4**

Determination of corrosion percentage of iron/steel by weight loss method

**5** **4 Hours**

**EXPERIMENT 5**

Determination of percentage of corrosion inhibition in iron/mild steel using a natural inhibitor

**6** **4 Hours**

**EXPERIMENT 6**

Electroplate copper on the given target object and estimate the amount of copper deposited at cathode

**7** **5 Hours**

**EXPERIMENT 7**

Determination of rate constant of acid catalyzed hydrolysis of ester

**Total: 60 Hours**

**Reference(s)**

1. Jain and Jain, Engineering Chemistry, 16th Edition, Dhanpat Rai Publishing Company, New Delhi, 2013.
2. P.H. Rieger, Electrochemistry, Second Edition (Reprint), Springer, Netherland, 2012
3. E. McCafferty, Introduction to Corrosion Science, Springer; 2010 Edition, January 2010
4. S. Vairam, Engineering Chemistry, John Wiley & Sons, 2014
5. H.J. Arnikaar, Essentials of Nuclear Chemistry, 4th edition, (revised) New Age International Publishers, 2011
6. U. Hanefeld, L. Lefferts, Catalysis: An Integrated Textbook for Students, Wiley- VCH, 2017

**22GE002 COMPUTATIONAL PROBLEM SOLVING****3 0 0 3****Course Objectives**

- Analyze the algorithm design techniques and development principles in solving the real life problems.
- Illustrate the different ways of organizing and storing the data in computing systems.
- Understand the basic network configuration and setup connections among different device systems.

**Course Outcomes (COs)**

1. Analyze a problem and formulate algorithms, pseudocodes and flowcharts.
2. Develop algorithmic solutions to simple computational problems and explore algorithmic approaches to problem solving.
3. Design and apply appropriate data structures for solving computing problems.
4. Compare the various storage devices used in a computer system.
5. Analyze the requirements for a given organizational structure and establish the connection between two or more computers to form a network.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	1	2										
2	3	3	3	3										
3	2	2	2	3										
4	2	2	2	2										
5	2	2	2	2										

**UNIT I****6 Hours****VISUAL PROCESS MODELING**

Scenario decomposition - Logical sequencing - Drawing flowchart - Preparation of visual process model.

**UNIT II****12 Hours****ALGORITHMIC DESIGN THINKING**

Analysis - Verification - Brute force - Divide and conquer - Greedy - Backtracking.

**UNIT III****12 Hours****DATA ORGANIZATION**

Elementary Data Organization - Abstract Data Types - Fundamentals of Linear and Non Linear Data Structures.

**UNIT IV****7 Hours****DATA STORAGE**

Flat File and Relational database - Data Read & Write in Local Storage, Server Storage and Cloud storage - Database Query Methods.

**UNIT V**

**8 Hours**

**NETWORKING ESSENTIALS**

Networking Components and Services - IP Addressing - Configuring and Managing the Campus Network - Network Security - Firewalls.

**Total: 45 Hours**

**Reference(s)**

1. David D. Riley, Kenya. Hunt, "Computational thinking for the modern problem Solver", CRC Press Taylor & Francis Group, 2014.
2. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", Third Edition, Pearson Education Asia, 2011.
3. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C", 2nd Edition, Pearson Education, 2016.
4. Abraham Silberschatz, Henry F. Korth and S. Sudarshan, "Database System Concepts", McGraw Hill, 2015.
5. Behrouz A. Forouzan, "Data Communication and Networking", 5th Edition, Tata McGraw-Hill, 2014.

**22GE004 BASICS OF ELECTRONICS  
ENGINEERING**

**2023**

**Course Objectives**

- To Understand the concept of energy transmission through mechanical, electrical and electromagnetic form.
- To Analyze the use of PN Junction Diode and BJT for signal conditioning.
- To apply the working principle of PN Junction Diode and BJT for the design of basic Digital Logic.
- To analyze the working and characteristics of Special Purpose Semiconductor Electronic Devices.

**Course Outcomes (COs)**

1. Understand the need for electrical and electromagnetic signal transmission.
2. Analyze the working principle and characteristics of PN junction diode.
3. Analyze the working principle and characteristics of Bipolar Junction Transistor.
4. Apply the working principle of PN Junction diode and BJT for designing basic Digital Logic functions.
5. Analyze the energy conversion needs and working principle of Special purpose electronic devices.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	3	3	1										
2	3	3	3	2										
3	3	3	3	2										
4	3	3	3	2										
5	3	3	3	1										

**UNIT I**

**6 Hours**

**ENERGY TRANSFER AND SIGNALS**

Energy Transmission through Mechanical, Electrical and Electromagnetic means, Signal as Energy Transmission, Complexity in signal transmission (Volume of Information, Distance and Time taken), Limitations of Mechanical Energy Transmission, Electrical and Electromagnetic Signal Transmission, Need for Conversion between Electrical and Mechanical Signals.

**UNIT II**

**8 Hours**

**SIGNAL CONDITIONING USING DIODE**

Need for Vacuum Tubes in the Evolution of Electronics, Overview of Vacuum Tubes, Diode and Triode, Limitations of Vacuum Tubes. Semiconductor Group in Periodic Table, Overview of Semiconductor Materials, Flow of electrical energy through PN Junction Diode, Signal Clipping, Signal Clamping and Signal Multiplication using PN Junction Diode, Limitations of PN Junction Diode.

**UNIT III** **6 Hours**

**SIGNAL CONDITIONING USING TRANSISTOR**

Need for controlling electrical signals, Principle of Bipolar Junction Transistor operation, Signal Switching and Amplification using BJT, Limitations of BJT, Principle of Field Effect Transistor operation.

**UNIT IV** **6 Hours**

**LOGIC SYNTHESIS USING DIODE AND TRANSISTORS**

Overview of Logic Gates, PN Junction and BJT as electronic switches, Digital Logic Synthesis using Diode and Transistor: Diode Logic, Resistor Transistor Logic, Diode Transistor Logic, Transistor Logic.

**UNIT V** **4 Hours**

**DEVICES FOR SPECIAL REQUIREMENTS**

Voltage Regulation using Zener Diode, Variable Capacitance using Varactor Diode, Electrical Energy to Light Energy conversion using Light Emitting Diode, Light to Energy to Electrical Energy conversion using Solar Cell.

**1** **4 Hours**

**EXPERIMENT 1**

Design and Implement a simple device to communicate basic information between two different small distance points using wired and wireless methods.

**2** **6 Hours**

**EXPERIMENT 2**

Design and Implement different wave shaping Circuits using PN Junction Diodes.

**3** **4 Hours**

**EXPERIMENT 3**

Design and Implement Voltage Multiplier Circuit using PN Junction Diodes and Capacitors.

**4** **4 Hours**

**EXPERIMENT 4**

Design and Implement a three Stage Circuit to convert 220V 50Hz AC mains supply to 12V DC supply.

**5** **4 Hours**

**EXPERIMENT 5**

Design and Implement a BJT Amplifier Circuit to amplify audio input signal.

**6** **4 Hours**

**EXPERIMENT 6**

Design and Implement Basic Logic Gates using PN Junction Diodes.

**7** **4 Hours**

**EXPERIMENT 7**

Design and Implement Basic Logic Gates using BJTs.

**Total: 60 Hours**

**Reference(s)**

1. Thomas L. Floyd, Electronic Devices: Electron Flow Version, Ninth Edition, Prentice Hall, 2012.
2. J Millman, C. Halkias & Satyabrata Jit, Electronic Devices and Circuits, Tata McGraw-Hill, 2007.
3. L Robert Boylestead, Louis Nashelsky, Electronic Devices and Circuit Theory, Pearson Education 2006.
4. David A. Bell, Electronic Devices and Circuits, Prentice Hall of India, 2003.
5. Adel S. Sedra & Kenneth C. Smith, Micro Electronic Circuits Theory and Applications, Sixth Edition, Oxford University Press, 2013.
6. Behzad Razavi, Microelectronics, Wiley India Pvt. Ltd.; 2nd edition (2018)

**22GE005 ENGINEERING DRAWING****1 0 2 2****Course Objectives**

- To provide knowledge on fundamentals of engineering drawings and conic sections.
- To impart skill on orthographic projections of points and lines.
- To familiarize on projection of planes and simple solids.
- To provide knowledge on section of solids and development of surfaces of simple solids.
- To impart skill on conversion of isometric view to orthographic projection and vice versa.

**Course Outcomes (COs)**

1. Understand the engineering drawing concepts as per industrial standards.
2. Construct orthographic projections of points and lines.
3. Draw the projection of planes and simple solids.
4. Draw the section of solids and development of surfaces.
5. Draw the orthographic projection from isometric view and vice versa.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2							2		2			2		
2	2							2		2			2		
3	1							2		2			2		
4	1							2		2			2		
5	1							2		2			2		

**UNIT I****7 Hours****FUNDAMENTALS OF ENGINEERING DRAWING**

Definition - standards - drawing tools - drawing sheets - scales - line and its types. Practices on lettering - numbering - dimension of drawings. Construction of conic sections - ellipse - parabola and hyperbola using eccentricity method.

**UNIT II****9 Hours****PROJECTION OF POINTS AND LINES**

Principles of projection - projection of points in four quadrants - first angle projection of straight lines - perpendicular to one plane - parallel and inclined to both planes.

**UNIT III****9 Hours****PROJECTION OF PLANES AND SOLIDS**

Projection of simple planes and projection of simple solids - parallel - perpendicular and inclined to one plane using change of position method - inclined to both the planes

**UNIT IV****9 Hours****SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES**

Section of Solids - simple position with cutting plane parallel - perpendicular and inclined to one plane with true shape of section. Development of surfaces - simple and truncated solids.



**UNIT V**

**11 Hours**

**ORTHOGRAPHIC PROJECTIONS AND ISOMETRIC VIEW**

Orthographic projections and isometric view of components used in engineering applications.

**Total: 45 Hours**

**Reference(s)**

1. N. D. Bhatt and V. M. Panchal, Engineering Drawing, Charotar Publishing House Pvt. Limited, 2019.
2. K.V. Natarajan, A Text Book of Engineering Graphics, Dhanalakshmi Publishers, 2013.
3. K Venugopal, Engineering Drawing and Graphics, Sixth edition, New Age International, 2013.
4. Basant Agarwal, Mechanical drawing, Tata McGraw-Hill Education, 2013.
5. Engineering Drawing Practice for Schools & Colleges, Bureau of Indian Standards - Sp46, 2013.

**22HS006 TAMILS AND TECHNOLOGY****1 0 0 1****Course Objectives**

1. Analyse graffiti on potteries as a form of historical and cultural documentation during the Sangam Age.
2. Investigate the building materials and the historical context of Hero stones during the Sangam Age by Analysing the details of stage constructions in Silappathikaram and their cultural significance.
3. Examine ancient knowledge of oceans and its impact on Tamil society.

**Course Outcomes (COs)**

1. Understand the significance of the weaving industry during the Sangam Age and its cultural importance.
2. Understand the significance of dams, tanks, ponds, and sluices in the agricultural and irrigation practices of the Chola Period.
3. Explore the architectural designs and structural construction methods used in household materials during the Sangam Age.
4. Explore the art of shipbuilding in ancient Tamil culture and its role in maritime trade and transportation.
5. Trace the development of scientific terminology and vocabulary in Tamil language.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									2	3				
2									2	3				
3									2	3				
4									2	3				
5									2	3				

**UNIT I****3 Hours****WEAVING AND CERAMIC TECHNOLOGY**

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

**UNIT II****3 Hours****DESIGN AND CONSTRUCTION TECHNOLOGY**

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**

**3 Hours**

**MANUFACTURING TECHNOLOGY**

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**

**3 Hours**

**AGRICULTURE AND IRRIGATION TECHNOLOGY**

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

**UNIT V**

**3 Hours**

**SCIENTIFIC TAMIL & TAMIL COMPUTING**

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

**Total: 15 Hours**

**Reference(s)**

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

**22HS006 - தமிழரும் தொழில்நுட்பமும்****1001****பாடத்திட்டத்தின் நோக்கம்**

1. சங்க காலத்தில் வரலாறு மற்றும் கலாச்சார ஆவணங்களின் ஒரு வடிவமாக, மட்பாண்டங்கள் மீதான கிராஃபிடிசை பகுப்பாய்வு செய்தல்.
2. சிலப்பதிகாரத்தில் கட்டப்பட்ட மேடை கட்டுமானங்களின் விவரங்களையும் அவற்றின் கலாச்சார முக்கியத்துவத்தையும் பகுப்பாய்வு செய்வதன் மூலம், சங்க காலத்தில் மாவீரர் கற்களின் கட்டுமானப் பொருட்கள் மற்றும் வரலாற்று சூழலை ஆராய்தல்.
3. சமுத்திரங்கள் பற்றிய பண்டைய அறிவையும், தமிழ் சமூகத்தில் அதன் தாக்கத்தையும் ஆராய்வது ஆகியவை இப்பாடத்திட்டத்தின் நோக்கம் ஆகும்.

**கற்றலின் விளைவு**

1. சங்க காலத்தில் நெசவுத் தொழிலின் முக்கியத்துவத்தையும் அதன் கலாச்சார முக்கியத்துவத்தையும் புரிந்து கொள்ளல்.
2. சோழர் கால விவசாய மற்றும் நீர்ப்பாசன நடைமுறைகளில் அணைகள், குளங்கள் மற்றும் மதகுகளின் முக்கியத்துவத்தைப் புரிந்து கொள்ளல்.
3. சங்க காலத்தில் வீட்டுப் பொருட்களில் பயன்படுத்தப்பட்ட கட்டடக்கலை வடிவமைப்புகள் மற்றும் கட்டமைப்பு கட்டுமான முறைகளை ஆராய்தல்.
4. பண்டைய தமிழ் கலாச்சாரத்தில், கப்பல் கட்டும் கலை, கடல் வர்த்தகம் மற்றும் போக்குவரத்தில் அதன் பங்கை ஆராய்தல்.
5. தமிழ் மொழியில் அறிவியல் சொற்களஞ்சியம் மற்றும் சொல்லகராதியின் வளர்ச்சியைக் கண்டறிதல்.

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

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

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

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

**அலகு III உற்பத்தித் தொழில் நுட்பம்: 3**

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

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

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

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

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

**TOTAL : 15 PERIODS**

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

**22BM301 TRANSFORMS AND PARTIAL  
DIFFERENTIAL EQUATIONS**

**3 1 0 4**

**Course Objectives**

- Understand the concepts of Fourier series, Transforms and formation of partial differential equations, which will enable them to model and analyze the physical phenomena
- Implement the Fourier analysis, an elegant method in the study of heat flow, fluid mechanics and electromagnetic fields
- Develop enough confidence to identify and model mathematical patterns in real world and offer appropriate solutions, using the skills learned in their interactive and supporting environment

**Course Outcomes (COs)**

1. Recognize the periodicity of a function and formulate the same as a combination of sine and cosine using Fourier series.
2. Apply Fourier transform to convert the function in time domain into a sum of sine waves of different frequencies, each of which represents a frequency component.
3. Formulate a function in frequency domain whenever the function is defined in time domain through Laplace transforms.
4. Use Z-transform to convert a discrete-time signal, which is a sequence of real or complex numbers, into a complex frequency domain representation.
5. Understand the concepts of partial differential equations and able to apply them to solve real scenarios.

**Articulation Matrix**

<b>CO No</b>	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>	<b>PO 7</b>	<b>PO 8</b>	<b>PO 9</b>	<b>PO1 0</b>	<b>PO1 1</b>	<b>PO1 2</b>	<b>PSO 1</b>	<b>PSO 2</b>	<b>PSO 3</b>
1	2	2													
2	2	2													
3	2	2													
4	2	2													
5	2	2													

**UNIT I**

**9 Hours**

**FOURIER SERIES**

Introduction-Periodic functions-Dirichlets conditions - General Fourier series - Odd and even functions - Parsevals Identity-Root mean square value- Harmonic analysis

**UNIT II**

**9 Hours**

**FOURIER TRANSFORM**

Fourier integral theorem- Fourier transform and inverse Fourier transform- Sine and cosine transforms - Properties - Transforms of simple functions = Convolution theorem - Parsevals identity

**UNIT III**

**9 Hours**

**LAPLACE TRANSFORM**

Laplace transform: Existence of Laplace transform- Properties of Laplace Transform-Laplace transform of periodic function- Inverse Laplace transform: Properties of inverse Laplace Transform-Partial

fraction method - Convolution- Application of Laplace transform to solve ordinary differential equations with constant coefficients.

**UNIT IV**

**9 Hours**

**Z TRANSFORM**

Z-Transform - Properties - Inverse Z-transform - Convolution method- Partial fraction method - Solution of difference equations using Z-transform.

**UNIT V**

**9 Hours**

**APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS**

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions -Solution of standard types of first order partial differential equations (clairauts form, Lagrange linear equation) - Linear partial differential equations of second order with constant coefficients.

**Total: 60 Hours**

**Reference(s)**

1. Erwin Kreyszig, Advanced Engineering Mathematics, Tenth Edition, Wiley India Private Limited, New Delhi, 2016.
2. Peter V O Neil., Advanced Engineering Mathematics, 7th Edition, TBH Publishers, 2013.
3. James Glyn, Advanced Modern Engineering Mathematics, Pearson, 3rd edition 2014.
4. Michael D Greenberg., Advanced Engineering Mathematics, Pearson Education, 2nd Edition 2002.
5. B. S. Grewal, Higher Engineering Mathematics, Forty third Edition, Khanna Publications, New Delhi 2015.

**22BM302 CIRCUIT ANALYSIS****3 1 0 4****Course Objectives**

- To apply basic laws in Circuits and to calculate the voltages and current in a circuit using basic theorems.
- To apply the concept of transients and resonance in series and parallel circuit
- To develop two port networks and analysis different types of two port networks

**Course Outcomes (COs)**

1. Apply Voltage-Current laws and transformation techniques to solve linear electric circuits and analyse the phase relationships of circuits with RLC components
2. Determine the electrical parameters of the circuits by using network theorems
3. Analyse the steady state and transient response of RLC circuit using Laplace transform
4. Analyse the frequency response of an electric circuit
5. Determine driving point and transfer function of two port network and classify different two port network

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2			1								1		
2	3	2											1		
3	3	2											1		
4	2	3											1		
5	2	3											1		

**UNIT I****10 Hours****CIRCUIT LAWS AND ANALYSIS TECHNIQUES**

Basic electrical components, Voltage - current laws, Divider theorem, Short and Open Circuits, Phase relationship for R, L and C, Impedance and Admittance for R, L and C, Mesh and Nodal Analysis for AC and DC circuits, Source transformation techniques, Star delta transformation techniques.

**UNIT II****9 Hours****NETWORK THEOREMS FOR DC AND AC CIRCUITS**

Superposition theorem - Thevenin's theorem - Norton's theorem - Maximum power transfer theorem - Reciprocity theorem.

**UNIT III****8 Hours****STEADY STATE AND TRANSIENT ANALYSIS OF AC AND DC CIRCUITS**

Steady state and Transient analysis of RL, RC, and RLC circuits using Laplace Transform for both AC and DC input.

**UNIT IV****9 Hours****RESONANCE AND MAGNETICALLY COUPLED CIRCUITS**

Resonance: Natural frequency and Damping Ratio - Series Resonance - Parallel Resonance - Quality Factor. Coupled Circuits: Self-inductance- Mutual inductance - Dot conversion - Ideal Transformer.



**UNIT V**

**9 Hours**

**LINEAR TWO PORT NETWORK PARAMETERS**

Driving point and transfer function of two port network, Z, Y, T, inverse T, Hybrid, Inverse Hybrid Parameters and its conversion.

**Total: 60 Hours**

**Reference(s)**

1. William Hayt, J V Jack, E Kemmerly and Steven M Durbin, Engineering Circuits Analysis, Tata McGraw-Hill, 2013.
2. Joseph Edminister and Mahmood Nahri, Theory and Problems of Electric Circuits Tata McGraw Hill, 2008.
3. A Sudhakar, S Shyammohan and Palli, Circuits and Network (Analysis and synthesis) Tata McGraw-Hill, 2010.
4. L Robert Boylested, Experiments in Circuit Analysis to Accompany Introductory Circuit Analysis, PHI, 2002.
5. M. Russell, Mersereau and Joel R. Jackson, Circuit Analysis- A System Approach, Pearson Education, 2009.
6. Steven T. Karris, Circuit Analysis I with MATLAB Applications, Orchard Publications, 2004

**22BM303 HUMAN ANATOMY AND PHYSIOLOGY****3 0 2 4****Course Objectives**

- To identify all the organelles of an animal cell and their function
- To understand structure and functions of the various types of systems of human body
- To demonstrate their knowledge of importance of anatomical features and physiology of human systems

**Course Outcomes (COs)**

1. Understand the structure and function of cells and tissues.
2. Outline Skeletal, Muscular and Respiratory systems and their importance.
3. Interpret the working of Cardiovascular and Lymphatic systems.
4. Analyze the functions of Nervous, Endocrine and Special sensory systems.
5. Analyze the functions of various components of the digestive system and evaluate the role of the urinary system in maintaining homeostasis.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3				2										
2	2				2										
3	3			1	2										
4	3	2		1	2										
5	3	2		1	2										

**UNIT I****9 Hours****BASIC ELEMENTS OF HUMAN BODY**

Cell: Structure and organelles - Functions of each component in the cell. Cell membrane - transport across cell membrane - origin of cell membrane potential - Action potential - Cell to cell signalling- Cell Division. Tissue Types - Specialized tissues - functions.

**UNIT II****9 Hours****SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS**

Skeletal: Bone types and functions - Joint-Types of Cartilage and functions. Muscular: Parts of Muscle-Movements. Respiratory: Components of respiratory system-Respiratory Mechanism. Types of respiration - Oxygen and carbon dioxide transport and acid base regulation.

**UNIT III****9 Hours****CARDIOVASCULAR AND LYMPHATIC SYSTEM**

Cardiovascular: Blood composition - functions of blood - functions of RBC. WBC types and their functions. Blood groups - Importance of blood groups - Identification of blood groups. Structure of heart - Conducting system of heart - Properties of Cardiac muscle - Cardiac cycle - Types of Blood Vessel - ECG - Heart sound - Volume and pressure changes and regulation of heart rate - Coronary Circulation. Factors regulating Blood flow. Lymphatic: Parts and Functions of Lymphatic systems - Types of Lymphatic organs and vessels.

**UNIT IV** **9 Hours**

**NERVOUS, ENDOCRINE AND SPECIAL SENSORY SYSTEMS**

Nervous: Structure of Neuron - Types of Neurons. Synapses and types. Condition of action potential in neuron. Brain - Divisions of brain lobes - Cortical localizations and functions - EEG. Spinal cord - Tracts of spinal cord - Reflex mechanism - Types of reflex. Autonomic nervous system and its functions. Endocrine - Pituitary and thyroid gland. Special sensory: Optics of Eye - Retina - Photochemistry of Vision - Neurophysiology of Vision - EOG. Structure and functions of Internal Ear - Mechanism of Hearing - Auditory pathway, Hearing Tests.

**UNIT V** **9 Hours**

**DIGESTIVE AND URINARY SYSTEMS**

Digestive: Organs of Digestive system - Digestion and Absorption. Urinary: Structure of Kidney and Nephron. Mechanism of Urine formation and acid base regulation - Urinary reflex - Homoeostasis and blood pressure regulation by urinary system.

**1** **3 Hours**

**EXPERIMENT 1**

Diagnosis of platelet related disorder and hemophilia by analyzing bleeding and clotting time.

**2** **3 Hours**

**EXPERIMENT 2**

Diagnosis of anemia by measuring the amount of hemoglobin in the blood.

**3** **4 Hours**

**EXPERIMENT 3**

Determine whether the donor's blood group is compatible with the recipient's blood group for a safe blood transfusion.

**4** **4 Hours**

**EXPERIMENT 4**

Diagnosis of Leukocytosis and Leukopenia by counting the WBC present in the blood

**5** **4 Hours**

**EXPERIMENT 5**

Diagnosis of Myocardial Infarction from Abnormal PQRST Waveform.

**6** **4 Hours**

**EXPERIMENT 6**

Diagnosis of myopathies and neuropathies using EMG.

**7** **4 Hours**

**EXPERIMENT 7**

Diagnose the conductive and sensorineural type of hearing loss.

**8** **4 Hours**

**EXPERIMENT 8**

Identification of refractive errors like myopia, hyperopia, and presbyopia.

**Total: 75 Hours**

**Reference(s)**

1. Elaine.N. Marieb, "Essential of Human Anatomy and Physiology",12th Edition, Pearson Education, New Delhi,2018
2. Gillian Pocock, Christopher D. Richards, "The Human Body - An Introduction for Biomedical and Health Sciences",Oxford University Press, USA,2009
3. William F.Ganong, "Review of Medical Physiology", 26nd Edition, McGraw Hill, New Delhi, 2019
4. Eldra Pearl Solomon, "Introduction to Human Anatomy and Physiology", W.B. Saunders Company, Harcourt Brace Jovanovich, 2003
5. Guyton & Hall, "Medical Physiology", 14th Edition, Elsevier Saunders,2020

**22BM304 ANALOG AND DIGITAL ELECTRONICS****3 0 2 4****Course Objectives**

- To study various number systems and to simplify the mathematical expressions using Boolean functions
- To design combinational and sequential circuits
- To design analog circuits for various application using operational amplifier

**Course Outcomes (COs)**

1. Interpret number systems, encoding techniques and simplifications of logic expressions using K-maps and design the combinational logic circuits
2. Design Sequential logic circuits for given real time problems
3. Apply the basic op-amp circuits for basic operation on signals
4. Design filter circuits and waveform generators using Op-Amp
5. Design and analyze the timer circuit and signal converters using Op-amp

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1	2												
2	2	1	3										2		
3	2	2											1	1	
4	2	1	3										2		
5	2	2	3										1	1	

**UNIT I****10 Hours****NUMBER SYSTEM AND LOGIC GATES**

Introduction to Digital Systems, Number Systems- Binary, Octal, Decimal and Hexadecimal, Methods of base conversions, Representation of signed numbers, Binary Arithmetic- Addition, Subtraction, Complementary numbering systems; Binary Codes- BCD codes, Gray codes; Basic Theorems and properties of Boolean Algebra, logic gates - Basic and Universal gates, Simplification of logic expressions using Karnaugh Map method - Combinational logic circuit design; half adder- full adder, Multiplexers and Demultiplexers - Decoders and encoders

**UNIT II****8 Hours****SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS**

Gated Latches & Flip Flops- Level triggered and Edge triggered Flip-Flops, Flip Flop Conversion. Shift Registers; Design of synchronous sequential circuits - Moore and Mealy models - State Assignment State table; state diagram; state reduction; Design of Counters- Binary Counter, Ring counters.

**UNIT III****9 Hours****OPERATIONAL AMPLIFIERS**

The characteristics of Ideal Operational Amplifier- equivalent circuit of an Op-Amp - virtual ground concept - Linear applications of op-amp - inverting and non-inverting amplifier, summing amplifier - differentiator and integrator. Nonlinear applications - comparator - Schmitt Triggers - Half wave and full wave rectifiers - Average detectors - peak Detector

**UNIT IV** **9 Hours**

**ACTIVE FILTERS AND SIGNAL GENERATOR**

Active filters (first and second order) - Low pass, high pass, band pass filters, band reject filters. Oscillators - RC Phase shift and Wein-bridge. Waveform generators - Square, triangular and saw tooth

**UNIT V** **9 Hours**

**TIMER, PLL, A/D AND D/A CONVERTERS**

555 Timer (internal diagram) and its applications - monostable and astable multivibrator. Phase locked Loop (565 - block diagram approach) and its applications. DAC - Binary weighted DAC and R-2R DAC. ADC - single slope and dual slope ADCs, successive approximation ADC.

**1** **6 Hours**

**EXPERIMENT 1**

Design an automatic health monitoring system to indicate the condition of a patient in an ICU using the concept of (4:2) encoder and (2:4) decoder.

**2** **4 Hours**

**EXPERIMENT 2**

Design a combinational logic circuit for a patient monitoring device to transmit any four vital parameters through the input channels and view the required parameter using appropriate selection lines.

**3** **4 Hours**

**EXPERIMENT 3**

In a hospital, patients' data will be recorded and stored in their database. Design a sequential logic circuit, to transmit/receive different types of patient data through a single channel and also transmit the signal with predetermined delay period.

**4** **4 Hours**

**EXPERIMENT 4**

Design a bioamplifier circuit with specified gain value to increase the strength of the biosignals. (ECG/EMG)

**5** **4 Hours**

**EXPERIMENT 5**

Design a Biosignal (ECG/EMG/EEG) processing unit to identify its zero crossings, and convert it into a digital signal using schmitt trigger circuit, which can be used as a feature for classification problems.

**6** **4 Hours**

**EXPERIMENT 6**

Design a ECG/EMG signal enhancement unit with appropriate filters (ECG/EMG/EEG)

**7** **4 Hours**

**EXPERIMENT 7**

Generate a sinusoidal signal using RC phase shift oscillator circuit, which can be used as a reference for bio signal processing unit.

**Total: 75 Hours**

**Reference(s)**

1. M.Morris Mano,Digital Logic and Computer design, Prentice Hall,2010
2. Ramakant A.Gayakwad,Op-AMP and Linear Ics,Prince Hall,2015
3. Robert B.Northrop, Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation, CRC Press, second edition,2012
4. SergioFranco, Design with Operational Amplifiers and analog Integrated circuits, McGraw-Hills, Fourth edition, 2014
5. Millman J ,Halkias.C., Integrated Electronics, TMH, Second edition, 2017
6. John.F.Wakerly, Digital Design Principles and Practices, Fourth Edition, Pearson Education, 2008

**22BM305 SENSORS AND MEASUREMENTS****3 0 2 4****Course Objectives**

- To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues
- To understand the purpose of measurement, the methods of measurements, errors associated with measurements.
- To know the principle of transduction, classifications and the characteristics of different transducers and study its biomedical applications.
- To know the different display and recording devices.

**Course Outcomes (COs)**

1. Understand the basic concept of measurements
2. Apply the suitable displacement, pressure and temperature sensors for biomedical applications
3. Analyze the characteristics of photoelectric and piezoelectric sensors
4. Apply AC and DC bridge circuits for various signal conditioning applications.
5. Apply different display and recording devices for various applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	1													
2	2	2	2												
3	3	1	2												
4	2	1	2												
5	2	2	2												

**UNIT I****9 Hours****SCIENCE OF MEASUREMENT**

Measurement System - Instrumentation - Classification of Transducers - Static and Dynamic - Errors in Measurements - Calibration - Primary and Secondary standards.

**UNIT II****9 Hours****DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS**

Resistive Transducers: Strain Gauge: Gauge factor, sensing elements, configuration, biomedical applications; strain gauge as displacement & pressure transducers, RTD materials & range, Characteristics, thermistor characteristics, biomedical applications of Temperature sensors Capacitive transducer, Inductive transducer, LVDT, Active type: Thermocouple - characteristics

**UNIT III****9 Hours****PHOTOELECTRIC AND PIEZOELECTRIC SENSORS**

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



**UNIT IV** **9 Hours**

**BRIDGES**

AC and DC Bridges - Wheat stone bridge, Kelvin, Maxwell, Hay, Schering - Concepts of filters, Pre-amplifier, impedance matching circuits- isolation amplifier, spectrum analyzer.

**UNIT V** **9 Hours**

**DISPLAY AND RECORDING DEVICES**

Digital voltmeter - Multimeter - CRO - Block diagram, CRT - Vertical & Horizontal deflection system, DSO, LCD monitor, PMMC writing systems, Servo recorders, photographic recorder, magnetic tape recorder, inkjet recorder, thermal recorder. Demonstration of the display and recording devices.

**1** **3 Hours**

**EXPERIMENT 1**

Design an electronic controller using LVDT transducers for the pressure measurement of a liquid flow in drug delivery systems

**2** **3 Hours**

**EXPERIMENT 2**

Design of signal conditioning circuit to detect the body temperature using thermistor.

**3** **4 Hours**

**EXPERIMENT 3**

Measurement of magnetic field using Hall Effect transducer for monitoring and controlling the magnetic field strength of MRI scan

**4** **4 Hours**

**EXPERIMENT 4**

Design a circuit to measure the liquid level of the water storage tank using a capacitive transducer

**5** **4 Hours**

**EXPERIMENT 5**

Measurement of SpO<sub>2</sub> in the blood using the optical transducers.

**6** **4 Hours**

**EXPERIMENT 6**

Design an electronic controller to control the position of gantry of the CT scanner using digital shaft encoder

**7** **4 Hours**

**EXPERIMENT 7**

Measurement of vibration in the ultrasonic blood flowmeter using piezoelectric transducers.

**8** **4 Hours**

**EXPERIMENT 8**

Measurement of the muscle contraction and force applied during exercises to track a patient's progress using strain gauge and load cell.

**Total: 75 Hours**

**Reference(s)**

1. Doebelin E.O. and Manik D.N., "Measurement Systems", Tata McGraw-Hill Education Pvt.Ltd., 6th Edition, 2011.
2. L.A Geddes and L.E.Baker , "Principles of Applied Biomedical Instrumentation", - John Wiley and sons, 3rd Edition, Reprint 2008.
3. Albert D.Helfrick and William D.Cooper, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 2007.
4. A.K.Sawhney, "Electrical and Electronics Measurement and Instrumentation", DhanpatRai & Co, New Delhi, 17th Edition, 2004.
5. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 3rd Edition, 2014.
6. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurement", Prentice Hall India Pvt. Ltd, New Delhi, 2nd Edition, Reprint, 2013.

**22HS004 HUMAN VALUES AND ETHICS**

**2 0 0 2**

**Course Objectives**

- Understand the concept of good values and comprehend the importance of value-based living.
- Recognize the culture of peace through education.
- Identify and apply the practices for value development and clarification.

**Course Outcomes (COs)**

1. Understand the importance of human values and ethics in life.
2. Execute the importance of harmonious living in a diverse society.
3. Analyze the sensitivity to the crying needs of society such as ungodliness, corruption, poverty, and suffering, and play a vital role in eradicating them.
4. Plan intellectually mature, morally upright, ethically correct, and spiritually inspired decisions.
5. Execute a correct balance between professional excellence and social commitment.

**UNIT I**

**6 Hours**

**COURSE INTRODUCTION - NEED, BASIC GUIDELINES AND ANALYSIS**

Importance of Human Values & Ethics in 21st Century - Understanding the theory of basic human values and ethics  
Openness to change -Self enhancement -Conservation -Self transcendence - Schwartz Value Survey: Self-Assessment

**UNIT II**

**6 Hours**

**EMBRACING THE COMMON ETIQUETTE**

Altruism- Integrity-Freedom-Justice-Honesty-Truthfulness-Responsibility-Compassion

**UNIT III**

**6 Hours**

**CONTINUOUS HAPPINESS AND PROSPERITY**

An overview on basic Human Aspirations- Understanding and living in harmony at various levels of life-Embracing self-love and wellness-Understanding harmony in the family and society

**UNIT IV**

**6 Hours**

**UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS**

Reflection on growing global multifold problems: poverty, pollution, hunger, disease, unemployment, caste system, child labour, gender equality, politics and violence.  
Understanding the challenges in cultural, personal, social, political, and economic environment

**UNIT V**

**6 Hours**

**UNDERSTANDING HARMONY IN THE NATURE AND EXISTENCE - WHOLE EXISTENCE AS CO-EXISTENCE**

Understanding the harmony in the Nature- Holistic perception of harmony at all levels of existence-Practice Exercises and Case Studies will be taken up in Practice Sessions

**Total: 30 Hours**

**Reference(s)**

1. Martin, G. The Little Book of Ethics: A Human Values Approach. Australia: G.P. Martin. 2011.
2. Gupta, N. L. Human Values For The 21St Century. India: Anmol Publications Pvt. Limited. 2002.
3. Mishra, A. Happiness Is All We Want. India: Bloomsbury Publishing.2017.
4. Universal Human Values. (n.p.): Booksclinic Publishing. 2023.
5. A Textbook on Professional Ethics And Human Values. India: New Age International (P) Limited.2007.

**22HS005 SOFT SKILLS AND EFFECTIVE COMMUNICATION**

**0 0 2 1**

**Course Objectives**

- Communicate proficiently in formal discussions at the workplace.
- Describe experiences and events, and briefly give reasons and explanations for opinions and plans.
- Interact with a degree of fluency and spontaneity that results in efficacious communication
- Convey agreement and disagreement in a polite but firm manner
- Communicate with coherence and imagination in both written and spoken formats

**Course Outcomes (COs)**

1. Enhance confidence in expressing thoughts in grammatically proper language and etiquette in waiting for the opportunity to provide input.
2. Effectively communicate in English on formal occasions and proficiency in the use of link words and other discourse markers
3. Provide constructive feedback and file logical complaints.
4. Analyse the understanding of oral and written communication in real-world situations.
5. Apply the improved spelling and punctuation in writing and heightened understanding of tone, pitch and stress in oral formats.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									2	3				
2									2	3				
3									2	3				
4									2	3				
5									2	3				

**1**

**6 Hours**

**SELF-EXPRESSION**

Group discussion/ Peer discussion - Communicating decisions and opinions - Tone, Pitch, Stress - Agreeing, Disagreeing, Suggesting, Speculating - Comparing and Contrasting - Comparatives and Superlatives

Discourse markers - Interjections

Decision making - Synthesis - Higher order thinking

**2**

**6 Hours**

**LESSON PLAN 2**

Group discussion/Peer discussion - Effective Communication

Types of communication - Written vs Spoken

Contractions

Intonation

Stress

Active voice

Question tags

Confidence and body language  
Guided writing- Outlining Main Points

**3**

**6 Hours**

**LESSON PLAN 3**

Group discussion/Peer discussion - Avoiding common errors  
Reduction of MTI  
Common errors  
Barriers to communication  
Accent

**4**

**6 Hours**

**CREATIVE EXPRESSION**

JAM, Debate, Review writing, Social media posts  
Synonyms  
Antonyms  
Cloze test  
Phrasal verbs  
Spotting errors  
Collocation  
Commonly mispronounced

**5**

**6 Hours**

**FORMAL EXPRESSION**

Lesson Plan 5: Critical composition  
Writing: Giving written feedback, Review writing, and Letter of complaint.  
Speaking: Giving constructive feedback and offering suggestions, asking for inputs, commenting politely on appropriate phrases  
Giving written feedback, Review writing, and Letter of complaint.  
Critical reasoning  
Modal verbs  
Polite ways to express negatives

**Total: 30 Hours**

**Reference(s)**

1. Word Power Made Easy by Norman Lewis, W. R. Goyal Pub. & Distributors, 2009.
2. Sasikumar, V, et al., A Course in Listening & Speaking Foundation Books, 2005.
3. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
4. Prasad, Hari Mohan. A Handbook of Spotting Errors, McGraw Hill Education, 2010.
5. Personality Development & Soft Skills, BarunK.Mitra, Oxford University Press, 2012
6. Business English by Ken Taylor, Orient Blackswan, 2011

**22BM401 PROBABILITY, STATISTICS AND  
RANDOM PROCESS**

**3 1 0 4**

**Course Objectives**

- Understand the basic concepts of probability and the distributions with characteristics and also random variables
- Summarize and apply the design of experimental methodologies of probability for the data analysis using statistical notions
- The random process represents the mathematical model of the random signals

**Course Outcomes (COs)**

1. Demonstrate and apply the basic probability axioms and concepts in their core areas of random phenomena.
2. Apply the concepts of probability distributions in an appropriate place of science and Engineering.
3. Apply the basic statistical inference techniques, including confidence intervals, hypothesis testing to science/engineering problems.
4. Design an experiment for an appropriate situation using ANOVA technique.
5. Apply Random Process techniques to the problem of random input signals.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2													
2	2	2													
3	2	2													
4	2	2													
5	2	2													

**UNIT I**

**9 Hours**

**PROBABILITY AND RANDOM VARIABLES**

Axioms of probability - Conditional probability - Total probability - Bayes theorem - Random variables - Probability mass function - Probability density functions - Properties.

**UNIT II**

**9 Hours**

**STANDARD DISTRIBUTIONS**

Binomial distribution - Poisson distribution - Negative binomial distribution - Exponential distribution - Gamma distribution - Normal distribution and their properties.

**UNIT III**

**9 Hours**

**TESTING OF HYPOTHESIS**

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample test based on Normal distribution for single mean and difference of means - Small sample tests: t-test for mean-F- test - Chi-square test for Goodness of fit and Independence of attributes.

**UNIT IV**

**9 Hours**

**DESIGN OF EXPERIMENTS AND CONTROL CHART**

One way and two way classifications - Completely Randomized Design - Randomized Block Design - Latin Square Design. Control charts for measurements (X and R charts) - Control charts for attributes (p, c and np charts).

**UNIT V**

**9 Hours**

**RANDOM PROCESSES**

Definition and examples - first order, second order, strictly stationary, wide sense stationary and Ergodic processes - Markov process - Poisson and Normal processes.

**Total: 60 Hours**

**Reference(s)**

1. Peyton Z Peebles, Probability, Random Variables and Random Signal Principles, Tata McGraw Hill Publications, New Delhi, 4th Edition, 2010.
2. Richard A Johnson and John Freund, Miller and Friends Probability Statistics for Engineers, 8th Edition, Pearson Education, 2015.
3. Henry Stark and John W. Woods, Probability and Random Processes with Applications to Signal Processing, Pearson Education, Delhi, 3rd Edition, 2002.
4. Athanasios Papoulis, S. UnniKrishna Pillai, Probability , Random Variables and Stochastic Processes, Tata McGraw Hill Publications, New Delhi, 4th Edition , 2010.



**22BM402 BIOSCIENCES IN MEDICAL  
ENGINEERING**

**3 0 2 4**

**Course Objectives**

- To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids
- To emphasize structural and functional aspects of living organisms
- To discuss the concepts of microbial culture and immunopathology

**Course Outcomes (COs)**

1. Understand the fundamental concepts of biochemistry correlated to biomedical engineering
2. Outline the concept of cell degeneration, cell repair and Neoplasia.
3. Analyze the effect of derangement in haematology
4. Analyze the growth of bacterial cultures
5. Analyze the pathological conditions related to immunity

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3			1	2			1				1	2		
2	2	2		1								1	2		
3	3	2		3	2			1				1	2		
4	2	2		2								1	2		
5	2	2		3	2		1	1				1	2		

**UNIT I**

**9 Hours**

**INTRODUCTION TO BIOCHEMISTRY**

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson-Hasselbalch equation, physiological buffers, fitness of the aqueous environment for living organism. Principle of viscosity, surface tension, adsorption, diffusion, osmosis and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes

**UNIT II**

**9 Hours**

**CELL DEGENERATION, REPAIR AND NEOPLASIA**

Cell injury - Reversible cell injury and irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological Calcification-Dystrophic and Metastatic. cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and malignant tumors, carcinogenesis, spread of tumours, autopsy and biopsy

**UNIT III**

**9 Hours**

**FLUID AND HEMODYNAMIC DERANGEMENTS**

Edema, Hyperemia/Ischemia, normal haemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, chronic venous congestion. Haematological disorders- Bleeding disorders, Leukaemia, Lymphomas Haemorrhage.

**UNIT IV**

**9 Hours**

**MICROBIAL CULTURES**

Morphological features and structural organization of bacteria, growth curve, identification of bacteria, culture media and its types, culture techniques and observation of culture.

<b>UNIT V</b>	<b>9 Hours</b>
<b>IMMUNOPATHOLOGY</b>	
Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonisation, phagocytosis, inflammation, Secondary immunodeficiency including HIV infection. Auto- immune disorders: Basic concepts and classification, SLE. Antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immune-electrophoresis, RIA and ELISA, monoclonal antibodies.	
	<b>Total: 45 Hours</b>
<b>1</b>	<b>3 Hours</b>
<b>EXPERIMENT 1</b>	
General tests for carbohydrates, proteins, and lipids.	
<b>2</b>	<b>2 Hours</b>
<b>EXPERIMENT 2</b>	
Preparation of serum and plasma from blood.	
<b>3</b>	<b>2 Hours</b>
<b>EXPERIMENT 3</b>	
Study of ELISA reader	
<b>4</b>	<b>2 Hours</b>
<b>EXPERIMENT 4</b>	
Estimation of Blood Glucose	
<b>5</b>	<b>4 Hours</b>
<b>EXPERIMENT 5</b>	
(a) Estimation of Creatinine	
(b) Estimation of Urea and Cholesterol.	
<b>6</b>	<b>1 Hours</b>
<b>EXPERIMENT 6</b>	
Separation of proteins by SDS electrophoresis	
<b>7</b>	<b>1 Hours</b>
<b>EXPERIMENT 7</b>	
Separation of amino acids by thin layer chromatography	
	<b>Total: 60 Hours</b>

**Reference(s)**

1. Rafi MD, "Textbook of Biochemistry for Medical Student", Second Edition, University Press, 2014
2. Donald Voet, Judith, G.Voet and Charlotte W. Pratt, "Principles of Biochemistry", 4th Edition, John Wiley and Sons, New Delhi, 2012.
3. David.W.Martin, Peter.A.Mayes, Victor. W.Rodwell, Harper's Illustrated Biochemistry, LANGE Medical Publications, 2018
4. Keith Wilson, John Walker, Practical Biochemistry- Principles & Techniques, Oxford University Press, 2009
5. Harsh Mohan, Text book of Pathology, Jaypee Brothers Medical publishers private Limited, 8th Edition, 2019

**22BM403 SIGNAL PROCESSING**

**3 1 0 4**

**Course Objectives**

- To Analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
- To design IIR filters for given specifications by following the suitable design procedures
- To design FIR filters for given specifications by following the suitable design procedures
- To analyze the finite word length effect in the design of digital signal processing systems
- To understand the architectural overview and addressing modes in DSP processors

**Course Outcomes (COs)**

1. Analyze the frequency domain behaviour of a given Discrete Time signal using Discrete Fourier Transform
2. Design digital IIR filters and construct its realization structures
3. Design digital FIR filters and construct its realization structures
4. Analyze the effect of finite word length for fixed & floating point number representation.
5. Analyze multirate signal processing concepts for real time applications

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2													
2	1		3												
3	1		3												
4	2	3													
5		3		2											

**UNIT I**

**10 Hours**

**DISCRETE FOURIER TRANSFORM: PROPERTIES, APPLICATIONS AND COMPUTATION**

Discrete Time Fourier Transform- Spectrum limitations, The Discrete Fourier Transform- Properties of DFT- Periodicity, Linearity, Symmetry, Multiplication-Circular Convolution. Efficient Computation of DFT-FFT Algorithm-Implementation of Radix 2 FFT algorithm (DIT and DIF)

**UNIT II**

**9 Hours**

**DESIGN OF IIR FILTERS**

Introduction to Digital filters - General consideration in the design of digital filters. Design of analogue Butterworth and Chebyshev Filters. Design of IIR digital filters using impulse invariant technique, bilinear transformation technique. Realization of IIR filters using direct, cascade and parallel forms.

**UNIT III**

**9 Hours**

**DESIGN OF FIR FILTERS**

Linear phase FIR filters – Design of FIR filters using Fourier series method, Frequency sampling techniques, Windowing techniques- Hamming, Hanning windows. Realization of FIR filters- Direct, Linear phase realization structures.

**9 Hours**

**UNIT IV**

**FINITE WORD LENGTH EFFECT IN DIGITAL FILTERS**

Number Representation-Fixed and Floating Point Quantization Noise-Finite Word Length Effects in Digital filters- Input Quantization, Product Quantization, Coefficient quantization error, Limit cycle oscillations.

**UNIT V**

**8 Hours**

**MULTIRATE SIGNAL PROCESSING**

Introduction to multirate signal processing – Interpolation by the factor I, Decimation by the factor D, Sampling rate conversion by the factor I/D, Application of multirate signal processing concepts in real time.

**Total: 45 Hours**

**Reference(s)**

1. Digital Signal Processing by John G. Proakis and Dimitris K. Manolakis, 4th edition, Pearson Education India, 2013
2. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schaffer, 3rd edition, 2010, Prentice Hall
3. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York.
4. Understanding Digital Signal Processing, Lyons, Richard G., 3/e, Pearson Education India, 2004
5. Digital Signal Processing: A Practical Approach, Barrie W. Jervis and Emmanuel C. Ifeachor 2/e, Pearson Education India, 2009.

**22BM404 COMMUNICATION SYSTEMS****3 0 0 3****Course Objectives**

- To understand the fundamental concepts of communication systems.
- To analyze different analog, digital modulation schemes and coding techniques
- To familiarize the basic concept of Optical Fiber in biomedical field.

**Course Outcomes (COs)**

1. Understand the concept of amplitude modulation techniques and in time and frequency domain
2. Apply angle and phase modulation technique to design FM transmitter and receiver
3. Analyze different types of digital modulation techniques in digital communication system
4. Apply various coding techniques to convert real time data into data suitable for transmission
5. Analyze fiber optic systems used in the domain of biomedical applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2						1							
2	2	1	3					1							
3	2	3						1							
4	1		3	2											
5	2	3		2				1						2	

**UNIT I****9 Hours****AMPLITUDE MODULATION**

Elements of communication systems - Modulation - Types - Need for modulation, Amplitude modulation - carrier waves- AM in time domain and frequency domain, Evolution and Description of SSB, DSBSC Techniques, AM Demodulator.

**UNIT II****9 Hours****ANGLE MODULATION**

Angle modulation - Phase modulation - Angle modulation spectrum - FM and Noise - FM stereo - FM measurements - FM Transmitters- FM Receivers - Receiver topologies - FM Demodulators

**UNIT III****9 Hours****DIGITAL MODULATION**

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 Modulation schemes (ASK-FSK-PSK-QAM).

**UNIT IV****9 Hours****INFORMATION CODING TECHNIQUES**

Entropy, Source encoding theorem, Shannon Fano coding, Huffman coding, mutual information, channel capacity, Error Control Coding, Linear Block Codes, cyclic codes.

**UNIT V**

**9 Hours**

**FIBER OPTIC SYSTEMS**

Basic Fiber Optic Systems - repeaters and optical amplifiers - wavelength division multiplexing - Fiber in local area networks - Biomedical Optical Fiber Sensors - Application of optical fiber in biomedical diagnosis.

**Total: 45 Hours**

**Reference(s)**

1. Simon Haykins, Communication Systems, Wiley, 5th Edition, 2009.
2. B.P.Lathi, Modern Digital and Analog Communication Systems, 4th Edition, Oxford University Press, 2011
3. Wayner Tomasi, Electronic Communication System, Pearson Education, 2012.
4. Miller, Modern Electronic Communication, Prentice Hall of India, New Delhi, 2010.
5. William Schweber, Electronic Communication System, Prentice Hall of India Ltd, India, New York, 2010.

**22BM405 EMBEDDED SYSTEMS****3 0 2 4****Course Objectives**

- To understand the overview of Embedded System Architecture.
- To apply the Embedded C programming concepts in Microcontroller
- To analyse embedded communication protocols

**Course Outcomes (COs)**

1. Understand the 8086 architecture and write ALP for 8086 processor.
2. Understand hardware and software architectures of Embedded Systems
3. Analyse the special features and architecture of TIVA C series microcontroller.
4. Analyse and program different communication protocols used for Embedded Networking.
5. Design embedded applications by interfacing the OFF-chip peripherals with the microcontroller.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2										1		
2	1	2	3										2		
3	2	3	2										3	2	
4	3	2	2											1	
5	1	3	2											2	

**UNIT I****9 Hours****8086 MICROPROCESSOR**

8086 Architecture-8086 Instruction set-8086 Addressing modes- 8086 ALP-Interrupts

**UNIT II****9 Hours****INTRODUCTION TO EMBEDDED SYSTEM**

Categories of embedded systems, Specialties of embedded systems, Recent trends in embedded systems, Hardware architecture, Software architecture, Communication software, Process of generation of executable image, Development/testing tools.

**UNIT III****9 Hours****TIVA-C MICROCONTROLLER**

TIVA-C Microcontroller Architecture and Its memory map, GPIO Programming, WDT Programming, Interrupt Programming, LPM Programming

**UNIT IV****9 Hours****COMMUNICATION PROTOCOLS**

UART, ADC, PWM, Timer, I2C, SPI

**UNIT V****9 Hours****OFF-CHIP PERIPHERAL INTERFACING AND PROGRAMMING**

RTC Interfacing, Bluetooth module interfacing, Analog Sensor interfacing, Motor Interfacing.

<b>1</b> <b>EXPERIMENT 1</b> 16-bit, 32-bit Arithmetic Operations (8086)	<b>4 Hours</b>
<b>2</b> <b>EXPERIMENT 2</b> String Operations (8086)	<b>4 Hours</b>
<b>3</b> <b>EXPERIMENT 3</b> Sorting operation (8086)	<b>5 Hours</b>
<b>4</b> <b>EXPERIMENT 4</b> Flashing of LEDS using Shift Register	<b>5 Hours</b>
<b>5</b> <b>EXPERIMENT 5</b> Interfacing DC and Stepper Motor	<b>6 Hours</b>
<b>6</b> <b>EXPERIMENT 6</b> Interfacing temperature sensor	<b>6 Hours</b>

**Total: 75 Hours**

**Reference(s)**

1. Ray K & Bhurchandi K.M, "Advanced Microprocessors and Peripherals: Architecture, Programming and Interface", 3rd Edition, McGraw Hill, New Delhi, 2012.
2. Prasad K V K K Embedded Real Time Systems Concepts, Design and Programming Dreamtech press 2013
3. Muhammad Ali Mazidi, Sarmad Naimi and Sepehr Naimi TI ARM Peripherals Programming and Interfacing Using C Language Pearson Education 2014
4. Jonathan W. Valvano Embedded Systems Introduction to Arm Cortex M Microcontrollers 5th edition ISBN 978-1477508992 2014
5. Embedded System Design Using TIVA, TI University Program, Learning Material.



**22HS007 ENVIRONMENTAL SCIENCE**

**2 0 0 -**

**Course Objectives**

- Understand the interdisciplinary and holistic nature of the environment
- Identify the significance of natural resources and environment on the quality of life and stimulate the quest for sustainable development
- Assess the socio-economic, political and ethical issues in environmental science

**Course Outcomes (COs)**

1. Examine the importance of interdisciplinary nature of environment studies, uses and exploitation of natural resources
2. Analyze the different types of ecosystems and biodiversity, its values and also role of professionals in protecting the environment from degradation
3. Impact the existing environmental challenges related to pollution and its management
4. Select suitable strategies for sustainable management of components of environmental science
5. Correlate the impacts of population and human activities on environment

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	1	2										
2	1	1										
3	2	2					1					
4	1											
5	2											

**UNIT I**

**6 Hours**

**NATURAL RESOURCES**

Forest resources: Use - over exploitation - deforestation - case studies. Water resources: Use - over utilization of surface and ground water - conflicts over water. Mineral resources: Use - exploitation - environmental effects of extracting and using mineral resources - case studies. Food resources: Effects of modern agriculture - fertilizer-pesticide problems (eutrophication, blue baby syndrome, bio magnification). Energy resources: renewable (solar, wind, and hydro).

**UNIT II**

**6 Hours**

**ECOSYSTEMS AND BIODIVERSITY**

Concept of an ecosystem: Structure and function of an ecosystem - producers - consumers - decomposers - food chains - food webs and ecological pyramids - Types of ecosystem: Introduction - characteristic features: desert ecosystem. Biodiversity - value of biodiversity - threats to biodiversity - endangered and endemic species - Conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

**UNIT III**

**6 Hours**

**ENVIRONMENTAL POLLUTION**

Pollution: Definition - causes - effects - control measures of air pollution - water pollution: (Sewage water treatment by activated sludge and trickling filter process) - noise pollution- thermal pollution. Disaster management: causes - effects - control measures of floods - earthquake

**UNIT IV**

**7 Hours**

**SOCIAL ISSUES AND ENVIRONMENT**

Sustainable development: Definition - Unsustainable to sustainable development - solid waste management - causes - effects - 5R Principles (landfills, incineration, composting). Water conservation - rain water harvesting - watershed management. Climate change - global warming - acid rain - ozone layer depletion. E-waste

**UNIT V**

**5 Hours**

**HUMAN POPULATION AND ENVIRONMENT**

Human population: Population growth - characteristics - variation among nations - population explosion - value education - HIV / AIDS. Role of information technology in environment and human health - occupational safety and health administration (OSHA)

**Total: 30 Hours**

**Reference(s)**

1. Anubha Kaushik, C.P. Kaushik, Environmental Science and Engineering , 4th Multi Colour Edition, New Age International Publishers, New Delhi, 2014
2. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons
3. T. G. Jr. Miller, S. Spoolman, New Environmental Science, 14th Edition, Wadsworth Publishing Co, New Delhi, 2014
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press
5. A. K. De, Environmental Chemistry, 7th Edition , New age international publishers, New Delhi, 2014

**22HS008 ADVANCED ENGLISH AND TECHNICAL  
EXPRESSION**

**0 0 2 1**

**Course Objectives**

- To enable students to achieve proficiency in academic writing
- effectively use the language to persuade others
- appreciate the nuances of the language and engage an audience
- use advanced tools of language to improve communicative competence
- prepare for professional demands at the workplace
- give concrete expression to the plans and goals

**Course Outcomes (COs)**

1. Understand the clarity in articulating the objectives and aims and improved proficiency in using the English language
2. Communicate effectively and with good interpersonal skills; speak in public, engage the audience, and lead a group discussion
3. Critically evaluate the ethics of persuasive appeals and confidence to influence opinion
4. Analyse a specific piece of information; take in what is read, and use good writing techniques with proper grammar and syntax in all formal situations
5. Create awareness and empathy to emotional signals in communication

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1									2	3					
2									2	3					
3									2	3					
4									2	3					
5									2	3					

**1**

**5 Hours**

**UNIT 1**

Creative Expression  
Lesson Plan 1 Persuasive Discourse  
Proposals

**2**

**5 Hours**

**LESSON PLAN 2**

Humor and satirical expression  
Creating Business Memes  
Comic Strips  
Stand-up comedy  
Caption writing  
Limericks

**3** **5 Hours**

**UNIT 2**

Formal Expression  
Lesson Plan 3 Organizing Subject matter  
Writing Action plans, Mind-Mapping, Paragraph writing  
Logical reasoning  
Conditional Clause  
Opening and closing sentences

**4** **5 Hours**

**LESSON PLAN 4**

Talking about plans

Action plans, Anecdotal references, order of communication/ narration, complete communication-Wh-questions  
Effective beginning and closing  
Rhetorical questions  
Appraising target audience

**5** **5 Hours**

**LESSON PLAN 5**

Research Writing  
Writing:SOPs,Research Objectives, Thesis Statement, Indexing,Academic Writing,Executive Summary,Survey Questionnaires,List of References

**6** **5 Hours**

**READING**

Quantitative  
Analysis and paraphrasing of reference materials

**Total: 30 Hours**

**Reference(s)**

1. Sangeeta Sharma et.al. Communication Skills for Engineers and Scientists, PHI Learning Pvt. Ltd, 2011
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001
4. Personality Development, Harold R. Wallace &L. Ann Masters, Cengage Learning, New Delhi
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi
6. English Grammar, Composition and Usage by N.K.Agrawal&F.T.Wood, Macmillan India Ltd., New Delhi

**22BM501 BIOMEDICAL INSTRUMENTATION****3 0 2 4****Course Objectives**

- To illustrate origin of bio potentials and its propagations to understand the different types of electrodes and its placement for various recordings.
- To design bio amplifier for various physiological recordings and analyze different measurement techniques for non-physiological parameters
- To Summarize different biochemical measurements

**Course Outcomes (COs)**

1. Categorize different bio potential electrodes based on its origin, propagations and characteristics.
2. Apply different bio-potential measurements techniques and analyze the characteristics of bio signals
3. Apply various Biosignal conditioning techniques as a pre-processing method in Biosignal processing.
4. Apply various technique for non-electrical physiological measurements
5. Analyze the performance of biochemical sensors and biochemical measurement techniques

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		1	1								1		
2	2	3		2	1								1		
3	2	2		3	1								1		2
4	2	2		2	1								1		2
5	2	3		2	1								1		2

**UNIT I****9 Hours****BIOPOTENTIAL ELECTRODES**

Origin of biopotential and its propagation, Electrode-electrolyte interface, electrode-skin interface, half-cell potential, Contact impedance, polarization effects of electrode-non polarizable electrodes. Types of electrodes surface, needle, and microelectrodes and their equivalent circuits. Recording problems-motion artifacts, measurement with two electrodes.

**UNIT II****9 Hours****BIOPOTENTIAL MEASUREMENTS**

Bio signals characteristics-frequency and amplitude ranges. ECG-Einthoven's triangle, standard 12 lead system, Principles of vector cardiography. EEG-10-20 electrode system, unipolar, bipolar and average mode. EMG-unipolar and bipolar mode. Recording of ERG, EOG and ECG.

**UNIT III****9 Hours****BIOSIGNAL CONDITIONING**

Need for bio-amplifier-single ended bio-amplifier, differential bio-amplifier, impedance matching circuit, isolation amplifiers- transformer and optical isolation- isolated DC amplifier and AC carrier amplifier, power line interference, Right leg driven ECG amplifier, Band pass filtering, artefacts and removal.

**UNIT IV**

**9 Hours**

**MEASUREMENT OF NON- ELECTRICAL PARAMETERS**

Temperature, respiratory rate and pulse rate measurements. Blood Pressure: indirect methods- Auscultatory method, oscillometric method, direct methods: electric manometer, pressure amplifiers, systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

**UNIT V**

**9 Hours**

**BIOCHEMICAL MEASUREMENT AND BIOSENSORS**

Biochemical sensors- pH, pO<sub>2</sub> and pCO<sub>2</sub>, Ion selective Field Effect Transistor (ISFET), Immunologically sensitive FET(IMFET), Blood glucose sensors, Blood gas analyzers- colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description)-Biosensors-Principles-amperometric and voltometric techniques, Electrophoretic techniques.

**Total: 45 Hours**

**Reference(s)**

1. Leslie Cromwell, Biomedical Instrumentation and measurement, 2nd edition, Prentice Hall of India, New Delhi,2015
2. John G. Webster, Medical Instrumentation Application and Design, 5th edition, Wiley India Pvt Ltd, New Delhi,2020
3. Khandpur R.S, Handbook of Biomedical Instrumentation, 3rd edition, Tata McGraw-Hill New Delhi,2014.
4. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education, 2004.
5. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill Publisher, 2003.

**22BM502 MEDICAL IMAGE PROCESSING****3 0 2 4****Course Objectives**

- To understand the fundamentals and of biomedical image processing.
- To understand image processing principles of CT, MRI, diagnostic and therapeutic devices.
- To develop the algorithms for image analysis and diagnosis in medical imaging.

**Course Outcomes (COs)**

1. Understand the fundamental concepts of images and its acquisition techniques.
2. Apply suitable image enhancement techniques to reduce the noise and interference level.
3. Apply various image segmentation techniques for feature extraction and classification applications.
4. Apply image compression techniques to reduce the size of the image
5. Analyze the features of medical images for disease diagnosis.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2		2	1							2	2		
2	1	2	3	2	1							2		1	2
3	1	3	2	3	1							1		1	2
4	1	1	3	2	1							1		1	2
5	1	2	2	3	1							1		1	2

**UNIT I****9 Hours****INTRODUCTION**

Objectives of biomedical image analysis - Computer aided diagnosis - Nature of medical images: X-ray imaging - Tomography - Nuclear medicine imaging - SPECT imaging - Positron imaging tomography - Ultrasonography - Magnetic resonance imaging. Removal of artefacts - Space domain filters - Frequency domain filters - Optimal filtering - Adaptive filters

**UNIT II****9 Hours****IMAGE ENHANCEMENT**

Image enhancement - Gray level transforms - Histogram transformation - Convolution mask operators - Contrast enhancement. Detection of regions of interest - Thresholding and binarization - Detection of isolated lines and points - Edge detection - Region growing.

**UNIT III****9 Hours****IMAGE SEGMENTATION**

Detection of discontinuous, Point-line- edge detection, Linear and Circular Hough Transform, Basic Global and Adaptive Thresholding, Region-based segmentation, and K-Means Clustering.

**UNIT IV****9 Hours****IMAGE COMPRESSION**

Fundamentals of Image compression models, Lossless compression: variable length coding, LZW coding, Arithmetic coding, Lossy compression: Wavelet and DCT coding, Predictive coding.

<b>UNIT V</b>	<b>9 Hours</b>
<b>IMAGE ANALYSIS</b>	
Analysis of shape and texture - Representation of shapes and contours - Shape factors - Models for generation of texture - statistical analysis of texture - Fractal analysis - Fourier domain analysis of texture - Segmentation and structure analysis of texture. Pattern classification and diagnostic decision - Measures of diagnostic accuracy - Applications: Contrast enhancement of mammograms - Detection of calcification by region growing- Shape and texture analysis of tumours.	
<b>1</b>	<b>3 Hours</b>
<b>EXPERIMENT 1</b>	
Design mean and median filters and use them to filter different medical images.	
<b>2</b>	<b>3 Hours</b>
<b>EXPERIMENT 2</b>	
Apply Thresholding algorithm on different medical and non- medical images.	
<b>3</b>	<b>3 Hours</b>
<b>EXPERIMENT 3</b>	
Apply edge detection on different medical images, and learn the applications of edge detection.	
<b>4</b>	<b>3 Hours</b>
<b>EXPERIMENT 4</b>	
Apply neighbourhood operations in segmentation tasks for the images that have the same intensity in different regions with different texture properties.	
<b>5</b>	<b>3 Hours</b>
<b>EXPERIMENT 5</b>	
Design different non- linear operators to process the similarity and consistency in images	
<b>6</b>	<b>3 Hours</b>
<b>EXPERIMENT 6</b>	
Apply Morphological operation on different medical and non-medical images.	
<b>7</b>	<b>4 Hours</b>
<b>EXPERIMENT 7</b>	
Apply pseudo-color generation	
<b>8</b>	<b>4 Hours</b>
<b>EXPERIMENT 8</b>	
Recognize the parallel beam projection geometry and the fan beam projection geometry.	
<b>9</b>	<b>4 Hours</b>
<b>EXPERIMENT 9</b>	
Apply several schemes for eliminating or reducing blur afflicting the image of interest.	
	<b>Total: 75 Hours</b>



**Reference(s)**

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, Pearson, Education, Inc., 4th Edition, 2018
2. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson Education, Inc., 1st Edition, 2015.
3. Milan Sonka, Vaclav Hlavac and Roger Boyle, Image Processing, Analysis and Machine vision, Cengage, 4th Edition, 2017.
4. Alan C. Bovik, Handbook of image and video processing, Elsevier Academic press, 2005.
5. S.Sridhar, Digital Image processing, Oxford University press, 2ndEdition, 2016.

**22BM503 HEALTHCARE ANALYTICS****3 0 0 3****Course Objectives**

- To understand the fundamentals of data mining techniques in healthcare.
- To understand the healthcare data analytics approaches used.
- To analyze the effective information retrieval from healthcare data using data analytics approaches.

**Course Outcomes (COs)**

1. Understand the fundamental concepts of healthcare data analytics
2. Analyze the effectiveness of data mining in clinical and non-clinical applications
3. Categorize the approaches to retrieve data from social media.
4. Analyze the process of advanced healthcare data analytics
5. Analyze the information present based on visual characteristics of an expert system.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2		2				1				1	1		
2		3		2		1		1				2		2	
3		2	2	3		1		1							
4		3		2											
5		3		2											

**UNIT I****9 Hours****INTRODUCTION TO HEALTHCARE DATA ANALYTICS**

Introduction, Healthcare data sources and basic analytics, Advanced data analytics for healthcare, Applications and practical systems for healthcare, resources for healthcare data analytics- Healthcare data sources and Basic analytics: Electronic Health Records (EHR), Components of EHR, Coding systems, Benefits of EHR, Barriers to Adopting EHR, Challenges using EHR data.

**UNIT II****9 Hours****MINING OF SENSOR DATA AND DATA MINING**

Introduction, Scopes and Challenges in mining sensor data, Challenges in Healthcare data analytics, sensor data mining applications, Nonclinical Health care applications, Introduction to data mining, Natural language processing, Mining information from clinical text and current methodologies, Informatics for integrating Biology, Challenges of processing clinical reports, Clinical applications.

**UNIT III****9 Hours****SOCIAL MEDIA ANALYTICS**

Introduction, Social media analysis for detection and tracking of infectious disease outbreaks: Outbreak detection, Analyzing and tracking outbreaks, syndromic surveillance systems based on social media, Social medical analysis for public health reserach: Topic models for analyzing health-related contents, detecting reports of adverse medical events and drug reactions, characterising life style and well-being, analysis of social media use in healthcare.

**UNIT IV**

**9 Hours**

**ADVANCED DATA ANALYTICS FOR HEALTHCARE**

Introduction- Basic statistical prediction models: Linear regression, generalized additive model, Logistic regression: Multi class, polytomous and ordered Logistic regression, Bayesian models, Markov Random Fields, Alternative clinical prediction models: Decision trees, ANN, cost sensitive learning, Advanced prediction models, survival models, Evaluation and validation.

**UNIT V**

**9 Hours**

**VISUAL ANALYTICS AND INFORMATION RETRIEVAL FOR HEALTHCARE**

Introduction, Medical data visualization, Visual analytics in Healthcare, Introduction to information retrieval, Knowledge based information in healthcare and biomedicine, content of knowledge- based information resources, indexing, retrieval: Exact match and partial match retrieval, Evaluation: system-oriented evaluation, user oriented evaluation, Introduction to clinical decision support system

**Total: 45 Hours**

**Reference(s)**

1. Chandan K Reddy and Charu C. Aggarwal, Healthcare Data Analytics, CRC Press, 2015
2. Vikas Kumar, Healthcare Analytics Made simple, Pack Publishing, 2018
3. Raymond A Gensinger, Analytics in Healthcare : An Introduction, HIMSS, 2014
4. Tinglong Dai, Sridhar Tayur, Handbook of Healthcare Analytics, Wiley, 2018
5. Hui Yang, Eva K, Lee, Healthcare Analytics: From Data to Knowledge to Healthcare Improvement, Wiley, 2016.

**22BM504 BIO CONTROL SYSTEMS****3 1 0 4****Course Objectives**

- To Study the principles of system modelling, system analysis and feedback control, and use them to design and evaluate feedback control systems with desired performance.
- Control system modelling: modelling of electric and mechanical systems, using differential equations, transfer functions, block diagrams, and state variables.
- Control system analysis: analysis of properties of control systems, such as stability, controllability, tracking, in time and frequency domains.
- Analyze the frequency domain specifications of the different systems.
- To study the concept of a physiological control system.

**Course Outcomes (COs)**

1. Formulate the transfer function model of electrical and mechanical systems.
2. Interpret the time response and steady error for the different order systems to various inputs.
3. Analyze stability condition for the given biocontrol systems
4. Analyze performance of the system using frequency response methods.
5. Categorize the model of physiological control systems.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	1									1	1		
2	2	3		2									1		
3		3		2								1	1		
4		3		2									1		
5		2	2	3								1	1		

**UNIT I****12 Hours****CONTROL SYSTEM MODELING**

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

**UNIT II****12 Hours****TIME RESPONSE ANALYSIS**

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

**UNIT III****12 Hours****STABILITY ANALYSIS**

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

**UNIT IV**

**12 Hours**

**FREQUENCY RESPONSE ANALYSIS**

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

**UNIT V**

**12 Hours**

**PHYSIOLOGICAL CONTROL SYSTEM**

Example of the physiological control system, the difference between engineering and physiological control systems, generalized system properties, models with the combination of system elements, linear models of physiological systems-Examples, Introduction to simulation, Illustration with real-time applications.

**Total: 75 Hours**

**Reference(s)**

1. I.J. Nagrath and M. Gopal, "Control System Engineering", New Age International Publisher, 2011.
2. Benjamin C. Kuo, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, 2012
3. M. Gopal, "Control Systems Principles and Design", Tata McGraw-Hill, 2012
4. M.N. Bandyopadhyay, "Control Engineering Theory and Practice", Prentice Hall of India, 2009.
5. Norman S. Nise, "Control Systems Engineering", 4th edition, New York, John Wiley, 2003.
6. K. Ogatta, "Modern Control Engineering", Pearson Education, New Delhi, 2010.

**22BM507 MINI PROJECT****0 0 2 1****Course Objectives**

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

**Course Outcomes (COs)**

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies
3. Utilize the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare the report and present oral demonstrations.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1	1	2			2	2	2			1	1
2	1	2	1	1	2			2	2	2			1	1
3	1	2	1	1	2			2	2	2	2		1	1
4	1	2	1	1	2			2	2	2	2		1	1
5	1	2			2			2	2	2			1	1

**22BM601 DIAGNOSTIC AND THERAPEUTIC  
EQUIPMENT**

**3 0 2 4**

**Course Objectives**

- To understand the ECG, EEG and EMG devices for measurement of physiological parameters.
- To explain diagnostic and therapeutic devices related to respiratory parameters.
- To understand the various sensory measurements that hold clinical importance.

**Course Outcomes (COs)**

1. Analyze the working and recording setup of all basic cardiac equipment.
2. Analyze the working and recording of all basic neurological equipment.
3. Categorize and analyze various diagnostic and therapeutic equipment related to EMG.
4. Apply appropriate measurement and assistive techniques related to the respiratory system.
5. Analyze the performance of sensory diagnostic equipment.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2		1				1				1	2	1	1
2	3	2		1				1				1	2	1	1
3	3	2		2				1				1	2	1	1
4	3	2		1				1				1	2	1	1
5	3	3		2				1				1	2	1	1

**UNIT I**

**9 Hours**

**CARDIAC EQUIPMENT**

Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, ECG machine maintenance and troubleshooting, Cardiac Pacemaker- Internal and External Pacemaker- Batteries, AC and DC Defibrillator- Internal and External, Defibrillator Protection Circuit, Cardiac ablation catheter.

**UNIT II**

**9 Hours**

**NEUROLOGICAL EQUIPMENT**

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

**UNIT III**

**9 Hours**

**MUSCULAR AND BIOMECHANICAL EQUIPMENT**

Recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation. Static Measurement - Load Cell, Pedobarograph. Dynamic Measurement - Velocity, Acceleration, GAIT, Limb position.

**UNIT IV** **9 Hours**

**RESPIRATORY MEASUREMENT AND ASSIST SYSTEM**

Instrumentation for measuring the mechanics of breathing - Spirometer- Lung Volume and vital capacity, measurements of residual volume, Pneumotachometer - Airway resistance measurement, Whole body Plethysmograph, Intra-Alveolar and Thoracic pressure measurements, Apnoea Monitor. Types of Ventilators - Pressure, Volume, and Time Controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.

**UNIT V** **9 Hours**

**SENSORY DIAGNOSTIC EQUIPMENT**

Psychophysiological Measurements - polygraph, basal skin resistance (BSR), galvanic skin resistance (GSR), Sensory responses - Audiometer-Pure tone, Speech, Eye Tonometer, Applanation Tonometer, slit lamp, auto refractometer.

**1** **3 Hours**

**EXPERIMENT 1**

Auditory system check-up using Audiometer

**2** **3 Hours**

**EXPERIMENT 2**

Pacemaker Simulator analysis

**3** **3 Hours**

**EXPERIMENT 3**

Examine Bio telemetry.

**4** **3 Hours**

**EXPERIMENT 4**

Working operation of CPAP ventilator

**5** **3 Hours**

**EXPERIMENT 5**

Demonstration of Heart Lung machine model

**6** **3 Hours**

**EXPERIMENT 6**

Demonstration of Hemodialysis model

**7** **3 Hours**

**EXPERIMENT 7**

Electrical safety measurements

**8** **3 Hours**

**EXPERIMENT 8**

Inspection ESU - cutting and coagulation modes.

**9** **3 Hours**

**EXPERIMENT 9**

Visual evoked potential analysis using EEG

**10** **3 Hours**

**EXPERIMENT 10**

Study of Ultrasound imaging modality

**Total: 75 Hours**



**Reference(s)**

1. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India Pvt. Ltd, New Delhi, 2012
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012.
3. L.A Geddes and L.E. Baker, "Principles of Applied Biomedical Instrumentation", 3rd edition, 2008.
4. Khandpur. R.S., "Handbook of Biomedical Instrumentation", Second edition, Tata McGrawHill Pub.Co.,Ltd. 2003.
5. Antony Y.K.Chan, "Biomedical Device Technology, Principles and Design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
6. Lesile Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

**22BM602 BIOMECHANICS****3 0 2 4****Course Objectives**

- To study the mechanics involved with various physiological systems.
- To gain knowledge in deriving the mathematical models related to blood vessels.

**Course Outcomes (COs)**

1. Understand the fundamental concepts of biomechanics in engineering and analyze its properties.
2. Apply solid and fluid dynamics in biomechanics.
3. Analyze the mechanical properties of hard and soft tissues.
4. Analyze the biomechanical properties of joints.
5. Design and develop the models specific to orthopaedic applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2		1	2	1						1	2		2
2	3	2		2		1						1	2		2
3	3	2		2	2	1						1	2		2
4	3	2		2	2	1						1	2		2
5	2	2	3	2	2	1		2				1	2	2	2

**UNIT I****9 Hours****INTRODUCTION**

Definition and perspective of biomechanics, Kinematic concept for analysing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human movement, Anthropometry.

**UNIT II****9 Hours****BIOMECHANICS OF SOLIDS AND FLUIDS**

Constitutive Equation, Stress, strain, viscoelasticity, models of viscoelasticity, Flow properties of blood, dynamics of fluid flow in cardiovascular system, Rheology of blood in micro vessels, Bio viscoelastic solids, Lubrication of joints.

**UNIT III****9 Hours****BIOMECHANICS OF HARD AND SOFT TISSUES**

Bone: structure, composition, mechanical properties, anisotropy, fracture mechanisms - pseudo elasticity, Structure, function, mechanical properties of: skin, ligaments, skeletal muscles and tendons, Constitutive equations for soft tissues.

**UNIT IV****9 Hours****BIOMECHANICS OF JOINTS**

Kinetics and kinematics of joints, Skeletal joints, mechanics of the elbow, mechanics of shoulder, mechanics of spinal column, mechanics of hip, mechanics of knee, mechanics of ankle.

<b>UNIT V</b>	<b>9 Hours</b>
<b>ORTHOPAEDIC APPLICATIONS</b>	
Gait analysis, Qualitative biomechanical analysis to: improve technique, understand injury development, Amputations and prosthetics, prosthetic components, Introduction to 3D printing, Introduction to accelerometer.	
<b>1</b>	<b>3 Hours</b>
<b>EXPERIMENT 1</b>	
Introduction to Motion Analysis: Linear Kinematics and Total Body Centre of Mass (TBCM).	
<b>2</b>	<b>3 Hours</b>
<b>EXPERIMENT 2</b>	
Angular Kinematics.	
<b>3</b>	<b>3 Hours</b>
<b>EXPERIMENT 3</b>	
Linear impulse and momentum.	
<b>4</b>	<b>3 Hours</b>
<b>EXPERIMENT 4</b>	
Angular impulse and momentum.	
<b>5</b>	<b>3 Hours</b>
<b>EXPERIMENT 5</b>	
Total Body Kinetics.	
<b>6</b>	<b>3 Hours</b>
<b>EXPERIMENT 6</b>	
A Joint Kinetics.	
<b>7</b>	<b>3 Hours</b>
<b>EXPERIMENT 7</b>	
Force measurement using Foot sensors.	
<b>8</b>	<b>3 Hours</b>
<b>EXPERIMENT 8</b>	
Musculoskeletal modelling.	
<b>9</b>	<b>3 Hours</b>
<b>EXPERIMENT 9</b>	
Simulation of Musculoskeletal models.	
<b>10</b>	<b>3 Hours</b>
<b>EXPERIMENT 10</b>	
A Gait Analysis	
	<b>Total: 75 Hours</b>

**Reference(s)**

1. Y.C.Fung, Bio-Mechanics, Mechanical Properties of Tissues, Springer-Verilog,1993.
2. C. Ross Ether and Craig A. Simmons, Introductory Biomechanics from cells to organisms, Cambridge University Press, New Delhi, 2007.
3. Susan J Hall, Basics of Biomechanics, McGraw Hill Publishing.co. New York, 8th Edition, 2019.
4. Dhanjoo N. Ghista, Orthopaedic Mechanics, Academic Press, 1990.
5. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, Fourth edition,2015.
6. John Enderle, Susanblanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, Third edition, 2011.

**22BM603 ARTIFICIAL INTELLIGENCE AND  
MACHINE LEARNING**

**3 0 2 4**

**Course Objectives**

- To understand the problem solving intelligent agents and searching techniques.
- To Impart domain knowledge in different machine learning method.
- To realize the different applications in AI

**Course Outcomes (COs)**

1. Analyze the concepts of intelligent agents and its structure
2. Apply appropriate search algorithms for solving given AI problems.
3. Differentiate learning strategies, regression and classification in Artificial Intelligence Systems.
4. Analyze the basic concepts of reinforcement learning and find solutions
5. Apply the machine learning techniques in AI applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2			2							1	2
2	2	2	1	2									2	2
3	2	2	2	3									2	2
4	3	2	2	1			2						1	2
5		2	2										2	2

**UNIT I**

**9 Hours**

**INTELLIGENT AGENTS**

Introduction to AI, Agents and Environments, Concept of rationality, Nature of environments, Structure of agents, problem solving agents, search algorithms, uninformed search strategies

**UNIT II**

**9 Hours**

**PROBLEM SOLVING**

Heuristic search strategies, Heuristic functions, Local search and optimization problems, Local search in continuous space Online search agents and unknown environments, optimal Decisions in games, Constraint satisfaction problems (CSP).

**UNIT III**

**9 Hours**

**MACHINE LEARNING METHODS**

Forms of learning, Supervised learning, Learning decision trees, Evaluation and choosing the best hypothesis, Theory of Learning, Regression and classification with linear models, Artificial Neural network, Non parametric model, Support vector machine, Ensemble learning.

**UNIT IV**

**9 Hours**

**REINFORCEMENT LEARNING**

Introduction to Reinforcement Learning, Active and Passive Reinforcement Learning, Generalization in reinforcement learning, Policy Search, Applications of Reinforcement Learning.

**UNIT V** **9 Hours**

**AI APPLICATIONS**

Natural Language Processing Language Models, Text Classification, Information Retrieval, Information Extraction, Machine Translation, Speech Recognition, Robotics, Robotic Hardware and Robotic perception.

**1** **4 Hours**

**EXPERIMENT 1**

Develop PEAS descriptions for given AI task

**2** **4 Hours**

**EXPERIMENT 2**

Implement basic search strategies for selected AI applications

**3** **5 Hours**

**EXPERIMENT 3**

Implement a classifier for the sales data

**4** **5 Hours**

**EXPERIMENT 4**

Develop a predictive model for predicting house prices

**5** **6 Hours**

**EXPERIMENT 5**

Apply reinforcement learning and develop a game of your own

**6** **6 Hours**

**EXPERIMENT 6**

Apply Natural language processing to develop filters for spam and non-spam mails

**Total: 75 Hours**

**Reference(s)**

1. Stuart Jonathan Russell, Peter Norvig, John Canny, Artificial Intelligence: A Modern Approach, Prentice Hall, Fourth edition, 2020
2. Ameet V Joshi, Machine Learning and Artificial Intelligence, Springer Publications, 2020
3. T.M. Mitchell, Machine Learning, McGraw-Hill 2017
4. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Third edition 2014
5. Stephen Marsland, Machine Learning An Algorithmic Perspective, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014

**22BM607 MINI PROJECT II****0 0 2 1****Course Objectives**

- Identify the problem statement and apply the engineering concepts to find the solution.
- Improve the analysing capability of the students.
- Increase the exuberance in finding the solution to various problems.

**Course Outcomes (COs)**

1. Formulate a real-world problem, identify the requirement, and develop the design solutions.
2. Identify technical ideas, strategies, and methodologies.
3. Utilize the new tools, algorithms, and techniques that contribute to obtaining the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis of the cost-effectiveness.
5. Prepare the report and present oral demonstrations.

**Articulation Matrix**

<b>CO No</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>
1	1	2	1	1	2			2	2	2			1	1
2			1	1	2			2	2	2			1	1
3			1	1	2			2	2	2	2		1	1
4			1	1	2			2	2	2	2		1	1
5					2			2	2	2			1	1

**22BM701 RADIOLOGICAL EQUIPMENT****3 0 0 3****Course Objectives**

- To understand the principle of X-ray, Computed Tomography, MRI and its uses in imaging
- To study the principles of different radio diagnostic equipment in Imaging
- To understand radiation therapy techniques and radiation safety.

**Course Outcomes (COs)**

1. Understand the working principle of the X-ray machine and its application.
2. Apply the concept of computer tomography for imaging applications.
3. Interpret the technique used for visualizing various sections of the body using magnetic resonance imaging
4. Apply suitable nuclear medicine techniques for disease diagnosis
5. Outline the features of radiation measuring instruments and radiation safety.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2						1				1	2		
2	1	2		3				1				1	2	2	
3	1	2		3				1				1	2	2	
4	1	2		3				1				1	2	2	
5	1	2		3				1				1	2	2	

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

Nature of X-rays- X-Ray absorption - Tissue contrast. X- Ray Equipment (Block Diagram)- X-Ray tube, collimator, Bucky Grid, power supply, Cathode and filament currents, focusing cup, Thermionic emission, Electromagnet induction, Line focus principle and the heel effect, causes of x-ray tube failure: Electron arcing/ filament burn out, Failure to warm up tube, High temperature due to over exposure, x-ray tube rating charts. X- ray image intensifier tubes - Fluoroscopy - Digital Fluoroscopy - Digital Fluoroscopy. Angiography, Cine Angiography, Digital subtraction Angiography. Mammography and Dental x-ray unit.

**UNIT II****9 Hours****COMPUTED TOMOGRAPHY**

Principles of tomography, CT Generations, X- Ray sources- collimation - X- ray detectors- Viewing systems- spiral CT Scanning - Ultra fast CT Scanners. Advantages of computed radiography over film screen radiography: Time, Image quality, Lower patient dose, Differences between conventional imaging equipment and digital imaging equipment: Image plate, Plate readers, Image characteristics, Image reconstruction techniques- back propagation and iterative method. Spiral CT, 3D Imaging and its application.

**UNIT III****9 Hours****MAGNETIC RESONANCE IMAGING**

Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave - rotation and precession - Introduction of magnetic resonance signals - bulk magnetization- Relaxation processes T1 and T2. Block Diagram approach of MRI system- system



magnet (Permanent, Electromagnet and super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), and shim coils, Electronic components, fMRI.

**UNIT IV**

**9 Hours**

**NUCLEAR MEDICINE TECHNIQUES**

Nuclear imaging- Anger scintillation camera- Nuclear tomography- single photon emission computer tomography, positron emission tomography - Recent advances- Radionuclide imaging- Bone imaging, dynamic renal function, myocardial perfusion. Non imaging techniques- haematological measurements, Glomerular filtration rate, volume measurements, clearance measurement, whole-body counting, surface counting.

**UNIT V**

**9 Hours**

**RADIATION THERAPY AND RADIATION SAFETY**

Radiation therapy- linear accelerator, Telegram Machine. SRS-SRT, Recent Techniques in radiation therapy - 3DCRT-IMRT-IGRT and Cyber knife- radiation measuring instruments- Dosimeter, film badges, Thermo Luminescent dosimeters- electronic dosimeter- Radiation protection in medicine- radiation protection principles.

**Total: 45 Hours**

**Reference(s)**

1. Gopal B. Saha, "Physics and Radiobiology of Nuclear Medicine" - Third edition Springer, 2006.
2. B.H.Brown, PV Lawford, R H Small wood, D R Hose, D C Barber, "Medical physics and Biomedical Engineering", CRC Press, 1999.
3. Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.
4. P. Raganathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine Concepts and Techniques", Paperback - Import, 2007.
5. Steve Webb, "The Physics of Medical Imaging", Adam Hilger, Philadelphia, 1988.
6. R. Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002.

**22BM702 HOSPITAL SYSTEM MANAGEMENT****3 0 2 4****Course Objectives**

- To understand the fundamentals of hospital administration and management.
- To explore various information management systems and relative supportive services.
- To learn the quality and safety aspects in hospitals.

**Course Outcomes (COs)**

1. Analyze the challenges in hospital administration with appropriate hospital management system.
2. Analyze the functions and characteristics of human resource management in hospitals.
3. Implement the various marketing research techniques and its challenges involved in Hospital system management.
4. Outline the quality and safety aspects to be maintained in the Hospital environment.
5. Structure the Information system to be implemented in the Hospital environment.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		3				2		1				1			
2		3		1		2		1				1			
3		2	2	2		2	2	1				1			2
4		2	2	2		2	3	1				2			2
5		2	3	1		2		1				2			3

**UNIT I****9 Hours****HOSPITAL MANAGEMENT**

Nature and Scope of a hospital, History of Indian Hospitals, Distinction between Hospital and Industry, Challenges in Hospital Administration, Hospital Planning- Equipment Planning - Functional Planning- Current issues in Hospital Management- Telemedicine- Biomedical Waste Management.

**UNIT II****9 Hours****HUMAN RESOURCE MANAGEMENT IN HOSPITAL**

Human Resource Management- Principles, Characteristics, Functions, Significance and Importance - Profile of HRD Manager, Good HR Practices, Causes for Poor Human Resource Management, Tools of HRD, Human Resources Inventory- Manpower Planning, Recruitment, Selection, Induction, Training Guidelines, Promotion, Termination and Communication.

**UNIT III****9 Hours****HOSPITAL DATA MANAGEMENT**

Managing A Service Organization - Hospital Service Delivery - Quality Control- Six Sigma, NABH. Hospital Queuing Systems - Simple Queuing Systems, Interdependent Queuing Systems- Hospital Management Functions - Operation Management, Finance and Cost Management, Materials Management - Case Studies.

**9 Hours**

#### **UNIT IV**

##### **QUALITY AND SAFETY ASPECTS IN HOSPITAL**

Quality system - Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000-9004- Features of ISO 9001- ISO 14000 - Environment Management Systems, NABA, JCI, NABL. Security - Loss Prevention - Fire Safety- Alarm System- Safety Rules. Health Insurance & Managing Health Care- Medical Audit- Hazard and Safety in a Hospital Setup.

#### **UNIT V**

**9 Hours**

##### **HOSPITAL INFORMATION SYSTEMS**

Management Decisions and Related Information Requirement - Clinical Information Systems- Administrative Information Systems - Support Service Technical Information Systems - Medical Transcription, Medical Records Department- Central Sterilization and Supply Department- Pharmacy- Food Services- Laundry Services.

##### **HOSPITAL TRAINING**

**30 Hours**

Students need to complete training in any leading Multi-specialty hospital for 30 Hours. They need to prepare an extensive report and submit to their respective course in- charges during the session. Out of the following departments, it is mandatory to complete training in any 10. The students can give a presentation of the remaining departments during laboratory hours

##### **Departments for visit**

- 1 Cardiology
- 2 ENT
- 3 Ophthalmology
- 4 Orthopedic and Physiotherapy
- 5 ICU/CCU
- 6 Operation Theatre
- 7 Neurology
- 8 Nephrology
- 9 Radiology
- 10 Nuclear Medicine
- 11 Pulmonology
- 12 Urology
- 13 Obstetrics and Gynaecology
- 14 Emergency Medicine
- 15 Biomedical Engineering Department
- 16 Histo-Pathology
- 17 Biochemistry
- 18 Pediatric/Neonatal
- 19 Dental
- 20 Oncology
- 21 PACS
- 22 Medical Records and Telemetry

**Total: 75 Hours**

**Reference(s)**

1. R.C.Goyal, Hospital Administration and Human Resource Management, PHI -Fourth Edition, 2006.
2. G.D.Kunders, Hospitals Facilities Planning and Management - TMH, New Delhi - Fifth Reprint 2007.
3. Ramani K V, Hospital Management - Text and Cases, Pearson education, New Delhi, 2012.
4. Malhotra A K, Hospital Management - An Evaluation, Global India Publications, New Delhi, 2009.
5. Norman Metzger, Handbook of Health Care Human Resources Management, 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.
6. Blane, David, Brunner, Health and social organization: Towards a Health Policy for the 21st Century, Eric Calrendon Press 2002.

**22BM707 PROJECT WORK I****0 0 4 2****Course Objectives**

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

**Course Outcomes (COs)**

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present the oral demonstrations.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	3	3	1	3	3	3	3	3		2	3	3
2	2	2	3	3	1	3	3	3	3	3	-	2	3	3
3	2	2	3	3	3	3	3	3	3	3	3	2	3	3
4	2	2	3	3	3	3	3	3	3	3	3	2	3	3
5	2	2			2			3	3	3		2	3	3

**22BM801 PROJECT WORK II****0 0 20 10****Course Objectives**

- Work in teams to propose, formulate, and solve a challenging open-ended design problem of significant scope, depth, and breadth.
- Understand and incorporate engineering standards and multiple realistic constraints, within realistic design time, budget, and performance objectives.
- Develop a prototype of the proposed design and demonstrate the prototype in accordance with the specifications.
- Effectively communicate information relating to all aspects of the design process in written, oral, and graphical form.

**Course Outcomes (COs)**

1. Formulate a real world problem, identify the requirement and develop the design solutions.
2. Identify technical ideas, strategies and methodologies.
3. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
4. Test and validate through conformance of the developed prototype and analysis the cost effectiveness.
5. Prepare report and present the oral demonstrations.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2	3	3	1	3	3	3	3	3		2	3	3
2	2	2	3	3	1	3	3	3	3	3		2	3	3
3	2	2	3	3	3	3	3	3	3	3	2	2	3	3
4	2	2	3	3	3	3	3	3	3	3	2	2	3	3
5	2	2			2			3	3	3		2	3	3

**22HS201 COMMUNICATIVE ENGLISH II****1 0 2 2****Course Objectives**

- Command over the English language for day-to-day transactions.
- Improve listening and reading skills
- Increase ability to comprehend complex content
- Enhance confidence in expressing with clarity and elegance
- Enthusiastic and reflective use of the language through sufficient and focused practice
- Articulate fluently and confidently in challenging situations

**Course Outcomes (COs)**

1. Engage with the English language in functional contexts
2. Express in both descriptive and narrative formats
3. Understand and make effective use of the English Language in Business contexts
4. Actively read and comprehend authentic text
5. Express opinions and communicate experiences.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									3	3		3		
2									3	3		3		
3									3	3		3		
4									3	3		3		
5									3	3		3		

**UNIT I****15 Hours****SELF-EXPRESSION/RESSION**

Personal Goals and Values - Being a Team Player-Expressing strengths and weaknesses-Abstract nouns -Adjectives-Active Listening skills-Note making-Pronunciation and Accent Personal goals and values - Reading for Gist and Details-Professional ethics-Reported Speech-Conjunctions Reading skills - phonemics, word/phrase recognition, sight words Personal Goals and Values-Conditional clauses- Hypothetical questions and answers-Sentence Structure-Simple Present Tense-Perfect tense

**UNIT II****15 Hours****CREATIVE EXPRESSION**

Instructive and Expository Expression - Creating brochures, catalogues, and manuals for products/services, Giving directions, Process writing, Sequencing experiments, Concept explanation-Reported speech-Voice Sentence equivalence-Proofreading

**UNIT III****15 Hours****FORMAL EXPRESSION**

Notices and Announcements-Writing: Creating notices and circulars for events, announcing college tours and lost and found-Varied Vocabulary - Gender Sensitive Vocabulary, Non-discriminatory Vocabulary, Concise Vocabulary-Paragraph writing - Effective titles, topics and supporting

sentences, calling in registrations and queries. Effective communication- Understanding purpose, reach and target audience, achieving complete communication  
Punctuation - Capitalization, Numeration, Use of proper nouns and articles-Spelling-Reading: Analyzing and interpreting notices and circulars-Understanding the gist of short real-world notices, and messages. Culling out keywords, Information words vs Supporting words-Interpreting Abbreviations, Acronyms and Short-forms-Listening: Analyzing and interpreting announcements  
Decoding - Screening for salient points-Note making-Raising queries for clarification-Speaking: Announcements-Giving complete information-Pronunciation and Enunciation Pace, Intonation, and Pitch-Conducting Events-Speaking: Master of ceremonies, Short speeches - welcome speech, the vote of thanks/ valedictory speech, award-acceptance speech Writing: Invitations, Preparation of script/draft after interviewing someone. Adjectives-Pronunciation/ Punctuation Precision and Concision-Politeness markers

**Total: 45 Hours**

**Reference(s)**

1. Sasikumar, V, et.al. A Course in Listening & Speaking FoundationBooks, 2005.
2. Murphy, Raymond. English Grammar in Use: A Self-Study Reference and Practice Book for Intermediate Students: with Answers. Cambridge: Cambridge University Press, 1985.
3. Prasad, Hari Mohan. A Handbook of Spotting Errors. Mcgraw Hill Education, 2010.
4. Reynolds, John. Cambridge First Language English. 2018th ed., Hodder Education, 2018.
5. Wiggins, Grant P., and Jay McTighe. Understanding by Design. Association for Supervision and Curriculum Development, 2008.



**22HSH01 HINDI****1 0 2 2****Course Objectives**

- To help students acquire the basics of Hindi
- To teach them how to converse in Hindi on simple day- to -day situations
- To help students understand a simple technical text in Hindi

**Course Outcomes (COs)**

1. Construct simple sentences and use vocabulary required for day- to -day conversation.
2. Distinguish and understand the basic sounds of Hindi language.
3. Apply appropriate grammar to write and speak in Hindi language
4. Comprehend the conversation and give correct meaning
5. Take up Hindi examinations conducted by Dakshin Bharat Hindi Prachar Sabha

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									3	3				
2									3	3				
3									3	3				
4									3	3				
5									3	3				

**UNIT I****9 Hours****VOWELS AND CONSONANTS**

Hindi Alphabet: Introduction (Self introduction) - Vowels - Consonants - Plosives - Fricatives - Nasal sounds - Vowel Signs - Chandra Bindu & Visarg -Table of Alphabet -Vocabulary.

**UNIT II****9 Hours****NOUNS**

Nouns: Genders -Masculine & Feminine -Reading Exercises

**UNIT III****9 Hours****PRONOUNS AND TENSES**

Pronouns and Tenses - Categories of Pronouns - Personal Pronouns - Second person (you & honorific) - Definite & Indefinite pronouns - Relative pronouns - Present tense - Past tense - Future tense - Assertive & Negative Sentences - Interrogative Sentences.

**UNIT IV****9 Hours****CLASSIFIED VOCABULARY**

Classified Vocabulary: Parts of body -Relatives Spices Eatables -Fruit & Vegetables -Clothes - Directions -Seasons Professions.

**UNIT V**

**9 Hours**

**CONVERSATIONS**

Speaking -Telling the times -Saying the Numbers from 1 to 50  
Speaking practice for various occasions.

**Total: 45 Hours**

**Reference(s)**

1. B.R. Kishore, Self Hindi Teacher for Non-Hindi Speaking People, Vee Kumar Publications (P) Ltd., New Delhi, 2009.
2. Hindi Prachar Vahini - 1
3. Videos, Stories, Rhymes and Songs.

**22HSG01 GERMAN****1 0 2 2****Course Objectives**

- To help students appear for the A1 level Examination
- To teach them how to converse fluently in German in day-to-day scenarios

**Course Outcomes (COs)**

1. Listen and identify individual sounds of German
2. use basic phonemes and words while speaking
3. read and understand short passages on familiar topics
4. use basic sentence structures while writing
5. understand basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									3	3				
2									3	3				
3									3	3				
4									3	3				
5									3	3				

**UNIT I****9 Hours****INTRODUCTION**

Introduction to the German language-Alphabets-Numbers Greetings -Days and Seasons-Working with Dictionary.

**UNIT II****9 Hours****LANGUAGE AND ITS COMMON USE**

Nouns -articles-Speaking about oneself-Listening to CD supplied with books-paying special attention to pronunciation

**UNIT III****9 Hours****TECHNICAL DEUTSCHE**

Regular & Irregular verbs -Personal pronouns-family-Introduction to types of sentences

**UNIT IV****9 Hours****INTERROGATION**

Question words -Types of Questions -Nominative case-Verb Conjugation -country -nationalities

**UNIT V****9 Hours****IMPLEMENTATION**

Verbs to be & to have -conjugation -Hobbies -Framing basic Questions and answers

**Total: 45 Hours**

**Reference(s)**

1. Kursbuch and Arbeitsbuch, NETZWERK A1 DEUTSCH ALS FREMDSPRACHE, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2015.
2. Langenscheidt Eurodictionary, German English / English German, Goyal Publishers & Distributors Pvt. Ltd., New Delhi, 2009.
3. Grundkurs, DEUTSCH Lehrbuch Hueber München, 2007.

**22HSJ01 JAPANESE****1 0 2 2****Course Objectives**

- To train students for N5 Level Examination
- To teach them use basic Japanese sentences in day-to-day conversation
- To make students familiar with the Japanese cultural facets and social etiquette

**Course Outcomes (COs)**

1. Recognize and write Japanese alphabet
2. Speak using basic sounds of the Japanese language
3. Apply appropriate vocabulary needed for simple conversation in Japanese language
4. Apply appropriate grammar to write and speak in Japanese language
5. Comprehend the conversation and give correct meaning

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									3	3				
2									3	3				
3									3	3				
4									3	3				
5									3	3				

**UNIT I****9 Hours****SELF INTRODUCTION / DEMONSTRATIVES / NOUN MODIFIERS**

Introduction to Japanese Japanese script - Pronunciation of Japanese(Hiragana (Katakana) Long vowels - Pronunciation of in,tsu,ga -Letters combined with ya,yu,yo - Daily Greetings and Expressions -Numerals. Speaking: Self Introduction - Listening: Listening to Greetings, Listening to specific information: Numbers, Time

**UNIT II****9 Hours****TIME EXPRESSION / VERBS - PAST**

Introduction to time -Introduction of verbs -Listening to specific information

**UNIT III****9 Hours****ADJECTIVES**

Word Sentence -Introduction to Adjectives -Technical Japanese Vocabulary -Pair Activity Day to day situational conversation

Listening to Japanese Alphabet Pronunciation -Simple Conversation

**UNIT IV****9 Hours****CONJUGATION OF II ADJECTIVE**

Past tense of Noun sentences and Na adjective sentences -Past tense of ii adjective sentences -houga adjective desu -Technical Japanese Vocabulary -Individual Activity - Listening to conversation with related particles

**UNIT V**

**9 Hours**

**CONJUGATION OF VERBS - TE FORM / TA FORM / NAI FORM / PLAIN FORM**

N gahoshidesu - V masu form tai desu - Verb te form - Technical Japanese Vocabulary -Listening to different Counters, simple conversations with verbs and adjectives

**Total: 45 Hours**

**Reference(s)**

1. Minna no Nihongo Japanese for Everyone Elementary Main Textbook1-1, Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.
2. Minna no Nihongo Japanese for Everyone Elementary Main Textbook 1-2 Goyal Publishers and Distributors Pvt. Ltd., Delhi, 2007.

**22HSF01 FRENCH**

**1 0 2 2**

**Course Objectives**

- To prepare the students for DELF A1 Examination
- To teach them to converse fluently in French in day-to-day scenarios

**Course Outcomes (COs)**

1. Help students acquire familiarity in the French alphabet & basic vocabulary
2. Listen and identify individual sounds of French
3. Use basic sounds and words while speaking
4. Read and understand short passages on familiar topics
5. Understand and use basic grammar and appropriate vocabulary in completing language tasks

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1									3	3				
2									3	3				
3									3	3				
4									3	3				
5									3	3		-		

**UNIT I**

**9 Hours**

**ENTRER EN CONTACT**

La langue française, alphabets, les numéros, les jours, les mois. Grammaire Les verbes s appeler, être, avoir, les articles définis, indéfinis Communication Saluer, s informer sur quelqu un, demander de se présenter Lexique L alphabet, les nationalités, l âge, les pays, les couleurs, les jours de la semaine, les mois de l année, les professions

**UNIT II**

**9 Hours**

**PARTAGER SON LIEU DE VIE**

Les français et leur habitat, des habitations insolites -Grammaire Verbes Conjugaison Present (Avoir / Être / ER, IR, RE Régulier et Irrégulier) Adjectifs les propositions de lieu Communication Chercher un logement, décrire son voisin, s informer sur un logement - Lexique L habitat, les pièces, l équipement, la description physique

**UNIT III**

**9 Hours**

**VIVRE AU QUOTIDIEN LES LOISIRS DES FRANÇAIS, LES GOUTS DES AUTRES, LES ACTIVITÉS QUOTIDIENNES**

Grammaire Articles contractés, verbes vouloir, pouvoir, devoir, adjectifs interrogatifs, future proche Communication Exprimer ses goûts, parler de ses loisirs, justifier un choix, exprimer une envie - Lexique le temps libre et les loisirs, les saisons, les activités quotidiennes, le temps (le matin, le soir, la nuit)

**UNIT IV**

**9 Hours**

**COMPRENDRE SON ENVIRONNEMENT SOUVIRIR A LA CULTURE**

Grammaire Verbes Finir, Sortir, les adjectifs demonstratifs, le passe compose, l imparfait  
Communication Propose a quelqu un de faire quelque chose, raconter une sortie au passe, parler d un film  
Lexique Les sorties, la famille, l art, les vetements et les accessoires

**UNIT V**

**9 Hours**

**GOUTER A LA CAMPAGNE**

Grammaire La forme negative, les verbes acheter, manger, payer, articles partitifs, le pronom en de quantite

Communication Accepter et refuser une invitation, donner des instructions, commander au restaurant  
Lexique Les services et les commerces, les aliments, les ustensiles, l argent

**Total: 45 Hours**

**Reference(s)**

1. Grammaire Progressive du Francais, CLE International, 2010
2. Saison1, Marie Noelle Cocton et al, Didier, 2014.
3. Preparation a l examen du DELF A1 Hachette
4. Reussir le DELF A1 Bruno Girardeau
5. Website: Francais Linguaphone Linguaphone Institute Ltd., London, 2000.
6. Francais Harrisonburg : The Rosetta Stone : Fairfield Language Technologies, 2001



**22BM001 SPEECH SIGNAL PROCESSING**

**3 0 0 3**

**Course Objectives**

- To familiarize the basic mechanism of speech production and the basic concepts of speech analysis and parametric representation of speech
- To impart ideas of Perception of Sound, Psycho-acoustic analysis, Spatial Audio Perception and speech analysis
- To disseminate Audio Compression Schemes

**Course Outcomes (COs)**

1. Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in real time applications
2. Analyze the speech signal based on its features
3. Implement Signal processing models of sound perception and apply the speech perception models in audio signal processing.
4. Apply suitable audio compression algorithms and standards for real time applications.
5. Analyze the subjective and objective qualities of audio signal.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		1								1	1		
2	2	3		2								1	1		
3	2	3		2								1	1		
4	1	2	1	3								1	1		
5	1	3		2								1	1		

**UNIT I**

**9 Hours**

**SPEECH PRODUCTION AND MODELLING**

Speech Production: Acoustic theory of speech production. Parametric representation of speech: AR Model, ARMA model. LPC Analysis (LPC model, Auto correlation method). Fundamentals of Speech recognition and Text-to-speech conversion. Speech coding, speech enhancement, Speaker Verification, Language Identification

**UNIT II**

**9 Hours**

**SPEECH ANALYSIS**

Speech Analysis: Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF) Frequency domain analysis (Filter Banks, STFT, Spectrogram), Cepstral Analysis, MFCC.

**UNIT III**

**9 Hours**

**SIGNAL PROCESSING MODELS OF AUDIO PERCEPTION**

Basic anatomy of hearing System. Auditory Filter Banks, Psycho-acoustic analysis: Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, Quantization Noise Shaping, MPEG psycho-acoustic model

**UNIT IV**

**9 Hours**

**AUDIO COMPRESSION METHODS**

Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Transform coding of digital audio: MPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression, Loss less coding methods

**UNIT V**

**9 Hours**

**SPATIAL AUDIO PERCEPTION AND RENDERING**

The physical and psycho-acoustical basis of sound localization and space perception. Spatial audio standards. Audio quality analysis: Objective quality analysis, Subjective quality analysis.

**Total: 45 Hours**

**Reference(s)**

1. Ellis, D., Gold, B., Morgan, N. Speech and Audio Signal Processing: Processing and Perception of Speech and Music. Germany: Wiley. 2011
2. Douglas O Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2/e, 2016
3. Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, July 1999, John Wiley & Sons, ISBN: 0471351547
4. Yu, D., Deng, L. Automatic Speech Recognition: A Deep Learning Approach. United Kingdom: Springer London. 2014
5. Schafer, R. W., Rabiner, L. R. Introduction to Digital Speech Processing. Netherlands: 2007

**22BM002 BIOMETRIC SYSTEMS****3 0 0 3****Course Objectives**

- To understand the general principles, design of biometric systems and the underlying trade-offs.
- To study the technologies of fingerprint, iris, face and speech recognition
- To study of evaluation of biometrics systems

**Course Outcomes (COs)**

1. Understand the concepts and characteristics of biometric systems
2. Apply fingerprint recognition technique for a real time application
3. Apply face and hand geometry recognition techniques for feature extraction and classification applications
4. Apply suitable methodology to iris recognition of a person
5. Analyse the features of voice signal and multimodal biometric systems

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1											3	2	1
2		2	3	1								1	3	2	1
3		2	3	1								1	3	2	1
4		2	3	1								1	3	2	1
5		3	2	1								1	3	2	1

**UNIT I****9 Hours****INTRODUCTION TO BIOMETRICS**

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

**UNIT II****9 Hours****FINGERPRINT TECHNOLOGY**

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

**UNIT III****9 Hours****FACE RECOGNITION AND HAND GEOMETRY**

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

**UNIT IV**

**9 Hours**

**IRIS RECOGNITION**

Introduction, Anatomical and Physiological underpinnings, Iris sensor, Iris representation and localization, Daugman and Wildes approach, Iris matching, Iris scan strengths and Weaknesses, System performance, future directions

**UNIT V**

**9 Hours**

**VOICE SCAN AND MULTIMODAL BIOMETRICS**

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

**Total: 45 Hours**

**Reference(s)**

1. James Wayman& Anil Jain, Biometric Systems- Technology Design and Performance Evaluation, SPRINGER (SIE), 1st Edition, 2011.
2. Paul Reid, Biometrics for Network Security, Pearson Education, 2004
3. Nalini K Ratha, Ruud Bolle, Automatic fingerprint recognition system, Springer, 2003
4. L C Jain, I Hayashi, S B Lee, U Halici, Intelligent Biometric Techniques in Fingerprint and Face Recognition, CRC Press, 1st Edition, 1999
5. S.Y. Kung, S.H. Lin, M.W., Biometric Authentication: A Machine Learning Approach, Prentice Hall, 2004

**22BM003 PATTERN RECOGNITION TECHNIQUES**

**3 0 0 3**

**Course Objectives**

- To understand different supervised learning techniques
- To understand different unsupervised learning techniques
- To obtain sound knowledge in the recent advancement on pattern recognition techniques

**Course Outcomes (COs)**

1. Understand the fundamental concepts of pattern recognition techniques in classification
2. Apply the unsupervised learning techniques for pattern classification
3. Apply suitable algorithm for structural pattern recognition
4. Apply appropriate technique to extract the feature from image
5. Analyse the advanced neural network structures for pattern recognition

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1													
2	2	3													
3	2	1											2		
4	1	3	1		2										
5	2	2	2										1	1	2

**UNIT I**

**9 Hours**

**PATTERN CLASSIFIER**

Overview of pattern recognition, Discriminant functions, Supervised learning, Parametric estimation, Maximum likelihood estimation, Bayesian parameter estimation, Perceptron algorithm, LMSE algorithm, Problems with Bayes approach, Pattern classification by distance functions, Minimum distance pattern classifier.

**UNIT II**

**9 Hours**

**UNSUPERVISED CLASSIFICATION**

Clustering for unsupervised learning and classification, Clustering concept, C-means algorithm - Hierarchical clustering procedures, Graph theoretic approach to pattern clustering, Validity of clustering solutions.

**UNIT III**

**9 Hours**

**STRUCTURAL PATTERN RECOGNITION**

Elements of formal grammars, String generation as pattern description, Recognition of syntactic description, Parsing, Stochastic grammars and applications.

**UNIT IV**

**9 Hours**

**FEATURE EXTRACTION AND SELECTION**

Entropy minimization, Karhunen, Loeve transformation, Feature selection through functions approximation, Binary feature selection.

**UNIT V**

**9 Hours**

**NEURAL PATTERN RECOGNITION**

Neural network structures for Pattern Recognition, Neural network based Pattern associators, Unsupervised learning in neural Pattern Recognition.

**Total: 45 Hours**

**Reference(s)**

1. Earl Gose, Richard Johnsonbaugh Steve Jost, Pattern Recognition and Image Analysis, Prentice Hall of India Pvt Ltd., NewDelhi,2015
2. Freeman J. A., and Skapura B.M, Neural networks, algorithms, applications and programming techniques, Addison Wesley,2003
3. RobertJ.Schalkoff, PatternRecognition: Statistical, Structural and Neural Approaches, JohnWiley&Sons Inc., New York,2007.
4. Tou and Gonzales, Pattern Recognition Principles, Wesley Publication Company, London,1974.
5. Duda R.O., Hart.P.E., and Strok, Pattern Classification, Second Edition Wiley, New York,2012.

**22BM004 BRAIN COMPUTER INTERFACE****3 0 0 3****Course Objectives**

- To understand the basics for Brain Computer Interface
- To classify different types of BCI system based on Biosignal acquisition
- To familiarize the medical and non-medical application of BCI

**Course Outcomes (COs)**

1. Understand the concepts of neuroscience and Brain Computer Interface systems
2. Categorize Brain Computer Interface systems
3. Analyze the Non-Invasive BCIs and categorize it based on its functions
4. Apply stimulation techniques for advanced BCIs
5. Analyse the ethical principles of BCIs for medical and non-medical fields.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		1									3	2	2
2	1	2		3									3	2	2
3	1	3		2									3	2	2
4	1	3		2									3	2	2
5	1	3		2				3				1	3	2	2

**UNIT I****9 Hours****INTRODUCTION**

Introduction to Neuroscience: Neurons, action potential generation, Recording and simulation of Brain, Review of signal processing techniques applied for EEG signal, building a BCI: Major Types of BCIs, Brain Responses Useful for Building BCIs, Conditioned Responses, Population Activity, Imagined Motor and Cognitive Activity, Stimulus-Evoked Activity

**UNIT II****9 Hours****INVASIVE BCI AND SEMI-INVASIVE BCIS**

Two Major Paradigms in Invasive Brain-Computer Interfacing, invasive BCIs in Animals, Invasive BCIs in Humans, Long-Term Use of Invasive BCIs, Semi-Invasive BCIs: Electrocorticographic (ECoG) BCIs, BCIs Based on Peripheral Nerve Signals

**UNIT III****9 Hours****NON-INVASIVE BCIS**

Electroencephalographic (EEG) BCIs: Oscillatory Potentials and ER, Slow Cortical Potential, Stimulus-Evoked Potentials, BCIs Based on Cognitive Tasks, Error Potentials in BCI, Co-adaptive BCI, Hierarchical BCIs, Other Non-invasive BCIs: fMRI, MEG, and fNIR, Functional Magnetic Resonance Imaging-Based BCI, Magnetoencephalography-Based BCIs, Functional Near Infrared and Optical BCIs

**UNIT IV**

**9 Hours**

**BIDIRECTIONAL, RECURRENT BCI AND STIMULATION**

Cursor Control with Direct Cortical Instruction via Stimulation, Active Tactile Exploration Using a BCI and Somatosensory Stimulation, Bidirectional BCI Control of a Mini-Robot, Cortical Control of Muscles via Functional Electrical Stimulation, Establishing New Connections between Brain Region, Sensory Restoration, Restoring Hearing: Cochlear Implants, Restoring Sight: Cortical and Retinal Implants, Motor Restoration, Deep Brain Stimulation (DBS) and Sensory Augmentation

**UNIT V**

**9 Hours**

**APPLICATIONS AND ETHICS**

Medical Applications: Sensory Restoration, Motor Restoration, Cognitive Restoration and Rehabilitation, Restoring Communication with Menus, Cursors, and Spellers, Brain-Controlled Wheelchairs, Nonmedical Applications: Web Browsing and Navigating Virtual Worlds, Robotic Avatars Mnemonic and Cognitive Amplification, Applications in Space, Gaming and Entertainment, Brain-Controlled Art, Ethics of Brain-Computer Interfacing : Medical, Health, and Safety Issues, Abuse of BCI Technology

**Total: 45 Hours**

**Reference(s)**

1. Chang S. Nam, Anton Nijholt, Fabien Lotte, Brain Computer Interfaces Handbook: Technological and Theoretical Advances, CRC Press, UK. 2018
2. Maureen Clerc, Laurent Bougrain, Fabien Lotte, Brain Computer Interfaces 2: Technology and Applications, Wiley Publisher, 2016.
3. Rajesh P. N. Rao, Brain Computer Interfacing: An Introduction, 1st Edition, Cambridge University Press, 2018.
4. Christian Kothe, Introduction to Modern Brain Computer Interface design video lectures, [https://sccn.ucsd.edu/wiki/Introduction\\_To\\_BrainComputer\\_Interface\\_Design](https://sccn.ucsd.edu/wiki/Introduction_To_BrainComputer_Interface_Design).



**22BM005 ADVANCED MEDICAL IMAGE  
ANALYSIS**

**3 0 0 3**

**Course Objectives**

- To understand the principles of basic imaging modalities and properties of image construction.
- To assess the quality of medical images based on image acquisition process
- To implement advanced medical imaging techniques during the development of image modalities

**Course Outcomes (COs)**

1. Analyze radiographic imaging techniques based on its nature and properties
2. Apply projection radiography in medical imaging
3. Analyze the computer tomography imaging technique based on image quality
4. Analyse the mechanics of nuclear medical imaging and the effects of image quality
5. Analyse the concept of MRI imaging and reconstruction

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3	2	2		1		1				1	3	2	2
2	1	2	2	2		1		1				1	3	2	2
3	1	3	2	2		1		1				1	3	2	2
4	1	3	2	2		1		1				1	3	2	2
5	1	3	1	2		1		1				1	3	2	2

**UNIT I**

**9 Hours**

**RADIOGRAPHIC IMAGING**

Basic imaging principles - Image quality - Physics of radiography - Ionization - forms of ionization radiation - nature and properties - Attenuation of electromagnetic radiation - radiation dosimetry

**UNIT II**

**9 Hours**

**PROJECTION RADIOGRAPHY**

Instrumentation: X-ray tubes, filtration, contrast agents, film screen detectors, image intensifiers, Digital radiography, mammography - Image formation: Geometric effects, blurring effects, film characteristics - Noise and Scattering: Signal to noise ratio, quantum scattering, Compton scattering

**UNIT III**

**9 Hours**

**COMPUTED TOMOGRAPHY**

CT Instrumentation: Generations, dual energy CT - Image formation: Line integrals, CT numbers, CT reconstruction techniques (fan beam, parallel ray, helical, cone beam) - Image quality: Resolution, noise and artifacts

**UNIT IV**

**9 Hours**

**NUCLEAR MEDICINE IMAGING**

Physics of nuclear medicine: Radioactive decay, modes of decay, radiotracers - Planar Scintigraphy: Instrumentation, Image capture, Image formation: Event position estimation, Acquisition modes, Anger

camera imaging equation, Image quality: Resolution, noise, Sensitivity, uniformity, energy resolution, factors affecting count rate

**UNIT V**

**9 Hours**

**MAGNETIC RESONANCE IMAGING**

Instrumentation - MRI data acquisition: slice selection, frequency encoding, gradient echoes, pulse repetition interval - Image reconstruction: rectilinear data, polar data, imaging equations, Image quality: Sampling, resolution, SNR, artifacts - Advanced contrast mechanisms

**Total: 45 Hours**

**Reference(s)**

1. Jerry L Prince, Jonathan M Links, Medical Imaging Signals and Systems, Prentice Hall Publications, 2015.
2. Wolfgang Birkfellner, Applied medical Image Processing- A basic course, Second Edition, CRC Press, 2014.
3. Rafael C. Gonzales, Richard E. Woods, Digital Image Processing, Fourth Edition, Pearson Education, 2018.
4. Anil Jain K. Fundamentals of Digital Image Processing, PHI Learning Pvt. Ltd., 2011.
5. William K. Pratt, Introduction to Digital Image Processing, CRC Press, 2013.

**22BM006 MACHINE VISION****3 0 0 3****Course Objectives**

- To review image processing techniques for machine vision.
- To understand the concept of shape, region and motion analysis.
- To study object recognition techniques.

**Course Outcomes (COs)**

1. Understand fundamental concepts of machine vision
2. Apply suitable techniques for filtering images to reduce the undesired components
3. Analyze the performance of various edge detection techniques in machine vision
4. Analyze the motion detection process using moving camera
5. Analyze the process of object recognition using patterns and features

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2		1									2		
2	1	2	3	2									1		
3		3	2	2									1		
4		3	2	2									1		
5		3	2	2									1		

**UNIT I****9 Hours****MACHINE VISION FUNDAMENTALS**

Machine Vision- Relationships to Other Fields-Role of Knowledge-Image Geometry-Perspective Projection-Coordinate Systems-Levels of Computation - Thresholding, Geometric Properties, Size, Position, Orientation, Projections, Run-Length Encoding, Binary Algorithms, Morphological Operators, Optical Character Recognition

**UNIT II****9 Hours****REGION AND FILTERING BASED PROCESSING**

Regions and Edges - Region Segmentation - Region Representation - Split and Merge - Region Growing - Image Filtering - Histogram Modification - Linear Systems - Linear Filters - Median Filter - Gaussian Smoothing

**UNIT III****9 Hours****EDGE DETECTION**

Gradient - Steps in Edge Detection - Comparison- Second Derivative Operators: Laplacian Operator, Second Directional Derivative, Laplacian of Gaussian, Image Approximation - Gaussian Edge Detection, Canny Edge Detector - Subpixel Location Estimation - Edge Detector Performance - Methods for Evaluating Performance - Figure of Merit - Sequential Methods - Line Detection

**UNIT IV****9 Hours****DYNAMIC VISION**

Change Detection - Change Detection - Segmentation using Motion - Motion Correspondence - Image flow - Segmentation using a Moving Camera - Tracking - Shape from Motion

**UNIT V**

**9 Hours**

**OBJECT RECOGNITION**

System Components - Complexity of Object Recognition - Object Representation: Observer-Centered Representations, Object-Centered Representations - Feature Detection - Recognition Strategies: Classification, Matching, Feature Indexing - Verification: Template Matching, Morphological Approach, Symbolic, Analogical Methods

**Total: 45 Hours**

**Reference(s)**

1. Ramesh Jain, Ramesh C Jain, Machine Vision, pp., McGraw Hill, 1995.
2. Fabio Solari, Manuela Chessa, Silvio P. Sabatini, Machine vision Applications and Systems, BoD Books on Demand, 2012.
3. J. Shi and C. Tomasi, Good Features to Track. In IEEE Conference on Computer Vision and Pattern Recognition, 1994.
4. D. G. Lowe, Distinctive Image Features from Scale-Invariant Keypoints. In International Journal of Computer Vision, 2004.
5. D. Comaniciu and P.Meer, Robust analysis of feature spaces: Color image segmentation. IEEE Conference on Computer Vision and Pattern Recognition, June 1997, 750-755.

**22BM007 DEEP LEARNING TECHNIQUES****3 0 0 3****Course Objectives**

- To understand the theoretical foundations, algorithms and methodologies of Machine Learning Algorithms
- To design and develop an application using specific deep learning models
- To provide practical knowledge in handling and analyzing real world applications.

**Course Outcomes (COs)**

1. Apply the concepts of Machine Learning Algorithms to solve real world problems
2. Apply the Deep Learning Architectures to classify the unstructured data.
3. Analyze the Convolutional Neural Networks and transfer learning models to obtain an optimal solution
4. Build a Recurrent Neural Networks, Recursive Nets models and classify the given inputs with reduced cost and time
5. Design a model using Auto encoders and Generative models for image generation

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	3										1		
2	2	2	3										1		
3	2	3	2	1									2		
4	2	1	3	1									2		
5	2	2	3	1									2	1	2

**UNIT I****10 Hours****MACHINE LEARNING BASICS**

Learning algorithms, Maximum likelihood estimation, Building machine learning algorithm, Basic Machine Learning Algorithms: Naïve Bayes, Support Vector Machine, Decision Tree, Random Forest, Neural Networks - Multilayer Perceptron, Back-propagation algorithm and its variants stochastic gradient decent, Curse of Dimensionality.

**UNIT II****9 Hours****DEEP LEARNING ARCHITECTURES**

Machine Learning and Deep Learning, Representation Learning, Width and Depth of Neural Networks, Activation Functions: RELU, LRELU, ERELU, Unsupervised Training of Neural Networks, Restricted Boltzmann Machines, Auto Encoders, Deep Learning Applications.

**UNIT III****9 Hours****CONVOLUTIONAL NEURAL NETWORKS AND TRANSFER LEARNING**

Architectural Overview, Motivation, Layers, Filters, Parameter sharing, Regularization, Popular CNN Architectures ResNet, AlexNet , Applications Transfer learning Techniques, Variants of CNN DenseNet, PixelNet.

**UNIT IV**

**8 Hours**

**SEQUENCE MODELING RECURRENT AND RECURSIVE NETS**

Recurrent Neural Networks, Bidirectional RNNs, Encoder decoder sequence to sequence architectures BPTT for training RNN, Long Short Term Memory Networks, Neural style transfer in Keras

**UNIT V**

**9 Hours**

**AUTOENCODERS AND DEEP GENERATIVE MODELS**

Under complete Auto encoder, Regularized Autoencoder, stochastic Encoders and Decoders, Contractive

Encoders - Deep Belief networks, Boltzmann Machines, Deep Boltzmann Machine, Generative Adversarial Networks.

**Total: 45 Hours**

**Reference(s)**

1. Ian Goodfellow, YoshuaBengio and Aaron Courville, Deep Learning, MIT Press, 2017.
2. Josh Patterson, Adam Gibson Deep Learning: A Practitioner's Approach, O'Reilly Media, 2017
3. Umberto Michelucci Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks press, 2018.
4. Kevin P. Murphy Machine Learning: A Probabilistic Perspective, The MIT Press, 2012.
5. Ethem Alpaydin, Introduction to Machine Learning, MIT Press, Prentice Hall of India, Third Edition 2014.

**22BM008 BIOMATERIALS AND ASSISTIVE  
DEVICES**

**3 0 0 3**

**Course Objectives**

- To understand the theoretical foundations, algorithms and methodologies of Machine Learning Algorithms
- To provide practical knowledge in handling and analyzing real world applications.

**Course Outcomes (COs)**

1. Understand the structure of bio-materials and its bio-compatibility
2. Apply appropriate implant materials in medical field based on their properties.
3. Analyse soft and hard tissue replacement implants in biomedical applications.
4. Analyse the functions and characteristics of advanced assistive devices
5. Apply suitable noise reduction techniques for hearing aids

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2				1		1				1	1		
2	2	2	3	2		1		1				1	1		
3	2	3	3	2		1		1				1	2		
4	2	3	1	2		1		1				1	2		
5	2	2	3	2		1		1				1	2	1	2

**UNIT I**

**9 Hours**

**STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY**

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

**UNIT II**

**9 Hours**

**IMPLANT MATERIALS**

Metallic implant materials, stainless steels, Ti-based alloys, ceramic implant materials, aluminium oxides, hydroxyapatite, glass ceramics, carbons. Polymerization, polyamides, Acrylic polymers, Hydrogels, rubbers, high strength, thermoplastics, medical applications. Bio polymers: collagen and elastin. Materials for ophthalmology: contact lens, Intra ocular lens. Membranes for plasma separation and blood oxygenation

**UNIT III**

**9 Hours**

**TISSUE REPLACEMENT IMPLANTS**

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

**UNIT IV**

**EXTRACORPOREAL DEVICES**

**9 Hours**

Principle of External counter pulsation techniques, intra-aortic balloon pump, Auxiliary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves. Artificial kidney, Dialysis action, haemodialysis unit, membrane dialysis, portable dialyser monitoring and functional parameters

**UNIT V**

**9 Hours**

**HEARING AIDS**

Common tests audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids principles, drawbacks in the conventional unit, Digital Hearing Aid Enhancement and Noise reduction, Artificial middle ears.

**9 Hours**

**Total: 45 Hours**

**Reference(s)**

1. Sujata V. Bhatt, Biomaterials, Narosa Publishing House, 7<sup>th</sup> Edition, 2005
2. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1<sup>st</sup> edition, 12-May-2010
3. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1<sup>st</sup> edition, 2003.
4. Tohru Ifukube, Sound based assistive technology- support to hearing, speaking and seeing, Springer International Publications, 2017
5. BD Ratner, AS Hoffmann, FJ Schoen, JE Lemmons, An introduction to Materials in Medicine, Academic Press, 1996.
6. Park Joseph D. Bronzino, Biomaterials-Principles and Applications, CRC press, 2003.



**22BM009 BIO MEMS AND NANO TECHNOLOGY****3 0 0 3****Course Objectives**

- To introduce various MEMS fabrication techniques.
- To impart knowledge on different types of sensors and actuators and their principles of operation at the micro scale level.
- To discuss the applications of MEMS in different fields of medicine

**Course Outcomes (COs)**

1. Outline the materials used for MEMS technology and its fabrication process
2. Analyze different types of sensors and actuators and their principles of operation at the micro scale level.
3. Apply MEMS in different field of medicine
4. Categorize Nano sensors for various applications in biomedical field
5. Analyse the performance of various Nano devices used in medical applications

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	1		2			1	1				1	1		
2	2	3		2			1	1				1	1		
3	2	2	3	2			1	1				1	2		
4	2	2		2			1	1				1	2		
5	2	3		2			1	1				1	2	1	2

**UNIT I****9 Hours****MEMS MATERIALS AND FABRICATION**

Typical MEMs and Microsystems, materials for MEMS - active substrate materials-Silicon and its compounds, Silicon piezoresistors, Gallium Arsenide, quartz, polymers. Micromachining - photolithography, thin film deposition, doping, etching, bulk machining, wafer bonding, LIGA.

**UNIT II****9 Hours****SENSORS AND ACTUATORS**

Mechanics for MEMs design - static bending of thin plates, mechanical vibration, thermo mechanics, fracture and thin film mechanics. Mechanical sensors and actuators - beam and cantilever - microplates, strain, pressure and flow measurements, Thermal sensors and actuators - actuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloys - Inertia sensor, flow sensor. Properties of piezoelectric materials, Piezoelectric sensor and actuator - inchworm motor.

**UNIT III****9 Hours****THE PROSPECT OF NANOMEDICINE**

Current Medical Practice, The Evolution of Scientific Medicine - Volitional Normative Model of Disease - Treatment Methodology - Evolution of Bedside Practice - The Nano medical Perspective, Nanomedicine and Molecular Nanotechnology -Pathways to Molecular Manufacturing - Molecular Transport and Sortation

**UNIT IV**

**9 Hours**

**NANOSENSORS**

Nanosensor Technology - Chemical and Molecular Nanosensor - Displacement and Motion Sensors - Force Nanosensor - Thermal Nanosensor - Electric and Magnetic Sensing - Cellular Bio scanning - Macrosensing - intergated nanosensor technologies, genomics & proteomics - real time & in vivo medical monitoring

**UNIT V**

**9 Hours**

**NANODEVICES FOR MEDICINE**

Nanodevices for Clinical Nanodiagnosics, Nanoendoscopy, Nanobiotechnology and Drug Delivery Devices - Tools for Nanosurgery, Nanoscale Laser Surgery, Nanorobotics for Surgery - Nanotechnology for Detection of Cancer, QDs, Dendrimers for Sensing Cancer Cell Apoptosis, Gold Nanoparticles for Cancer Diagnosis, Nanotubes for Detection of Cancer Proteins, Nanoparticles for the Optical Imaging of Tumours.

**Total: 45 Hours**

**Reference(s)**

1. Chang Liu, "Foundations of MEMS", Pearson Education International, New Jersey, USA, 2nd Edition, 2011
2. Robert .A. Freital.Jr, "Nanomedicine " Landes Bioscience Press 2010.
3. Wanjun Wang, Stephen A.Soper, "BioMEMs: Technologies and applications", CRC Press, New York, 2007.
4. Robert A. Freitas, "Nanomedicine, Volume IIA: Biocompatibility", Landes Bioscience, 2011.
5. Jain.K.K, "Handbook of Nanomedicine" Springer, 2012.

**22BM010 VIRTUAL INSTRUMENTATION**

**3 0 0 3**

**Course Objectives**

- Design basic Virtual Instrumentation Systems using LabVIEW
- Interface DAQ systems with Computer through LabVIEW
- Analyze Signals using Virtual Instrumentation Systems.

**Course Outcomes (COs)**

1. Analyze the building blocks of a Graphical Programming Tool.
2. Apply the concepts of loops and arrays to design simple GUI based applications using LabVIEW.
3. Apply the concepts of Data Acquisition using DAQ Systems and interfacing it with PC.
4. Design basic virtual instrumentation systems using LabVIEW.
5. Analyze the signals using a Virtual Instrumentation System

**Articulation Matrix**

<b>C O No</b>	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>	<b>PO 7</b>	<b>PO 8</b>	<b>PO 9</b>	<b>PO1 0</b>	<b>PO1 1</b>	<b>PO1 2</b>	<b>PSO 1</b>	<b>PSO 2</b>	<b>PSO 3</b>
1	1	2	2	3	3									3	
2	1	2	3	2	3									3	
3	1	2	2	2	2									3	
4	1	2	3	3	2									3	
5	1	2	3	3	3									3	

**UNIT I**

**9 Hours**

**FUNDAMENTALS OF VIRTUAL INSTRUMENTATION**

LabVIEW - graphical user interfaces- controls and Indicators - programming - data types - data flow programming - Editing Debugging and Running a Virtual Instrument- Graphical programming palettes and tools - Front panel objects.

**UNIT II**

**9 Hours**

**GRAPHICAL PROGRAMMING ENVIRONMENT IN VI**

FOR Loops, WHILE loops, Shift Registers, CASE structure, formula nodes-Sequence structures- Arrays and Clusters- Array operations - Bundle, Unbundle - Bundle/Unbundle by name, graphs and charts - string and file I/O - High level and Low level file I/Os.

**UNIT III**

**9 Hours**

**INTERFACING DAQ SYSTEM WITH PC**

Basics of DAQ Hardware and Software - Concepts of Data Acquisition and terminology - Installing Hardware, Installing drivers -Configuring the Hardware - addressing the hardware in LabVIEW- Digital and Analog I/O function - Buffered I/O.

**UNIT IV**

**9 Hours**

**SIMPLE PROGRAMMING IN VI**

Simple programs in VI- Advanced concepts in LabVIEW- TCP/IP VIs , Synchronization - other elements of Virtual Instrumentation - Bus extensions - PXI - Computer based instruments.

**UNIT V**

**9 Hours**

**ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI**

Fourier transform - Power spectrum - Filtering tools - CRO emulation - Audio signal processing using Signal processing toolkit-Virtual instrumentation application in Biomedical, Process Control and Mechatronics.

**Total: 45 Hours**

**Reference(s)**

1. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2010.
2. Garry M. Johnson, LabVIEW Graphical Programming, Tata McGraw Hill, 1996.
3. Labview Basics I and II Manual, National Instruments.
4. Barry Paton, Sensor, Transducers and LabVIEW, PHI, 2000.
5. Lisa K Wlls, LabVIEW for Everyone,PHI,1996.

**22BM011 REHABILITATION AND ROBOTICS  
ENGINEERING**

**3 0 0 3**

**Course Objectives**

- To understand the sensory rehabilitation systems.
- To learn the use of the orthopedic prosthetics and orthotics in rehabilitation.
- To understand rehabilitation medicine and advocacy.

**Course Outcomes (COs)**

1. Understand the concepts of rehabilitation devices and its design considerations
2. Identify suitable orthotic and prosthetic devices for rehabilitation based on its functional advancements
3. Analyze the features and configurations of wheel mobility and the therapeutic exercise technique in rehabilitation
4. Analyse the role of Robotics for automation in biomedical engineering
5. Analyse the functions of rehabilitation robotics

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	3		2		1						3	
2	1	2		2		2		1						3	
3	1	3		2		2		1						3	
4	1	3		3										3	
5	1	3		3										3	

**UNIT I**

**9 Hours**

**INTRODUCTION TO REHABILITATION**

Engineering Concepts in Sensory Rehabilitation, Motor Rehabilitation - Rehabilitation Engineering Technologies: The Conceptual Frameworks - The Provision Process - Education and Quality Assurance - Specific Impairments and Relates Technologies- Future Developments - Design Considerations - Sensory augmentation and substitution- Visual system, Auditory system, Tactual system

**UNIT II**

**9 Hours**

**PROSTHETIC AND ORTHOTIC DEVICES**

Engineering concepts in motor rehabilitation, Fundamentals - Amputation - Lower extremity prosthetics - Upper limb prosthetics (trans radial), (trans humeral) - Ankle foot orthoses (AFO) - Knee Ankle Foot Orthoses (KAFO) - Truncal and Cervical orthoses - Assistive Devices - Applications

**UNIT III**

**9 Hours**

**WHEELED MOBILITY AND THERAPEUTIC EXERCISE TECHNIQUE**

Introduction - Categories of Wheelchairs - Wheelchair Prescriptions - Wheelchair Structure and Component Design - Ergonomics of Wheelchair Propulsion - Power Wheelchair Electrical Systems - Personal Transportation - Wheelchair Safety, Standards And Testing, Rehab-Therapy - Co-ordination exercises - Frenkels exercises - Gait Training - Relaxation exercises - Strengthening exercises - Mobilization exercises - Endurance exercises

**UNIT IV**

**9 Hours**

**INTRODUCTION OF ROBOTICS**

Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic Stabilization-Applications of robotics in medicine

**UNIT V**

**9 Hours**

**REHABILITATION ROBOTICS**

Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume - Precision of movement - End effectors - Sensors. human-robot interaction, Functions of rehabilitation robotics, rehabilitation robotics in recent areas - exoskeletons, Neuroplasticity, robotic therapy

**Total: 45 Hours**

**Reference(s)**

1. Robinson C.J," Rehabilitation Engineering", CRC Press, 2006
2. Rory A Cooper, " Rehabilitation Engineering Applied To Mobility And Manipulation", IOP Publishing Ltd 1995.
3. Joseph D Bronzino," The Biomedical Engineering Handbook",2nd edition, CRC Press,2000.
4. John Iovine, "Robots, Android and Animatronics", McGraw-Hill, 2nd Edition, 2012.
5. Robert J. Schilling, "Fundamentals of Robotics- Analysis and Control", Pearson Education, 2006.

**22BM012 CRITICAL CARE EQUIPMENT****3 0 0 3****Course Objectives**

- To offer clear understanding of various intensive care equipment and their working.
- To understand the necessity of different operation theatre equipment.
- To know about different dialyzers and ventilators.

**Course Outcomes (COs)**

1. Apply suitable design techniques in new monitoring devices for ICU and assist the medical personnel's during emergency situations
2. Analyze the working of various operation theatre equipment and suggest suitable surgical instruments and operational devices.
3. Compare the various techniques for clinical diagnosis, therapy and surgery, and its recent methods
4. Assess the centralized systems required during critical care environment
5. Analyze the conditions of critical care equipment in the aspect of patient safety.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		1		1		1					1	1	1
2	2	3		2		1		1					2	1	1
3	2	2		2		1		1					2	1	1
4	1	2		1		1	1	1					1	1	1
5	1	3		1		2	1	1					2	1	1

**UNIT I****9 Hours****INTENSIVE CARE UNIT EQUIPMENT**

Suction apparatus, Different types; Sterilizers, Chemical, Radiation, Steam for small and large units. ICU ventilators. Automated drug delivery systems, Infusion pumps, components of drug infusion system, closed loop control infusion system, implantable infusion system. BMD Measurements - SXA - DXA - Quantitative ultrasound bone densitometer.

**UNIT II****9 Hours****OPERATION THEATRE EQUIPMENT**

Craniotomy, Electrosurgical Machines (ESU), electrosurgical analysers, surgical aspirator, Instruments for operation. Anaesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy - Laparoscopy - Cryogenic Equipment - Anaesthesia gas, Anaesthesia gas monitor - surgical Microscope.

**UNIT III****9 Hours****ASSISTIVE CRITICAL CARE EQUIPMENT**

Defibrillators, Haemodialysis Machine, Different types of Dialyzers, Membranes, Machine controls and measurements. Heart Lung Machine, different types of oxygenators, peristaltic pumps, Incubators.

**UNIT IV**

**9 Hours**

**CENTRALISED SYSTEMS**

Centralized Oxygen, Nitrogen, Air supply & Suction. Centralized Air Conditioning, Operation Theatre table & Lighting. C Arm.

**UNIT V**

**9 Hours**

**PATIENT SAFETY**

Patient electrical safety, Types of hazards, Natural protective mechanisms against electricity, Leakage current, Inspection of grounding and patient isolation, Hazards in operation rooms, ICCU and IMCUs, Opto couplers and Pulse transformers.

**Total: 45 Hours**

**Reference(s)**

1. John G. Webster, " Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd, New Delhi, 2015
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012
3. Khandpur. R.S., "Handbook of Biomedical Instrumentation", Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003
4. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
5. Antony Y.K.Chan, "Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
6. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.



**22BM013 NUCLEAR MEDICINE****3 0 0 3****Course Objectives**

- To understand the basic of various imaging modalities in nuclear medicine
- Study the diagnostics and therapeutic applications of nuclear medicine and radiation safety procedures and regulations

**Course Outcomes (COs)**

1. Understand the concepts of physics used in nuclear medicine
2. Categorize the radiopharmaceuticals based on its characteristics, diagnosis and treatment methods
3. Analyze the performance of nuclear medicine instruments
4. Apply radionuclide and realize the medical applications in radionuclide.
5. Analyze the biological effects of radiation and safety aspects in nuclear medicine.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2		1		1	1	1					1	1	1
2	2	3		2		1	1	1					2	1	1
3	2	2		3		1	1	1					2	1	1
4	1	2		2		1	1	1					1	1	1
5	1	3		2		2	1	1					2	1	1

**UNIT I****9 Hours****NUCLEAR MEDICINE PHYSICS**

Basic Elementary introduction to structure of matter -elements - molecules and atoms - Radioactivity and interaction of radiation: Alpha, Beta and gamma emission, Laws of radioactive decay, Mechanisms of radioactive decay, Radiation intensity and exposure, Decay schemes and energy levels, Compton scattering, Pair productions, Particle interactions

**UNIT II****9 Hours****RADIOPHARMACEUTICALS**

Radionuclide production,  $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$  generator, Mechanism of localization, Types of radiopharmaceuticals, characteristics of radio pharmaceuticals, Radiopharmaceuticals for diagnosis and treatments in human, Dispensing of radio pharmaceuticals.

**UNIT III****9 Hours****PHYSICS OF NUCLEAR MEDICINE INSTRUMENTATION**

Construction and principle operation of Gamma camera, Rectilinear scanner, Basic principles of pulse height analyser, Radiation detectors-Ionization chamber, Geiger Muller counter, Semiconductor detectors, Scintillation detectors, Electronic Instrumentation for radiation detection system

**UNIT IV****9 Hours****DIAGNOSTIC AND THERAPEUTIC APPLICATIONS OF RADIONUCLIDE**

Invitro and Invivo Diagnostic techniques - PET - CT, Single photon emission computed tomography (SPECT), Radio iodine therapy for Thyrotoxicosis, Differentiated thyroid cancers, Palliative treatment for bone metastasis -  $^{32}\text{P}$  and  $^{89}\text{Sr}$  Strontium Dosage-Intravascular particulate radio nuclide Therapy,

Receptor targeted therapy, <sup>131</sup>I - MIBG Therapy, Targeted internal radiation in HCC: 90 Y, Radio - synovectomy using Yttrium

**UNIT V**

**9 Hours**

**RADIATION BIOLOGY AND SAFETY**

Biological effects of radiation-Somatic and hereditary effects of radiation-Radiation protection indifferent nuclear isotope therapy procedures, Management of radiation accidents, Radiation effect on pregnancy and fertility, Diagnosis, evaluation and treatment of radiation overexposure, Instruments used in radiation survey & monitoring, Handling of radioactive patients, Role of national and international bodies in radiation safety, ICRP recommendations, BARC regulations regarding limits of radiation exposure.

**Total: 45 Hours**

**Reference(s)**

1. Simon Cherry, James Sorenson, Michael Phelps. "Physics in Nuclear Medicine", Elsevier Saunders, 4th Edition, 2012
2. Jerrold T Bushberg, J.Anthony Seibert, Edwin M Leidholdt, John M Boone, Lippincott, "The Essential Physics of Medical Imaging", Williams & Wilkins, 3rd edition, 2011
3. Fred A Mettler, Milton J Guiberteau, "Essentials of nuclear Medicine and molecular imaging", 7th Edition, Elsevier, 2018.
4. Gopal B.Saha, " Physics and Radiation biology of Nuclear Medicine", 2006

**22BM014 CELL BIOLOGY****3 0 0 3****Course Objectives**

- To provide a basic understanding of cell, its structure, function, types and about its culture.
- To understand the concepts in Cell Biology.
- To compare cellular processes and regulation
- To carry out the recent trends in cell and molecular research

**Course Outcomes (COs)**

1. Apply structural information of cells to differentiate Eukaryotic cell and prokaryotic cell
2. Categorize cell organelles based on its types and functions
3. Analyse the transportation of action potential from one cell to another
4. Analyse the cause, and methods of cell signalling and signal transduction.
5. Analyse the cell culture preparation process

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	2									1	1	
2	1	3	2	2									1	1	
3	1	3		2									1	1	
4	1	3		2									1	1	
5	1	3		2									1	1	

**UNIT I****9 Hours****CELL STRUCTURE**

Cells - definition, Eukaryotic cell and prokaryotic cell -differences and key organelles, Relationship and evolution of Eukaryotic cell and prokaryotic cell, plant cells and animal cells - differences and general structure - Cellular environment, tissues, various types of cell, Extra cellular matrix, cytoskeletal proteins, Cell Cycle - Mitosis and meiosis.

**UNIT II****9 Hours****CELL ORGANELLES**

Cell Organelles and function - Nucleus, Cytoplasm, Endoplasmic reticulum, Golgi complex, lysosomes, cell membranes, chloroplast, mitochondria - structure, importance and function.

**UNIT III****9 Hours****CELLULAR TRANSPORT**

Transport across cell membranes - importance, classification - Active and passive, passive transport - movement of water, small lipid across membrane. Active - Na<sup>+</sup> K<sup>+</sup> ATPase Pump, Lysosomal and Vacuolar pumps. Cotransport - Symport, antiport - examples, Endocytosis and Exocytosis transport across prokaryotic membrane, entry of viruses and toxins.

**UNIT IV****9 Hours****CELL SIGNALING AND SIGNAL TRANSDUCTION**

Cell signaling - process importance, various kinds of Receptors and ligands - Examples, Different modes of action of ligands, Qualification and characterization of receptors, different modes of signal

transduction and amplification with examples, signaling through G-Proteins (Monomeric and trimeric), signaling for growth factors, second messengers, protein kinases, Ca ions and cAMP molecule in signaling.

**UNIT V**

**9 Hours**

**CELL CULTURE**

Definition, Media preparation, Propagation of eukaryotic and prokaryotic cell, cell lines, primary cultures, stock cell cultures, maintenance of cell lines in cell culture, explants cultures, differentiation and contamination

**Total: 45 Hours**

**Reference(s)**

1. James E Darnell, Harvey F Lodish, David Baltimore, " Molecular Biology of the Cell" , W.H. Freeman publishers, 2012
2. Geoffrey Cooper, "The Cell: A molecular approach", OUP USA; 8th edition, 2019.
3. Vermaand Aggarval," Cytology", S. Chand Publications, 2003.
4. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, "Molecular Biology of the cell", fifth edition, Taylor and Francis group, 2012.
5. De Robertis & De Robertis, "Cell Biology", 4th Edition, 2010.
6. Gerald Karp," Cell and Molecular Biology" , John Wiley and sons Inc, 2013.

**22BM015 TISSUE ENGINEERING****3 0 0 3****Course Objectives**

- To study Cell cycle and differentiation
- To understand the basics about stem cells and its applications
- To familiarize different synthetic and natural biomaterials in tissue replacements

**Course Outcomes (COs)**

1. Understand the fundamental concepts of Tissue Engineering
2. Apply the concepts of stem cell, gene therapy in healthcare systems
3. Apply Engineering design methods to tissue engineering
4. Apply suitable material for designing artificial organs using tissue engineering
5. Analyse the characteristics of Biomaterials in Tissue engineering

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2											3		
2	1	2	3			1							2	2	
3	1	2	3			1							2	2	
4	1	2	2			1		1					2	3	
5	1	3	2			1							2	3	

**UNIT I****9 Hours****FUNDAMENTALS OF TISSUE ENGINEERING**

Particles, waves, probability amplitudes, Schrodinger equation, wave packets solutions, operators, expectation values, Eigen functions, piecewise constant potentials

**UNIT II****9 Hours****STEM CELLS AND GENE THERAPY**

Embryonic stem cells - Liver stem cells - adult epithelial tissue stem cells - mesenchymal stem cells - strategies of gene therapy - Ex vivo Vs in vivo gene therapy, gene transfer vector, cell - specific targeting strategies, combining gene transfer with stem cell strategies, challenges to gene therapy for tissue engineering

**UNIT III****9 Hours****ENGINEERING METHODS AND DESIGN**

Soft lithography, self-assembled monolayer, micro fluidic patterning, laminar flow patterning, cells interaction with polymers, cell interaction with three dimensional polymer scaffolds and gels - polymer scaffolds fabrications, electrospinning, freeze drying, microfabrication of cell seeded scaffolds - three dimensional scaffold design and engineering

**UNIT IV****9 Hours****MATERIALS IN TISSUE ENGINEERING**

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

**UNIT V**

**9 Hours**

**APPLICATIONS**

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

**Total: 45 Hours**

**Reference(s)**

1. Robert P lanza, Robert Langer and Joseph Vacanti, "Principles of tissue engineering", Academic Press, California, 2007
2. W. Mark Saltzman, "Tissue Engineering: Engineering principles for design of replacement organs and tissue", Oxford University Press Inc New York, 2004
3. Gary E. Wnek, Gary L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering" , Marcel Dekker Inc, New York, 2008
4. R. Lanza, Anthony Atala (Eds), "Essential of Stem Cell Biology", Academic Press, USA, 2013
5. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, "Molecular Biology of the Cell" , Garland Science Publications, New York, 2008

**22BM016 GENETIC ENGINEERING****3 0 0 3****Course Objectives**

- To understand the concepts of Genetics
- To introduce the practice of recombinant DNA technologies
- To solve genetic engineering problems and design target gene expression with advanced genetic engineering techniques.
- To explore with genetic engineering techniques for cloning target gene or protein expression.

**Course Outcomes (COs)**

1. Understand the concepts of Genetics
2. Apply Recombinant DNA technology for gene cloning methods for construction of Gene Libraries
3. Apply the polymerase chain reaction in disease diagnosis, forensic science and genetic Engineering
4. Analyse the advancements in genetic Engineering
5. Analyse genetic engineering concepts in drugs and vaccine preparation and its ethical issues.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2										1	3		
2	1	2	3			1		1				1	2	2	
3	1	2	3			1		1				1	2	2	
4	1	3	2			1		1				1	2	3	
5	1	3	2			1		3				1	2	3	

**UNIT I****9 Hours****BASICS OF GENETICS**

Biomolecules: Carbohydrates, Proteins, Lipid, Amino acid and Nucleic acids. Nucleic acids: Introduction, History, DNA and RNA- genetic material, types, mutation. Chromosome, Gene, Expression of genetic information, Regulation of mRNA stability.

**UNIT II****9 Hours****RECOMBINANT DNA TECHNOLOGY**

Gene cloning - concept and basic steps; Restriction modification enzymes used in recombinant DNA technology, endonucleases, ligases and other enzymes useful in gene cloning; Vectors: plasmid, bacteriophage and other viral vectors, cosmids, artificial chromosomes, Ti plasmid, shuttle vectors, expression vectors; DNA delivery methods; Construction of genomic and cDNA libraries; Techniques for selection, screening and characterization of transformants.

**UNIT III****9 Hours****ROLE OF POLYMERASE CHAIN REACTION**

Concept of PCR; DNA polymerases; primer designing, linkers, adapters, setting up PCR reactions; Various types of PCR; Applications of PCR in disease diagnostics, forensic sciences and genetic engineering.

**UNIT IV**

**9 Hours**

**ADVANCED APPROACHES IN GENETIC ENGINEERING**

Gene expression in prokaryotes & eukaryotes, Tissue specific promoter, wound inducible promoters, Strong and regulatable promoters, promoter analysis (EMSA and DNA foot printing), gene expression profiling (real time PCR, SAGE, differential display, Microarray); DNA sequencing methods; Molecular markers: RAPD, RFLP, AFLP, SNP; Site directed mutagenesis, gene silencing techniques.

**UNIT V**

**9 Hours**

**APPLICATIONS OF GENETIC ENGINEERING**

Genetic engineering and Biotechnology; Creation of recombinant microorganisms, transgenic plants and animals; cloning of sheep (Dolly) & other mammals; applications in conservation; therapeutic vs. reproductive cloning; ethical issues and the prospects for human cloning; Gene therapy; DNA drugs and vaccines.

**Total: 45 Hours**

**Reference(s)**

1. Patrick Faraday, "Genetic Engineering: Emerging concepts and Technologies", Syrawood Publishers, 2018.
2. "The Biotech Primer: An Insider's Guide to the Science Driving the Biopharma Industry", The Biotech Primer For Non-Scientists Series, November 15, 2019
3. Sandhya Mitra, "Genetic Engineering", Mcgraw Hill, 2nd edition, 2017.
4. R. W Old," Principles of gene manipulation - An introduction to genetic engineering", Distributors, USA, Publishers" Business Services, 1989.
5. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering", Cambridge University Press, 2023.



**22BM017 CANCER BIOLOGY****3 0 0 3****Course Objectives**

- To impart knowledge on Cancer Biology fundamentals and principles of carcinogenesis.
- To discuss about molecular cancer cell biology and metastasis
- To introduce various therapeutic procedures for treating carcinoma
- To emphasize knowledge of the historical background for the development of the tumor microenvironment

**Course Outcomes (COs)**

1. Understand the concepts of cancer biology and different forms of cancers
2. Analyse the molecular mechanisms behind carcinogenesis
3. Analyse the processes of Mutation of cancer cell genomes of living cells
4. Analyze the treatment procedures currently available for cancer.
5. Categorize different therapeutic techniques used for cancer

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	3	2				1						1	2	1	
2	1	3	3			1						1	2	2	
3	1	3	3			1						1	2	2	
4	1	3	2			1		1				1	2	2	
5	1	3	2			1		1				1	2	2	

**UNIT I****9 Hours****FUNDAMENTALS OF CANCER BIOLOGY**

Regulation of cell cycle, Mutations that cause changes in signal molecules, Cancer genes - Tumour suppressor genes, oncogenes and their mutations, Modulation of cell cycle in cancer, Different forms of cancers, Clinical examination, Radiological examination, Biopsy and its type, Prediction of aggressiveness of cancer, tumour markers, Molecular tools for early diagnosis

**UNIT II****9 Hours****PRINCIPLES OF CARCINOGENESIS**

Theory of carcinogenesis, Chemical carcinogenesis, Metabolism of carcinogenesis, Principles of physical carcinogenesis, X-ray radiation, Mechanisms of radiation carcinogenesis, Diet and cancer

**UNIT III****9 Hours****PRINCIPLES OF MOLECULAR CELL BIOLOGY OF CANCER**

Signal targets and cancer, Activation of kinases, Oncogenes, Identification of oncogenes, Retroviruses and Oncogenes, Detection of oncogenes, Oncogenes/Proto oncogenes activity, Growth factors related to transformation, Telomerases.

**UNIT IV****9 Hours****PRINCIPLES OF CANCER METASTASIS**

Clinical significances of invasion, Heterogeneity of metastatic phenotype, metastatic cascade, Basement description, Proteinases and tumour cell invasion

**UNIT V**

**9 Hours**

**NEW MOLECULES FOR CANCER THERAPY**

Different forms of therapy, Chemotherapy, Radiation therapy, Detection of cancers, Use of signal targets towards a therapy of cancer, Gene therapy, Cancer resistance to chemotherapy, Advancement in cancer therapy, Nano systems for drug delivery, Enzyme inhibitors in relation to cancer therapy

**Total: 45 Hours**

**Reference(s)**

1. David Kerr, Francesco Pezzella, Mahvash Tavassoli, Cancer Biology, Oxford University Press, 2019.
2. Aysha Divan, Janice Royds, Cancer Biology and Treatment, Oxford University Press, 2020.
3. Momna Hejmadi, Introduction to Cancer Biology, bonbooks, 2023
4. Carsten Carlberg, Eunike Velleuer, Cancer Biology: How Science Works, Springer International Publishing 2021.
5. Walter M. Stadler , Cancer Biology Review A Case-Based Approach, Demos Medical Publishing, 2013

**22BM018 BIO COMPUTATIONAL TECHNIQUES****3 0 0 3****Course Objectives**

- To introduce the biocomputational techniques
- To familiarize the protein structure, modelling and simulation
- To introduce advanced computational techniques in Biology

**Course Outcomes (COs)**

1. Apply the concept of sequencing in physiology
2. Apply distance and character based methods for phylogenetic tree construction
3. Apply modelling and simulation concept to study protein structure
4. Develop suitable machine learning approaches for system engineering and modelling procedures
5. Apply perl programming for biological data analytics

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	1	2										2		2
2	2	2	3										2		2
3	2	2	3		2								2		2
4	2	1	3		2								2		2
5	2	2	3		2								2		2

**UNIT I****9 Hours****INTRODUCTION TO COMPUTATIONAL BIOLOGY AND SEQUENCE ANALYSIS**

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications.

**UNIT II****9 Hours****PHYLOGENETICS**

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

**UNIT III****9 Hours****PROTEIN STRUCTURE, MODELLING AND SIMULATIONS**

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modelling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

**UNIT IV**

**9 Hours**

**MACHINE LEARNING, SYSTEMS BIOLOGY AND OTHER ADVANCED TOPICS**

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA computing.

**UNIT V**

**9 Hours**

**PERL FOR BIOINFORMATICS**

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

**Total: 45 Hours**

**Reference(s)**

1. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press. 2019
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
4. Tisdall, James, Beginning PERL for Bioinformatics, O Reilly Publications, 2001
5. Andrew R. Leach, Molecular Modelling Principles And Applications, Second Edition, Prentice Hall 2009

**22BM019 NEUROSCIENCE****3 0 0 3****Course Objectives**

- To understand the basics of nervous systems and its functions
- To characterize neuronal cells
- To identify the effect of neuronal functions and the neural disorders
- To select suitable testing methods for analysing neural behaviour

**Course Outcomes (COs)**

1. Apply the concept of action potential propagation to understand neuron Synaptic potentials and Receptor potentials
2. Analyse the characteristics of neuronal cells based on its characterisation
3. Analyse the effect of neuronal function based on the neurotransmission models
4. Analyse the different types of neurological disorders and its causes
5. Analyse the neuronal behavioural using appropriate testing methods

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	3									1	1	1	1
2	2	3	2									1	1	1	1
3	2	3	2									1	2	1	1
4	2	3	2									1	2	1	1
5	2	3	2									1	2	1	2

**UNIT I****9 Hours****INTRODUCTION TO NERVOUS SYSTEM**

Nervous system: Introduction, Central and peripheral nervous system, Signalling molecules, First growth factor, First Neuro transmitters in brain, functional organization, Synaptic potentials and Receptor potentials.

**UNIT II****9 Hours****NEURO ANATOMY**

Structures and functions of neurons, Synapse: function, signals produced by neurons, Sensors function, Glial cells, molecular and cellular organization of neuronal differentiation, characterization of neuronal cells.

**UNIT III****9 Hours****NEUROPHYSIOLOGY AND NEUROPHARMACOLOGY**

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission. Synaptic transmission, neurotransmitters and their release; fast and slow neurotransmission; characteristics of neurites; hormones and their effect on neuronal function.

**UNIT IV**

**9 Hours**

**NEUROLOGICAL DISORDERS**

Pathogenesis, Genetic basis of neurological disorders, Psychiatric Disorders: Psychiatric epidemiology, Unipolar depression, Bipolar depression, Seasonal affective disorder, Panic disorder, Autism, Stroke, Huntington disease

**UNIT V**

**9 Hours**

**BEHAVIOUR SCIENCE**

Neuronal mechanism of behaviour, Animal behaviour, Behaviour in various environments, Behavioural and cognitive neuroscience, Behavioural studies using animal model, Testing motor functions, Grip Strength Test, Testing Cognitive Functions, Learning and memory related test

**Total: 45 Hours**

**Reference(s)**

1. Georg Goldenberg, Bruce L. Miller - Neuropsychology and Behavioral Neurology\_ Handbook of Clinical Neurology, Elsevier - libgen.lc., 2008
2. Michael J. Aminoff, Handbook of Clinical Neurology, Elsevier, London, 2012
3. Mason P., Medical Neurobiology, Oxford University Press, 2011
4. Mathews G.G. Neurobiology, 2nd edition, Blackwell Science, UK, 2000
5. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University Press, USA, 1994

**22BM020 CARDIOVASCULAR ENGINEERING**

**3 0 0 3**

**Course Objectives**

- To understand the basics of cardiovascular system
- To analyse events of cardiac cycle
- To learn hemodynamics of cardiac systems

**Course Outcomes (COs)**

1. Understand the concepts and controls of cardiovascular system.
2. Analyse the mechanical events related to human cardiac cycle
3. Analyse the cardiac excitation and contraction process
4. Assess the cardiac output for the specific events using suitable methods
5. Analyse Hemodynamic with respect to cardiovascular system

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2									1			
2	1	3	2	2								1	2	1	
3	1	3	2	2								1	2	2	
4	1	3	2	2								1	2	1	
5	1	3	2	2								1	2	1	

**UNIT I**

**9 Hours**

**OVERVIEW OF THE CARDIOVASCULAR SYSTEM**

Functions of the cardiovascular system, Circulation of blood, Central control of the cardiovascular system

**UNIT II**

**9 Hours**

**CARDIAC CYCLE**

Mechanical events, Arterial cycle and central venous pressure cycle, Clinical aspects of human cardiac cycle

**UNIT III**

**9 Hours**

**CARDIAC EXCITATION AND CONTRACTION**

Mechanism of contraction, Sinoatrial node function, cardiac conduction system, Atrioventricular node function, Autonomic regulation of the heart rate

**UNIT IV**

**9 Hours**

**ASSESSMENT OF CARDIAC OUTPUT**

Fick principle, Thermodilution and indicator dilution methods, Pulse Doppler methods, miscellaneous methods

**UNIT V**

**9 Hours**

**HEMODYNAMICS**

Relationship between pressure, flow and resistance, Frank-Starling law, Preload, afterload and contractility, Control of stroke volume and cardiac output

**Total: 45 Hours**

**Reference(s)**

1. Anne Waugh, Allison Grant, Ross and Wilson Anatomy and Physiology, Elsevier, edition 14. 2018.
2. George A Stouffer, J Larry Klein, Cardiovascular Hemodynamics for the clinician, First edition, John Willey & Sons, 2017
3. Joseph D.Bronzino, Biomedical Engineering Fundamentals, Taylor& Francis, 2006
4. John Enderle, Susan blanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Elsevier, 2005.
5. Michel R Labrosse, Cardiovascular Mechanics, First edition, CRC press, Taylor and Francis Group, 2019



**22BM021 PHYSIOLOGICAL MODELLING**

**3 0 0 3**

**Course Objectives**

- To introduce system concept to physiology
- To introduce relationship between engineering control system and physiological control system
- To familiarize lumped and distributed parametric modelling techniques for understanding physiology
- To model dynamically varying physiological system

**Course Outcomes (COs)**

1. Apply Engineering system concept for human physiological systems.
2. Analyze system transfer function and the feedback approach to derive mathematical model of a Physiological system
3. Analyze the vital homeostatic mechanisms as closed loop control system
4. Develop suitable models for analysing Cardiopulmonary System
5. Analyse Respiratory physiology using mathematical model and its simulation

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	3	2								1	3	2	1
2	2	3	2	2								1	3	2	1
3	2	3	2	2								1	3	2	1
4	2	2	3	2								1	3	2	1
5	2	3	2	2								1	3	2	1

**UNIT I**

**9 Hours**

**SYSTEM CONCEPT**

Purpose of physiological modelling and signal analysis, Characterization of simple physiological system, System properties: Resistance, linear resistance analysis, static and dynamic resistance, Storage, system with volume storage, electrical analog of compliance, combined hollow elastic element, cylindrical elements, storage in thermal systems, storage in mechanical systems Distributed Vs lumped parametric model, unmyelinated nerve fiber model simulation

**UNIT II**

**9 Hours**

**SYSTEM ANALYSIS AND FEEDBACK**

Review: transfer function, First and second order system transfer function and step response transfer function, sinusoidal analysis of second order system. Difference between engineering and physiological control systems. Muscle reflex system Open vs closed loop system. Positive and negative feedback system

**UNIT III**

**9 Hours**

**PHYSIOLOGICAL CONTROL SYSTEMS AND ANALYSIS**

Homeostasis: Body temperature, Glucose regulation, Blood pressure regulation, Fight-Flight response, Body fluid, pH regulation, electrolyte regulation, Transient and steady state response - Steady state operating point- the steady-state characteristics

**UNIT IV**

**9 Hours**

**MODELLING OF CARDIOPULMONARY SYSTEM AND OTHER MODELS**

Review of cardiovascular anatomy and physiology, two-element and three element Windkessel model, cardiac muscle model, Model of Isovolumic ventricle and ejection effect Simplified model of heart with heart valves- Baroreflex Model- simplified circulatory model.

**UNIT V**

**9 Hours**

**RESPIRATORY SYSTEM AND OTHER MODELS**

Review of Respiratory system anatomy and physiology, Lung modelling, Pressure Model, Linear lung model with sinusoidal airway dynamics, Gas model, chemical regulation of ventilation, Cheyne-Stoke breathing, biot breathing, Hodgkin-Huxley model, Thermal system

**Total: 45 Hours**

**Reference(s)**

1. Benjamin C Kuo, Automatic control systems, Tenth Edition, McGraw-Hill Education, 2017
2. Michel C Khoo, Physiological Control Systems -Analysis, simulation and estimation, Prentice Hall of India, 2001
3. Marmarelis, Nonlinear Dynamic Modeling of Physiological Systems, Wiley-IEEE Press,2004
4. Bernhard Graimann, Brendan Allison, GertPfurtscheller, Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction, Springer, 2010
5. David T Westwick, Robert E. Kearney, Identification of Nonlinear Physiological Systems, Wiley-IEEE Press, 2003

**22BM022 PROSTHETIC AND ORTHOTIC DEVICES****3 0 0 3****Course Objectives**

- To introduce appropriate assist device suitable for specific disorder
- To Develop new assist devices for the needy
- Understand orthopaedic prosthetics and orthotics in rehabilitation

**Course Outcomes (COs)**

1. Apply suitable assistive technology (AT) for human mobility
2. Analyse sensory impairment of vision and hearing and suggest suitable aiding device
3. Analyze the recent advancements in assistive technology for Vital organs
4. Model an assistive device for a given organ impairment
5. Evaluate the performance of an implant design based on its performance parameters

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	3	2		1		1				1	2	3	2
2		2	2	3		1		1				1	2	3	2
3		2	2	3		1		1				1	2	3	2
4		1	3	2		1		1				1	2	3	2
5		2	2	3		1		1				1	2	3	2

**UNIT I****9 Hours****ASSISTIVE TECHNOLOGY FOR MOBILITY**

Basic assessment and evaluation for mobility, Control systems, navigation in virtual space by wheelchairs, Wheel chair seating and pressure ulcers, Fuzzy logic expert system for automatic tuning of myoelectric prostheses, Intelligent prosthesis

**UNIT II****9 Hours****ASSISTIVE TECHNOLOGY AND SENSORY IMPAIRMENTS**

Visual and auditory impairment, assessment methods, Libraille, GRAB, mathematical Braille, Augmentative and alternative methods for hearing impairment, Use of multimedia technology to help hard of hearing children, Haptic as a substitute for vision

**UNIT III****9 Hours****ASSIST DEVICES FOR VITAL ORGANS AND ADVANCEMENTS IN TECHNOLOGY**

Cardiac assist devices, Intra-Aortic Balloon Pump (IABP), auxiliary ventricles, Dialysis for kidneys, Intermittent positive pressure breathing (IPPB) type assistance for lungs, Latest use of assistive technology for chronic heart diseases and healthcare, Information technology, telecommunications, new media in assisting healthcare, Future trends in assistive technology, virtual reality based training system for disabled children

**UNIT IV**

**9 Hours**

**PRINCIPLES OF IMPLANT DESIGN**

Principles of implant design, cardiac implants, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration

**UNIT V**

**9 Hours**

**IMPLANT DESIGN PARAMETERS AND ITS SOLUTION**

Biocompatibility, local and systemic effects of implants, Design specifications for tissue bonding and modulus matching, Degradation of devices, natural and synthetic polymers, corrosion, wear and tear, Implants for Bone, Devices for nerve regeneration, dental and otologic implants

**Total: 45 Hours**

**Reference(s)**

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010
2. Kenneth J. Turner, Advances in Home Care Technologies: Results of the match Project, Springer, 1st edition, 201
3. Gerr, M. Craddock, Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003
4. Marion. A. Hersh, Michael A. Johnson, Assistive Technology for visually impaired and blind, Springer Science & Business Media, 1st edition, 2010

**22BM023 REGENERATIVE MEDICINE AND  
ERGONOMICS**

**3 0 0 3**

**Course Objectives**

- To familiarize nature and significance of stem cells and its applications
- To Explain the Molecular therapy for regeneration
- To outline the basics of Biomechanical, physiological and anthropometric background.

**Course Outcomes (COs)**

1. Understand the concept of regenerative medicine and its applications
2. Analyze the usage of stem cells in various clinical applications and injuries
3. Apply suitable biomaterials for designing regenerative medicine
4. Analyse the Anthropometric design principles utilization in regenerative medicine
5. Analyse the ergonomic impacts in Human physiology

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2			1		1		1		1		1	1	1	1
2		3	1	2		1		1		1		1	1	3	2
3		1	3	2		1		1		1		1	1	2	2
4		3	1	2		1		1		1		1	1	3	2
5		3	1	2		1		1		1		1	1	3	2

**UNIT I**

**9 Hours**

**REGENERATIVE MEDICINE**

Regenerative Therapy, Introduction-Large scale manufacturing of cells, tissues and organs, Artificial organs, Gene therapy Applications-Engineered Tissues and Regenerative Medicine, Molecular therapy for regeneration, Personalized therapies in Regenerative Medicine, Applications of Regenerative Medicine

**UNIT II**

**9 Hours**

**STEM CELL BIOLOGY**

Introduction, Types & sources of stem cell with characteristics: hematopoietic differentiation pathway, Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, cancer stem cells, induced pluripotent stem cells.

**UNIT III**

**9 Hours**

**BIOMATERIALS AND HUMAN- ENVIRONMENT INTERACTION**

Biomaterials: Properties of Biomaterials, Surface, bulk, mechanical and biological properties, Biomechanical, Physiological, Anthropometric background, Posture, Sitting, Standing, Change of posture, Hand and arm postures, Movement, Lifting, carrying, pulling and pushing.

**UNIT IV**

**9 Hours**

**ANTHROPOMETRY**

Anthropometric design principles, work space envelope, factors in design of work space surfaces, principles of seat design, principles of control panel, reducing accidents by altering behaviour.

**UNIT V**

**9 Hours**

**HUMAN FACTORS AND ERGONOMICS**

Standards, Applications in healthcare, Neuro-ergonomics in human-system interaction, Case Study Biomedical Application, Design optimization of Medical Equipment.

**Total: 45 Hours**

**Reference(s)**

1. HosseinBaharvand (Editor), Nasser Aghdami (Editor). Regenerative Medicine and Cell Therapy (Stem Cell Biology and Regenerative Medicine). Humana Press; 2013 edition
2. Pascale Carayon, Handbook of Human Factors and Engineering, Second Edition, CRC Press, 2011
3. Raphael G., Richard S., Stem Cell-Based Tissue Repair, Cambridge RSC Publishing, 1st Edition, 2011
4. Lanza R., Gearhart J. et al. Essential of Stem Cell Biology, Elsevier Academic, 1st Edition, 2006.
5. Gavriel Salvendy, Handbook of Human Factors and Ergonomics, John Wiley & Sons, Fourth Edition 2012.
6. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, Third Edition, 2016

**22BM024 FINITE ELEMENT ANALYSIS**

**3 0 0 3**

**Course Objectives**

- To introduce the concepts of finite element methods for biomechanical analysis
- To familiarize beam elements and scalar problem in two dimension
- To explain analysis approach to field problems

**Course Outcomes (COs)**

1. Understand the concept of modelling in deriving one dimensional and two dimensional equations for Finite Element Modelling(FEM) techniques
2. Apply the beam element and scalar problem in two dimensional FEM approaches
3. Apply the finite element analysis in biomechanical research
4. Analyse the characteristics of non-linear real time problems with FEM
5. Analyse the impact of physiological model for the given force using FEM

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2	1	2								1	1	1	
2		2	1	2								1	2	1	
3		2	1	2								1	2	1	
4		3	1	2								1	2	2	
5		3	1	2								1	2	2	

**UNIT I**

**9 Hours**

**INTRODUCTION TO MODELLING**

Historical Background, Mathematical Modelling of field problems in Engineering, Governing Equations, Natural and Essential Boundary conditions - Basic concepts of the Finite Element Method. One Dimensional Second Order Equations, Discretization, element types- Linear and Higher order Elements Derivation of Shape functions and Stiffness matrices and force vectors.

**UNIT II**

**9 Hours**

**BEAM ELEMENTS AND SCALAR PROBLEM IN TWO DIMENTION**

Fourth Order Beam Equation Transverse deflections, Natural frequencies of beams and longitudinal vibration. Second Order 2D Equations involving Scalar Variable Variation Formulation Finite Element Formulation Triangular Elements Shape functions and element matrices and vectors. Application to Field Problems in Bio mechanics, Quadrilateral elements.

**UNIT III**

**9 Hours**

**APPLICATIONS TO FIELD PROBLEMS**

Higher order elements. Natural co-ordinate systems Isoparametric elements Shape functions for isoparametric elements One, two and three dimensions Serendipity elements Numerical integration and application to plane stress problems transformation in coordinates- Jacobian of transformation order of convergence- numerical integration example problems- shape functions in natural coordinates- rectangular elements- Lagrange family.

**UNIT IV**

**9 Hours**

**NON-LINEAR ANALYSIS**

Introduction to Nonlinear problems, some solution methods, computational procedure, simple material nonlinearity, stress stiffening, contact interfaces, problems of gaps and contact, geometric nonlinearity, modelling considerations.

**UNIT V**

**9 Hours**

**IMPACT ANALYSIS**

Mechanical properties of biological and commonly used biomedical engineering materials, Critical reviews of finite element analysis in biomechanical research. Modelling and force analysis of musculoskeletal systems Stress calculations

**Total: 45 Hours**

**Reference(s)**

1. King-Hay Yang, Basic Finite Element Method as Applied to Injury Biomechanics, Elsevier Academic Press. 2017
2. Connie McGuire, Finite Element Analysis: Biomedical Aspects, NY Research press, 2015
3. Moratal D., Finite Element Analysis from Biomedical Applications to Industrial Developments, InTech Publisher, 2014
4. J N Reddy, Finite element methods, Tata McGrawHill, 2003
5. Seshu, Text Book of finite element analysis, Prentice Hall, New Delhi, 2003



**22BM025 HAPTICS**

**3 0 0 3**

**Course Objectives**

- To introduce Haptic concepts
- To familiarize different classifications of Haptics and its applications
- To Explain building technology of Haptics

**Course Outcomes (COs)**

1. Apply suitable display devices for Haptic device based on their performances
2. Apply Human perceptual parameters in Haptics technology
3. Apply appropriate haptic sensors for Machine Haptics
4. Analyse the design of computer haptics
5. Evaluate the role of haptic systems in medical and nonmedical fields

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	3		1						1	1	2	
2	1	2	3	2		1						1	1	2	
3	1	2	1	3		1						1	1	2	
4	1	3	2	2		1						1	1	2	
5	1	2	1	3		1		1				1	2	2	2

**UNIT I**

**9 Hours**

**INTRODUCTION**

Touch, Sense of Touch, Perception of world through touch, Haptics, Tactile system, Tactile receptors, Sensory and Motor specialization of Hand, Haptic perception, Haptic Illusion, Tactile and Haptic Displays, Haptic exploration, Concepts and terminologies

**UNIT II**

**9 Hours**

**HUMAN HAPTIC PERCEPTION**

Introduction, Touch and cognition, Human Haptic system: Mechanical structure of Arm, Hand haptics system, Human sensory system, The motor system, Haptic cognition, Haptic exploration, Concept of Illusion, Human perceptual parameters for Haptics: Interface development, Perception Thresholds

**UNIT III**

**9 Hours**

**MACHINE HAPTICS**

Introduction, Haptic Interfaces: Robotic perspective, Haptic interface system, HAVE sensor: Electromechanic sensors, Optical sensors, Capacitive sensor, Resistive sensor, Force sensors, strain gauge sensors, Magnetic sensor, HAVE actuators: Magnetic Levitation Devices, Nonholonomic devices, Magnetic sensors and parallel mechanisms, performance specifications: physical attributes, special attributes and temporal attributes

**UNIT IV**

**9 Hours**

**COMPUTER HAPTICS**

Introduction, Haptic rendering subsystems, Polygon, based representation and scene graph, collision detection techniques and bounding volumes, control methods for Haptic systems: Impedance control

architecture, Feed, forward impedance control architecture, positive feedback Impedance control architecture, Hybrid compensation Impedance control architecture, Admittance control architecture

**UNIT V**

**9 Hours**

**HAPTICS APPLICATIONS**

Introduction, Haptics for Medical Applications: Surgical simulation, stroke based rehabilitation, support of the visually impaired, Tele, surgery, Media: Haptic broadcasting. E, commerce, Video games, other application: Mobile Haptics, Haptics and VR, Introduction to Wearable Haptic devices

**Total: 45 Hours**

**Reference(s)**

1. Lynette Jones, Haptics, The MIT Press, 2018
2. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics Technologies: Bringing Touch to Multimedia, Springer Science & Business Media, 2011
3. Tom Bruno, Wearable Technology: Smart Watches to Google Glass for Libraries, Rowman & Littlefield Publishers, Lanham, Maryland, 2015.
4. Hiroyuki Kajimoto, Masashi Konyo, Shoichi Hasegawa, Takuya Nojima, Ki-Uk Kyung, Haptic Interaction: Science, Engineering and Design. (2017). Switzerland: Springer Nature Singapore.
5. Abdulmotaleb El Saddik, Mauricio Orozco, Mohamad Eid, Jongeun Cha, Haptics Technologies Bringing Touch to Multimedia, Springer, 2011

**22BM026 MEDICAL TEXTILES****3 0 0 3****Course Objectives**

- To learn about different types of Biomaterials
- To understand the Biomedical application of different textile structures
- To analyze the Functional requirements of textile structures for specific end use
- To understand the Selection and characterization of textile materials used for biomedical applications

**Course Outcomes (COs)**

1. Categorize medical textiles based on the material used and its usage in medical field
2. Apply material properties of biopolymers suitable for implantable, non, implantable and drug delivery textiles
3. Apply textile technology to implantable and drug delivery systems
4. Apply appropriate textile technology to wound care and dressing applications
5. Analyse the components of smart textile and ethical issues of textile technology

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		2		1							2	1	
2	2	2		2		1							2	1	
3	2	2		2		1							2	1	
4	1	2		2		1							2	1	
5	1	3		2		1		2					2	1	

**UNIT I****9 Hours****INTRODUCTION**

Medical textiles , classification, current market scenario in international and national level , government initiatives; antimicrobial fibres and finishes; nano fibrous materials and films; super absorbent polymers; operating room garments; personal health care and hygiene products and their testing methods; applications of non, wovens in medicine; textiles in infection prevention control.

**UNIT II****9 Hours****BIOPOLYMERS**

Biopolymers: classification and their properties, requirements, and applications, testing methods; In vitro tests , direct contact, agar diffusion & elution methods , in vivo assessment of tissue compatibility. Tissue engineering: properties and materials of scaffolds, relationship between textile architecture and cell behavior , applications of textile scaffolds in tissue engineering.

**UNIT III****9 Hours****IMPLANTABLES, NON, IMPLANTABLES AND DRUG DELIVERY**

Bandages, types, properties and applications; compression garments, types, properties and applications; sutures: types and properties; implantable textiles: hernia mesh , vascular prostheses , stents; Extra corporeal materials: Cartilage nerves , liver ligaments, kidney, tendons, cornea; Drug delivery textiles: classification , mechanism various fabrication methods , characterization , applications.

**UNIT IV**

**9 Hours**

**WOUND CARE AND REUSABLE MEDICAL TEXTILES**

Wound: types and healing mechanism, textile materials for wound dressing , bio active dressing , anti microbial textiles dressing , composite dressing , , testing of wound care materials; Wound 97 compression textiles; Reusable medical textiles: types, advantages, physical properties and performance , , reusable processing methods.

**UNIT V**

**9 Hours**

**SMART MEDICAL TEXTILES AND LEGAL ISSUES**

Smart textiles , types, characteristics , smart textiles in wound care; applications of phase change and shape memory materials , monitoring pregnancy, children and cardio patients , mobile health monitoring ; electronics in medical textiles; Smart textiles in rehabilitation and applications; textile sensors for healthcare ;legal and ethical values involved in the medical textile materials

**Total: 45 Hours**

**Reference(s)**

1. Joon B. Park., and Joseph D. Bronzino., Biomaterials , Principles and Applications , CRC Press, Boca Raton London, New York, Washington, D.C. 2002.
2. Anand S.C., Kennedy J.F.,Miraftab M., and Rajendran S., Medical Textiles and Biomaterials for Health Care , Wood head Publishing Ltd., 2006
3. Horrocks A R, Anand S C , Handbook of Technical Textiles, Woodhead Publishing and Textile Institute, USA, 2000.
4. Adanur S., Wellington Sears Handbook of Industrial Textiles , Technomic Publishing Co. Inc., Lancaster Pennsylvania, 1995, ISBN 1, 56676, 340, 1 4
5. Michael Szycher and Steven James Lee, Modern Wound Dressing: A Systematic Approach to Wound Healing , Journal of Biomaterials Applications, 1992

**22BM027 WEARABLE SYSTEMS AND BODY AREA NETWORKS**

**3 0 0 3**

**Course Objectives**

- To provide an overview of the technical background of Body Area Networks (BAN) and its application in health care using mobile technology
- To explain the hardware requirement of BAN
- To familiarize the communication and security aspects in the BAN

**Course Outcomes (COs)**

1. Analyse the performance and challenges of body area networks (BAN) for healthcare
2. Analyse the suitability of selected hardware for BAN
3. Analyse the wearable sensors and standards for BAN
4. Apply mobile devices for healthcare monitoring
5. Analyze the mobile health technology used for various healthcare applications

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3		2		1		1					2	1	
2	1	3		2		1		1					2	1	
3	1	3		2		1		1					2	1	
4	1	2		2		1		1					2	1	
5	1	3		2		1		1					2	1	

**UNIT I**

**9 Hours**

**BODY AREA NETWORKS**

BAN and healthcare, Technical challenges, sensor design, Biocompatibility, energy supply, energy scavenging methods, optimal node placement, number of nodes, networks for BAN, System security and reliability, standards. BAN Architecture

**UNIT II**

**9 Hours**

**HARDWARE FOR BAN**

Processor, Low Power MCUs, mobile computing MCUs, Integrated processor with radio transceiver, memory types and ranges, Antenna types, PCB antenna, wire antenna, ceramic antenna, external antenna, Sensor interface, power sources, batteries and fuel cells for sensor nodes.

**UNIT III**

**9 Hours**

**WEARABLE SENSORS AND STANDARDS FOR BAN**

Wearables fundamentals and role of wearable sensors, Attributes of wearable, flexible electronics, meta, wearable, Future of wearable, research road map, Wireless personal area network technologies, Zigbee, coexistence issues with BAN.

**UNIT IV**

**9 Hours**

**MOBILE DEVICES FOR HEALTHCARE**

Wearable system for ECG Monitoring, Evaluation of night time performance, smart phone based health care monitoring system, Phone based fall risk prediction, RFID based personal mobile medical assistance, Secure medical sensor network

**UNIT V**

**9 Hours**

**MOBILE HEALTH TECHNOLOGIES AND APPLICATIONS**

Mobile nutrition tracking, case study, accessing existing virtual electronic patient record, mobile personal health records, Monitoring hospital patients, sensing vital signs and transmission using wireless networks, Context aware healthcare applications with case study

**Total: 45 Hours**

**Reference(s)**

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
3. Canjun Yang , G.S.Virk, Huayong yang , Wearable sensors and Robots , Proceeding of international conference on wearable sensors and robots, 2017
4. Zhang, Yuan, Ting, Wearable Medical Sensors and Systems, Springer, 2013
5. Guang, ZhongYang(Ed.), Body Sensor Networks, Springer, 2006.
6. Mehmet R. Yuce, Jamil Y.Khan, Wireless Body Area Networks Technology, Implementation, and Application, Pan Stanford Publishing Pte. Ltd., Singapore, 2012

**22BM028 TELEMEDICINE AND IOT****3 0 0 3****Course Objectives**

- To understand the principles, practices and areas of application in Hospital management.
- To understand the telemedicine in different sectors
- To introduce the relevance of Telemedicine to the existing technology through demonstrations, case studies, simulations in the field of Telemedicine and IoT

**Course Outcomes (COs)**

1. Understand the concepts and multimedia principles used in telemedicine
2. Outline telemedicine standards and regulations in device design
3. Apply mobile technology in Tele healthcare
4. Apply appropriate peripherals and communication protocol of IOT in Tele medicine
5. Apply suitable technology in tele medicine for real time scenario

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1		2			1						1			
2	1		2	2		1		2				1	2		
3	1	2	3	2		1						1	2		
4	1	2	3	2		1						1	2		
5	1	2	3	2		1						1	2		

**UNIT I****9 Hours****TELEMEDICAL TECHNOLOGY**

Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Telehealth, Tele care, Organs of telemedicine, Principles of Multimedia, PSTN, POTS, ANT, ISDN, Internet, Air wireless communications, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www). Clinical data, local and centralized

**UNIT II****9 Hours****TELEMEDICAL STANDARDS**

Data Security and Standards, Mechanisms of encryption, phases of Encryption. Protocols: TCP/IP, ISO:OSI, Standards to followed DICOM, HL7, H. 320 series (Video phone based ISBN) T. 120, H.324 (Video phone based PSTN), Video Conferencing, Real, time Telemedicine integrating doctors / Hospitals, Clinical laboratory data, Radiological data, and other clinically significant biomedical data, Administration of centralized medical data, security and confidentiality of medical records and access control, Cyber laws related to telemedicine

**UNIT III****9 Hours****MOBILE TELEMEDICINE**

Tele radiology: Definition, Basic parts of tele radiology system, Tele pathology, multimedia databases, color images of sufficient resolution, Dynamic range, spatial resolution, compression methods, Interactive control of color, Medical information storage and management for telemedicine, patient information medical history, test reports, medical images diagnosis and treatment. Hospital information system, Doctors, paramedics, facilities available. Pharmaceutical information system

**UNIT IV**

**9 Hours**

**INTRODUCTION TO IOT**

Introduction to Internet of Things (IoT). Review of CC3200 core and its architecture, Introduction to advanced ARM Cortex M4 architecture, Peripherals overview, User API, Power challenges with IoT, CC3200 Simplelink applications, starting with Code Composer Studio V6. Various wireless protocols and its applications: ZigBee, Bluetooth Low Energy, 6LowPAN, Wi, Fi

**UNIT V**

**9 Hours**

**APPLICATIONS**

Telemedicine access to health care services, health education and self, care. Introduction to robotics surgery, telesurgery. Tele cardiology, Tele oncology, Telemedicine in neurosciences, Electronic Documentation, e, health services security and interoperability, Telemedicine access to health care services. Introduction to WLAN, WLAN parameters, AP/STATION modes and its Security types, Socket connection, WLAN AP and WLAN STATION configuration settings.

**Total: 45 Hours**

**Reference(s)**

1. R.S.Khandpur Telemedicine Technology and Applications (mhealth, Telehealth and ehealth), PHI Learning Pvt.Ltd, Delhi, 2017
2. Wootton, R., Craig, J., Patterson, V., Introduction to Telemedicine, Royal Society of Medicine Press Ltd, Taylor & Francis 2006
3. Latifi, R. Current Principles and Practices of Telemedicine and e, Health, IOHS Press, Washington DC, 2008
4. Bashshur, R.L., Shannon G.W., History of Telemedicine, New Rochelle NY: Mary Ann Liebert Publishers, 2009
5. Victor Lyuboslavsky, Telemedicine and Telehealth 2.0: A Practical Guide for Medical Providers and Patients, CreateSpace Independent Publishing Platform, 1st edition, 2015



**22BM029 BIOINFORMATICS****3 0 0 3****Course Objectives**

- To understand the evolving field of bioinformatics.
- To analyse large biological data sets
- To formulate the usage of biological tools effectively

**Course Outcomes (COs)**

1. Implement Bioinformatics in data generation
2. Identify appropriate biological data base for various analysis
3. Apply suitable analytical techniques to Biological data for research.
4. Implement the concepts of genomic technology in bioinformatics
5. Analyse genetic variability of clinical data

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	2	3								1	1	2	
2		2	3	2								1	1	2	
3		2	3	2								1	1	2	
4		2	3	2								1	1	2	
5		2	1	3				1				1	1	2	

**UNIT I****9 Hours****INTRODUCTION TO BIOINFORMATICS AND DATA GENERATION**

Bioinformatics and its relation with molecular biology. Examples of tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, PubMed, PDB ), Data generation; Generation of large scale molecular biology data , Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X, Ray Diffraction, and microarray, Applications of Bioinformatics

**UNIT II****9 Hours****BIOLOGICAL DATABASE AND ITS TYPES**

General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum).

**UNIT III****9 Hours****STRUCTURAL BIOINFORMATICS**

Fundamentals of X, ray diffraction, NMR spectroscopy of macromolecules, Protein Structure: Primary, Secondary, Super Secondary, Domains, Tertiary, Quaternary, Structural features of RNA: Primary, Secondary, Tertiary, Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and Analysis tools.

**UNIT IV**

**9 Hours**

**DIFFERENT TYPES AND METABOLIC PATHWAYS**

Genomics: Genome Annotation, Genome Assembly, Structural and Functional Genomics. Comparative Genomics, Metagenomics: Introduction, metagenome, shotgun metagenomics (pyrosequencing), Metabolic pathway database (KEGG pathway database), Concept of metabolome and metabolomics

**UNIT V**

**9 Hours**

**GENE EXPRESSION AND REPRESENTATION OF PATTERNS AND RELATIONSHIP**

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies, and Graphical models (including Markov chain and Bayes notes). Genetic variability and connections to clinical data.

**Total: 45 Hours**

**Reference(s)**

1. Introduction to Bioinformatics Algorithms by Neil Jones and Pavel Pevzner. 2015.
2. Bioinformatics by David Mount, 2016.
3. Bioinformatics: Principles and Applications by Zhumur Ghosh and BibekanandMallick, 2010.
4. Bioinformatics: Sequence and Genome Analysis by Mount and David W, 2005.

**22BM030 VIRTUAL AND AUGMENTED REALITY  
IN HEALTHCARE**

**3 0 0 3**

**Course Objectives**

- To introduce the relevance of this course to the existing technology through demonstrations, 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

**Course Outcomes (COs)**

1. Assess the principle and functions of Virtual Reality (VR)
2. Apply modelling procedures to develop VR applications
3. Design and configure Haptic model in regard to human parameters
4. Assess the principle and components of Augmented Reality (AR)
5. Analyse utility of computer vision and techniques in Augmented Reality (AR)

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		2									2	2	
2	2	2	3	2									2	2	
3	2	2	3	2									2	2	
4	2	2	3	2									2	2	
5	2	3	2	2									2	2	

**UNIT I**

**9 Hours**

**INTRODUCTION TO VIRTUAL REALITY**

Definition of Virtual Reality (VR), Principles of VR, Main components, the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture Interfaces-Output Devices: Graphics displays-sound displays & haptic feedback, Physiological data recording, Position and movement measuring systems, Problems in VR.

**UNIT II**

**9 Hours**

**VR DEVELOPMENT PROCESS & CONTENT CREATION CONSIDERATIONS**

Geometric modelling - kinematics modelling- physical modelling - behaviour modelling - model Management. 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 III**

**9 Hours**

**VR ON THE WEB & VR ON THE MOBILE**

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 IV**

**9 Hours**

**INTRODUCTION TO AUGMENTED REALITY WITH AR HARDWARE**

Defining augmented reality, history of augmented reality, Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.

**UNIT V**

**9 Hours**

**COMPUTER VISION FOR AR & AR TECHNIQUES**

Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application, AR Techniques – Marker based and Marker Less approach.

**Total: 45 Hours**

**Reference(s)**

1. Jason Jerald. 2015. The VR Book: Human, Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.
2. C. Burdea & Philippe Coiffet, Virtual Reality Technology, Second Edition, Gregory, John Wiley & Sons, Inc.,2008.
3. Augmented Reality: Principles and Practice (Usability) by Dieter Schmalstieg & Tobias Hollerer, Pearson Education (US), Addison, Wesley Educational Publishers Inc, New Jersey, United States, 2016. ISBN: 9780321883575.
4. Wade Alhalabi, Virtual Reality Implementation in Healthcare Settings, Medical Information Science Reference, 2017.
5. James Roland, Virtual Reality and Medicine , Reference Point Press, Incorporated, 2018.

**22BM031 MEDICAL OPTICS****3 0 0 3****Course Objectives**

- To introduce the basic instrumentation related to photonics
- To familiarize the practical applications of optics related to medicine
- To analyze the diagnostic and therapeutic applications in medical optics

**Course Outcomes (COs)**

1. Identify suitable and essential instruments used in medical optics.
2. Analyze the optical properties of tissues for visualizing its structure
3. Apply appropriate Laser for surgical applications
4. Apply optics concept for Non, thermal diagnostic applications
5. Apply optics in therapeutic applications

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3		2				1					2	2	
2	2	2	3	2				1					2	2	
3	2	2	2	2				1					2	2	
4	1	2	3	2				1					2	2	
5	1	2	3	2				1					2	2	

**UNIT I****9 Hours****INSTRUMENTATION IN PHOTONICS**

Review of basic properties of light, Reflection, Refraction, Scattering, fluorescence and phosphorescence. Instrumentation for absorption, Scattering and emission measurements, excitation light sources, high pressure arc lamp, LEDs, Lasers. Optical filters. Optical detectors, Time resolved and phase resolved detectors, optical tweezers.

**UNIT II****9 Hours****OPTICAL PROPERTIES OF THE TISSUES**

Light transport inside the tissue, optical properties of tissue. Laser Characteristics as applied to medicine and biology, Laser tissue Interaction, Chemical, Thermal, and Electromechanical. Photo ablative processes.

**UNIT III****9 Hours****SURGICAL APPLICATIONS OF LASERS**

Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Laser Tissue welding, Case study.

**UNIT IV****9 Hours****NON THERMAL DIAGNOSTIC APPLICATIONS**

Phototherapy, Photodynamic therapy (PDT), Principle and mechanism, Oncological and non, oncological applications of PDT, Bio stimulation effect, applications, Laser Safety Procedures.

**UNIT V**

**9 Hours**

**THERAPEUTIC APPLICATIONS**

Pulsed Laser use in Cardiology, Dentistry and oral surgery, Ophthalmology, Optical Tweezers, Vascular welding, Cosmetic Surgery, Soft tissue treatment, Dermatology Fetal surgery.

**Total: 45 Hours**

**Reference(s)**

1. Tuan VoDinh , Biomedical photonics Handbook, CRC Press LLC, 2014
2. MarkolfH Niemz, Laser Tissue Interaction Fundamentals and Applications , Springer, 2007
3. Paras N. Prasad, Introduction to Bio photonics, A John Wiley and sons, Inc. Publications, 2003
4. Mark E Brezinski, Optical Coherence Tomography Principles and Applications, Academic Press, 2006
5. R Splinter and B A Hooper, An Introduction to Biomedical Optics, Taylor and Francis, 2007

**22BM032 MEDICAL WASTE MANAGEMENT****3 0 0 3****Course Objectives**

- To introduce the healthcare hazard control and accidents
- To familiarize biomedical waste management
- To explain facility guidelines, infection control and patient safety

**Course Outcomes (COs)**

1. Categorize the consequences of medical hazard in environment
2. Implement the Legal guidelines on Waste Disposals
3. Apply appropriate procedure for generation and segregation of medical waste
4. Apply proper guidelines for medical waste transportation, treatment and disposal
5. Analyse the effective practices to minimize the medical waste and financial commitment

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2				1		2			2	1	2		1
2		2				3		2			2	1	1	1	2
3		3	2			1		1			2	1	2	1	1
4		3	2			1		2			2	1	2	1	2
5		3	2			1		1			3	1	2	2	1

**UNIT I****9 Hours****INTRODUCTION**

Introduction, Need for disposal of biomedical Waste, Definition, general and hazardous health care waste, infectious waste, genotoxic waste, waste sharps, biomedical waste, categories, composition of biomedical waste, specification of materials, sources, hospitals, health care establishments, others.

**UNIT II****9 Hours****IMPACTS AND LEGISLATION POLICIES**

Health impacts, direct and indirect hazards, potential hazards, infection, infection agents, legislation and policies, biomedical waste handling, rules, CPCB guidelines, BARC guidelines, radioactive waste disposal, WHO guidelines, management in developing countries

**UNIT III****9 Hours****GENERATION AND SEGREGATION**

Colour coding, yellow, red, blue, white, contents of waste bag, label, biomedical waste, minimize, collection and handling, infection control system, needle sticks injury, hospital policy, segregation, decontaminating, disinfection unit, autoclaving, sharp waste containers, shredding, incrimination, biomedical symbol, microwave, hydro, pulping, plasma torch.

**UNIT IV****9 Hours****TRANSPORTATION, TREATMENT AND DISPOSAL**

Central storage, Onsite pre, treatment, mechanical treatment, chemical disinfection, offsite transportation, offsite and onsite, treatment, common treatment, liquid waste treatment, Conventional

treatment, wet thermal technology, incineration, alternative treatment technology, microwave technology, rotoclave system, hydroclave, ETP, process electron beam treatment, plasma pyrolysis , gastification systems, non, infectious waste, treatment, composting, rotating jumbling system, French composting, vermin composting, disposal, sharp disposal, deep burial, secured landfill.

**UNIT V**

**9 Hours**

**MANAGEMENT ISSUES**

Waste minimization, recycling, reuse, health and safety practices, protective equipment usage, occupational health programmers, safety, emergency practices, management, non clinical support devices, Quality improvement tools and strategies, budget allocation, maintenance, records, annual reports

**Total: 45 Hours**

**Reference(s)**

1. D.B. Acharya, Meeta Singh, "The Book of Hospital Management", Minerva Press, 2003
2. Mohd Faisal Khan, "Hospital Waste Management: Principle and Guidelines", Kanishka Publishers, 2010
3. Madhuri Sharma, "Hospital Waste Management and its Monitoring", Jaypee Brothers Medical Publishers, 2007
4. Mohammad Mohsin, "Hospital: Waste Management", VDM Publishing, 2010
5. Domiel A Vallero, "Biomedical Ethics for Engineers", Elsevier Publications, 1st Edition, 2007



**22BM033 MEDICAL ETHICS****3 0 0 3****Course Objectives**

- To introduce the legal and ethical principles in health care settings
- To familiarize the professional ethics to be followed by Biomedical Engineers
- To explore the patient safety and regulatory aspects followed in hospitals

**Course Outcomes (COs)**

1. Implement legal and professional guidelines for the health professions
2. Apply regulatory codes of ethics in healthcare systems
3. Implement medical device safety aspects based on quality systems requirement
4. Analyze success and failure aspects of bioethics
5. Analyze the need of sustainable bioethics

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	2	2				3			2	2		1	
2		2	2	2				3			2	2		1	
3		2	2	2				3			2	2		1	
4		3	2	2				3			2	2		1	
5		3	2	2				3			2	2		1	

**UNIT I****9 Hours****INTRODUCTION TO MEDICAL ETHICS**

Definition of Medical ethics, Scope of ethics in medicine, International code of Ethics for occupational health professionals, Ethical Theories, Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Role of ethics in Healthcare workplace, Autonomy, Non Malfeasance, Beneficence, Veracity, Justice, OSHA, Decision Model for Healthcare Dilemmas, Applications of Plus decision making model.

**UNIT II****9 Hours****CODE OF ETHICS FOR BIOMEDICAL ENGINEERS**

Bioethics-The principle of Double effect, Code of Hammurabi, Engineering Competence, Ethical Issues in biomedical research Cloning and stem cell research, Neuro ethics, Organ Transplantation, Hypothetico deductive method, Research Conflict of Interest.

**UNIT III****9 Hours****MEDICAL DEVICE SAFETY**

Shared Responsibility for Medical device safety. WHO International Health Regulations (IHR), Stages of regulatory control of medical devices, Ethics committee, its members and functions, Global Harmonization Task Force (GHTF). Quality systems requirement, ISO, Voluntary and mandatory standards, Collateral Standards EMC radiation protection & programmable medical device system, Particular Standards-type of medical device.

**UNIT IV**

**9 Hours**

**BIOETHICAL SUCCESS AND FAILURE**

Measurements of success and Failure, Technological Success and failure, Risk as a bioethical concept, Safety, risk and reliability in design, Reliability An ethics metric, reducing risk, risk as an ethical concept, risk based ethics. Medical device failure, Five failure types, Bio-terrorism.

**UNIT V**

**9 Hours**

**SUSTAINABLE BIOETHICS**

Introduction to Sustainable Bioethics Rational ethics, Life cycles and Concurrent Engineering, Bioethics of Combustion, Systematic Bioethics Seveso Plant disaster, Poverty and Pollution, Interdependence, Macro ethics and Micro ethics, The Humble Engineer.

**Total: 45 Hours**

**Reference(s)**

1. William Charney, Handbook of Modern Hospital Safety, CRC Press, 2nd Edition, 2009.
2. AlmiraBadnjevic, Mario Cifrek, RatkoMagjarevic, ZijadDzemic, Inspection of Medical Devices: For Regulatory Purposes, Springer Nature, 2018.
3. Daniel A Vallero, Biomedical Ethics for Engineers, Elsevier Publications, 1st Edition, 2007.
4. Eileen E. Morrison, Ethics in Health Administration: A Practical Approach for Decision Makers, Jonnes and Bartletts Publication, 2nd Edition, 2011.
5. Robert M Veatch, Basics of Bio Ethics, Prentice Hall, Inc., 2nd Edition, 2003

**22BM034 PATIENT SAFETY AND STANDARDS****3 0 0 3****Course Objectives**

- To introduce the safety procedures in healthcare organizations
- To familiarize the Health care organization structure and responsibilities
- To explore the safety standard to be followed in hospitals

**Course Outcomes (COs)**

1. Apply safety procedures in healthcare organizations
2. Apply safety norms in different departments in healthcare sector according to their working environments
3. Analyze the Health care organization structure and the responsibilities of different levels to implement safety
4. Analyze the regulatory standards for medical device maintenance
5. Outline the accreditation protocols for a hospital and its safety standards

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	2	2		1		2				1		2	
2		2	2	2		1		2				1		2	
3		3	2	2		1		2				1		2	
4		3	2	2		1		2				1		2	
5		2	2	2		1		2				1		2	

**UNIT I****9 Hours****INTRODUCTION**

Guidelines and safety practices for improving patient safety, Human error and patient safety, safer care, patients for patient safety, Human factors, patient safety from the perspective of medical residents, patient safety in the world, Infection prevention and control, Adverse event investigation and Risk assessment.

**UNIT II****9 Hours****PATIENT SAFETY IN DIFFERENT HEALTHCARE DEPARTMENTS**

Patient safety in Intensive care and Anaesthesiology, Safe surgery, Emergency department clinical risk, obstetric safety patient, patient safety in internal medicine, risks in oncology and radiation therapy, patient safety in orthopaedics and Traumatology, patient safety in paediatrics, patient safety in paediatrics and ophthalmology.

**UNIT III****9 Hours****HEALTH ORGANIZATION**

Community and Primary Care, Complexity Science as a Frame for Understanding the Management and Delivery of High Quality and Safer Care, Measuring Clinical Workflow to Improve Quality and Safety, shift work Organization, Non-technical Skills in Healthcare, Medication Safety, Digital Technology and Usability, Coping with the COVID-19 Pandemic: Roles and Responsibilities for Preparedness.

**UNIT IV**

**9 Hours**

**REGULATORY STANDARDS FOR MEDICAL DEVICE MAINTENANCE**

International Standards, Medical Device Directive 93/42/EEC, Medical Electrical Equipment ISO 60601, Safety Testing of Medical Devices ISO 62353, Medical Device Inspection ISO17020. Indian Standards, National Health Mission, Biomedical Equipment Management and Maintenance Program (BMMP), ISO 9001-2008, AERB Compliance, Radiation protection.AE(RP)R-2004, Safety Code AE/RF-MED/SC-3.

**UNIT V**

**9 Hours**

**HOSPITAL ACCREDITATION AND SAFETY STANDARDS**

Accreditation, JCI Accreditation & its Policies. Life Safety Standards- Protecting Occupants, Protecting the Hospital and Individuals from Fire, Smoke, and Heat. Managing Hazardous Medical Material and Waste, Laboratory and Radiation safety, Health and safety hazards of shift work. Patient Safety, Human factors, Reliability, Evidence based Medicine, Root cause Analysis.

**Total: 45 Hours**

**Reference(s)**

1. Donaldson L, Ricciardi W, Sheridan S, Tartaglia R, editors. Textbook of Patient Safety and Clinical Risk Management [Internet].
2. Cham (CH): Springer; 2021. PMID: 36315660.
3. William Charney, Handbook of Modern Hospital Safety, CRC Press, 2nd Edition, 2009.
4. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, Inspection of Medical Devices: For Regulatory Purposes, Springer Nature, 2018

**22BM035 MEDICAL DEVICE REGULATIONS****3 0 0 3****Course Objectives**

- To introduce the regulations in medical device design
- To discuss the regulations of medical device design in various medical industries

**Course Outcomes (COs)**

1. Understand the basic concepts of medical device regulations
2. Apply the global policies on medical device regulations
3. Analyze implications of the regulations
4. Analyze the Standards and Regulations used for medical devices
5. Analyze the software and Quality system regulation in medical device design

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2		2		1	1	2				1	1	2	
2		2		2		1	1	2				1	1	2	
3		3		2		1	1	2				1	1	2	
4		3		2		1	1	2				1	1	2	
5		3		2		1	1	2				1	1	2	

**UNIT I****9 Hours****INTRODUCTION**

Defining the device, Overview of quality function deployment, Business proposal Reliability: Definition, Quality Vs Reliability Vs Unreliability, Types of Reliability, Optimizing reliability, Reliability's effects on medical devices. Concept of Failure: Causes of Failure, Practical aspects of failure, Failure rates, Hardware failure, Software Failure. Safety and Risk Management: Medical device safety and risk management, Effectiveness/performance of medical devices, Phases in the life span of a medical device

**UNIT II****9 Hours****DRUG MANUFACTURING PRACTICES**

Global Harmonization Task Force (GHTF): Objectives, Scope of the four GHTF study groups, Benefits of the GHTF, Global Medical Device Nomenclature (GMDN) The Food and Drug Administration: Device classification, Registration and listing, The 510 (k) Process, Declaration of conformity, The PMA application, Investigational Device Exemptions (IDEs), Good Manufacturing Practices(GMPs).

**UNIT III****9 Hours****MEDICAL DEVICE DIRECTIVES**

The European Union: European Directives, European Standardization Bodies, European Standards Development Process, Other European Standards Considerations, Conformity Assessment and Testing, European Organization for Testing and Certification. The Medical Devices Directives: Process, Choosing the appropriate directive, Identifying the applicable essential requirements

**UNIT IV**

**9 Hours**

**STANDARDS AND REGULATIONS**

Standards and Regulation: Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of Standards

**UNIT V**

**9 Hours**

**SOFTWARES AND QUALITY SYSTEM REGULATIONS**

Software and Quality system regulation: Software as a Technology, Domestic and International Software Regulations and Standards. Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, Corrective and preventive action

**Total: 45 Hours**

**Reference(s)**

1. Michael Cheng, Medical Device Regulations Global Overview and Guiding Principles, World Health Organization, 2003.
2. Des O'Brien , Medical Device Regulations Roadmap A Beginners Guide, Create Space Independent Publishing Platform, 2017.
3. Aakash Deep, Medical Device Regulations A Complete Guide, Elsevier Science, 2022.
4. Jack Wong, Raymond Tong, Jenny Stanford Publishing Handbook of Medical Device Regulatory Affairs in Asia, Second Edition, 2018.
5. G.R Higson, Medical Device Safety, The Regulation of Medical Devices for Public Health and Safety, 2001.

**22BM036 FORENSIC SCIENCE IN HEALTHCARE****3 0 0 3****Course Objectives**

- To explain the basic principles of forensic science, crime and criminal justice system, police organization, the role of investigator and tools and techniques used in crime science
- To emphasize the importance of scientific methods in crime identification and detection.
- To deal with the modus operandi and role of modus operandi bureau in crime investigation

**Course Outcomes (COs)**

1. Understand the principles and laws of Forensic Science in Forensic Examination
2. Apply the scientific tools and techniques to the investigation of crimes
3. Outline the Criminal Justice System and Police organization in India
4. Analyse the forensic evidences in crime scene and the role of investigator in sketching and examination of crime scene
5. Analyse and examine the modus operandi and role of modus operandi bureau in crime investigation

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2		1		2		3				1			
2		2		2		2		3				1			
3		2		2		2		3				1			
4		3		2		2		3				1			
5		3		2		2		3				1			

**UNIT I****9 Hours****INTRODUCTION TO FORENSIC SCIENCE**

Introduction, Definition, Principles, Laws of Forensic Science, Historical Background of Forensic Science in India, Need of Forensic Science in present scenario, Organizational set up of Forensic Science Laboratories at state and central level, their types and Divisions, Forensic Examination.

**UNIT II****9 Hours****TOOLS AND TECHNIQUES IN FORENSIC SCIENCE**

Branches of Forensic Science, Forensic science in international perspectives, including set up of INTERPOL and FBI, Duties of Forensic Scientists, Code of conduct for Forensic Scientists, Qualifications of Forensic Scientists, Data depiction, Report writing

**UNIT III****9 Hours****CRIME AND POLICE ORGANIZATION**

Definition, types of crime, causes of crime, prevention of crime, Difference in blue and white collar crime, Introduction of Cyber crime, Criminal Justice System, Organizational set up of Police at central and state level, Functions of Police, Functions of Police in analyzing a crime scene, Different paramilitary forces in India

**UNIT IV**

**9 Hours**

**CRIME SCENE**

Introduction, Significance Role of Investigator, Evaluation of crime scene, protection of crime scene, Photography of Crime scene, Tools and techniques, Significance of Photography and Videography, Introduction of Sketching, Purpose of Sketching, Making of Sketches

**UNIT V**

**9 Hours**

**FORENSIC EVIDENCES AND ANALYSIS AND MODUS OPERANDI**

Hair analysis, Fiber analysis, Ballistics & Tool marks: Soil, Glass and Paint, Footprints and tyre impressions, Bite Marks, Finger prints, Blood Spatter Analysis, DNA analysis, Forensic Anthropology and Entomology, Investigation & examination procedure of various types of cases, Murder, Burglary, Railway & Air Crashes, Road Accidents etc.

**Total: 45 Hours**

**Reference(s)**

1. W.J. Tilstone, M.L. Hastrup and C. Hald, Fishers, Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).
2. Saferstein, Richard. Criminalistics An Introduction to Forensic Science, 11th ed. Prentice Hall, Saddle River, NJ. 2011
3. H.B. Baldwin and C.P. May in, Encyclopedia in Forensic Science, Volume 1, J.A. Siegel, P.J. Saukko and G.C. Knupfer (Eds.), Academic Press, London (2000).
4. V.J. Geberth, Practical Homicide Investigation, CRC Press, Boca Raton (2006).
5. T. Bevel and R.M. Gardner, Bloodstain Pattern Analysis, 3rd Edition, CRC Press, Boca Raton (2008).



**22BM037 CLINICAL ENGINEERING****3 0 0 3****Course Objectives**

- To provide a basic understanding of the clinical engineering profession, qualifications, roles, activities, and expectations
- To practice medical equipment and analyze challenges with their healthcare technology
- To explore the Health Technology Management systems with medical devices and supportive services with advanced application.

**Course Outcomes (COs)**

1. Assess the roles and responsibilities of Clinical Engineering in healthcare
2. Apply Engineering knowledge to in medical technology management practices
3. Analyse the impact of health care technology package (EHTP) in healthcare
4. Analyse clinical engineering program indicators
5. Outline the advances technologies implementation for patient safety

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2	2				1				1	1	1	1
2	2	2	3	2				1				1	1	1	1
3	2	3	2	2				1				1	2	1	1
4	2	3	2	2				1				1	2	1	1
5	2	2	2	2				1				1	2	1	2

**UNIT I****9 Hours****INTRODUCTION**

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System, Enhancing patient safety.

**UNIT II****9 Hours****MEDICAL TECHNOLOGY MANAGEMENT PRACTICES**

Strategic Medical Technology Planning, Scope , Clinical necessity operational support, strategic planning process Technology assessment: Technology audit, Budget strategies, Prerequisite for medical technology assessment, Management Practice for Medical Equipment, Device evaluation, Risk reduction, Asset management, ESHTA

**UNIT III****9 Hours****ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP)**

Introduction, Health care technology management, Package development: Methodology, Logical framework, Implementation, Information promotion and dissemination, EHTP Justification, EHTP matrix, EHTP advantages, Impact Analysis

**UNIT IV**

**9 Hours**

**CLINICAL ENGINEERING PROGRAM INDICATOR**

Clinical engineering: program services, Program database, Clinical Engineering Program management, Program indicator, Managing clinical engineering performance using program indicators, Indicator management process

**UNIT V**

**9 Hours**

**ADVANCED TECHNOLOGY FOR PATIENT SAFETY**

Factors Contributing to Medical Errors: Health Care Reimbursement, Health Care Failure Mode and Effect Analysis (HFMEA), Patient Safety Best Practices Model Bar coding, Computerized Physician Order Entry (CPOE), and Clinical data repositories, Process analysis, Methodology. Computerized medical equipment management systems.

**Total: 45 Hours**

**Reference(s)**

1. Ernesto Iadanza, Joseph Dyro, Clinical Engineering Handbook, Elsevier Academic Press, 2014
2. Robert Miniati, Clinical Engineering from Devices to Systems, Academic Press, 23-Dec-2015 - Technology & Engineering
3. Ernesto Iadanza, Clinical Engineering Handbook, 2nd Edition, Elsevier, Academic Press, November 2019, ISBN 9780128134672
4. Jacobson B and Webster J G Medical and Clinical Engineering Prentice Hall of India New Delhi 1999
5. Cesar A. Cacere& Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersey, 1979.

**22BM038 MEDICAL DEVICE DESIGN****3 0 0 3****Course Objectives**

- Students will be able to know about the Medical product design and development
- Patient safety and regulatory aspects followed in hospitals
- Professional ethics to be followed by Biomedical Engineers

**Course Outcomes (COs)**

1. Implement Good Design Practice in medical product design
2. Apply appropriate methodologies for Product development
3. Analyse important regulatory schemes to be followed in medical device design
4. Apply testing, validation and market analysis for developed product
5. Analyse challenges in converting innovation into product in Healthcare sector

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		3	2	1				1				2		2	
2		2	2	2				1				2		2	
3		3	2	2				1				2		2	
4		3	2	2				1				2		2	
5		2	2	2				1				2		2	

**UNIT I****9 Hours****INTRODUCTION TO MEDICAL PRODUCT DESIGN**

Definition, History and Modern Practice, Designs; Design and Product Life Cycle, Design Process, Understanding the innovation cycle, Good Design Practice. Understanding, analysing and validating user needs, Screening Needs, Technical Requirements, Concept Generation, Innovation Survey Questionnaire, Morphological Matrix, QFD, Concept Analysis and validation, Concept Modelling, Concept Screening & Validation.

**UNIT II****9 Hours****PRODUCT DEVELOPMENT**

Breakthrough Products, Platform Products, Front End of Innovations, Fuzzy Front End, Generic Product Development Process, Variants of Development Processes, Good Documentation Practice, and Prototyping Specifications, Prototyping, Medical Device standards, Quality management systems (ISO 13485), Medical Device Classification, Design of Clinical Trials.

**UNIT III****9 Hours****REGULATORY SCHEMES**

Design Control & Regulatory Requirements, Documentation in Medical Devices, Regulatory pathways, Biomedical Evaluation of Medical Devices, ISO Medical Devices, Applications of Risk Management to Medical Devices (ISO 14971), Electrical Safety Standard, IEC60601-1, IEC60601-2, IEC60601-6, Protection of Electrical and Electronic Parts, Assemblies and Equipments (ESD S20.20-2014).

**UNIT IV**

**9 Hours**

**SCALABLE PRODUCT DEVELOPMENT**

Design for manufacturing, Design for assembly, Design for Serviceability, Design for usability, Medical Device Verification & Validation, Product Testing & Regulatory compliance, Clinical trial & validation, Device Certification.

**UNIT V**

**9 Hours**

**PRACTICAL CHALLENGES ON MEDICAL DEVICE DEVELOPMENT**

Product life cycle, challenges in Practicing International Regulatory Requirements, Risk Management: Integration of Risk Management into the supporting QMS, Use of Codes to Identify Medical Devices, Application of Risk Management throughout product life cycle.

**Total: 45 Hours**

**Reference(s)**

1. John G. Webster, Medical Instrumentation: Application and Design, 5th Edition, June 2020
2. Peter J. Ogradnik, Medical Device Design: Innovation from Concept to Market, Academic Press is an imprint of Elsevier, 1st edition 2013
3. Paul H. King, Richard C. Fries, Arthur T. Johnson, Design of Biomedical Devices and Systems, CRC Press, Tailor and Francis Group, 3rd Edition, 2015
4. Andres D. Lantada, Handbook on Advanced Design and Manufacturing Technologies for Biomedical Devices, Springer London 2013
5. Paul G. Yock, StefanosZenios, Joshua Makower, Todd J. Brinton, Uday N. Kumar, F. T. Jay Watkins, Lyn Denend, Thomas M. Krummel, Christine Kurihara, Biodesign: The Process of Innovating Medical Technologies, Cambridge University Press; 2nd edition, 2 February 2015

**22BM039 MEDICAL EQUIPMENT MAINTENANCE  
AND TROUBLESHOOTING**

**3 0 0 3**

**Course Objectives**

- To troubleshoot and quality control in medical equipment for biomedical engineering students
- To provide knowledge about the troubleshooting of various equipment used in hospitals and quality standard of medical equipment

**Course Outcomes (COs)**

1. Apply the common troubleshooting procedures in testing electronic equipment
2. Analyze and identify the fault in given analog and digital circuits using appropriate procedures
3. Apply troubleshooting procedures to find faults in medical equipment
4. Asses the quality of medical devices by applying suitable procedures
5. Analyse medical device regulation procedure in device design

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2		3									1	2	
2		3		3									1	2	
3		2		3									1	2	
4		3		3				2					1	2	
5		2		3				2					1	2	

**UNIT I**

**9 Hours**

**FUNDAMENTAL TROUBLESHOOTING TESTING PROCEDURES**

Equipment failure and its causes, Functional block diagram of a troubleshooting system, troubleshooting process & fault finding aids, troubleshooting techniques and their correction action, Testing of active and passive components: resistor, capacitor, inductor, BJT, JFET, & MOSFET

**UNIT II**

**9 Hours**

**FAULT DIAGNOSIS IN INTEGRATED CIRCUITS**

Characteristics of ideal op amps, typical op amp based medical circuits, Fault diagnosis in op amp circuits, Digital troubleshooting methods, Digital IC Trouble shooters, logic clip, logic probe, logic pulser, logic current tracer, logic comparator, Circuit board Troubleshooting.

**UNIT III**

**9 Hours**

**BIOMEDICAL EQUIPMENT TROUBLESHOOTING**

Troubleshooting- ECG Machine, EEG Machine, defibrillator, electrosurgical unit, anaesthesia machine, autoclaves & sterilizers, endoscope, incubators, nebulizer, oxygen concentrators, sphygmomanometers, suction machine, X ray machine.

**UNIT IV**

**9 Hours**

**MEDICAL DEVICE DESIGN QUALITY**

Definition of quality, essence of quality, Quality operating system and the device life cycle, Evolution of quality, Business excellence: a value proposition, Health care quality.

**UNIT V**

**9 Hours**

**DESIGN FOR SIX SIGMA AND MEDICAL DEVICE REGULATION**

Global Perspective on medical device regulations, medical device classification (USA, Europe & GHTF). Medical device safety, medical device quality management systems requirements, Medical device regulation throughout the product development life cycle, Purpose of ISO 9001:2001&ISO 13485.

**Total: 45 Hours**

**Reference(s)**

1. Khandpur R S, Troubleshooting Electronic Equipment- Includes Repair & Maintenance, Tata McGrawHill, 2nd edition, 2009.
2. Basem S EL-Haik& Khalid S Mekki, Medical Device Design for Six Sigma: A Road Map for Safety and Effectiveness, John Wiley & Sons, 1st edition, 2008
3. Nicholas Cram & Selby Holder, Basic Electronic Troubleshooting for Biomedical Technicians, TSTC Publishing, 2nd edition, 2010.
4. Dan Tomal& Neal Widmer, Electronic Troubleshooting, McGraw Hill, 3rd edition, 2004.
5. World Health Organisation, Maintenance & Repair of Laboratory, Diagnostic imaging & Hospital Equipment, Geneva, 1994.

**22BM040 ADVANCED BIOSENSORS****3 0 0 3****Course Objectives**

- To familiarize with the concepts of biosensors
- To Study the operating principle of transducers for measurement of physical quantities
- To Study the operating principle of optical sensors

**Course Outcomes (COs)**

1. Assess the static, dynamic characteristics and errors associated with given sensor/Transducer
2. Apply suitable sensor to measure physical industrial quantities
3. Assess the working principle of a given biosensor
4. Apply suitable biosensors in healthcare applications
5. Integrate advanced sensing technologies for improved sensing accuracy

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	3	2										2	2	
2	2	2	2	2									2	2	
3	1	3	2										2	2	
4	1	2	2	2		2							2	2	
5	1	3	2	3									2	2	

**UNIT I****9 Hours****INTRODUCTION**

Transducer Introduction, Definition, Classification and Characteristics of transducers, Selection criteria, Static Characteristics, Dynamic Characteristics, Standards, Calibration, types, Need for Calibration.

**UNIT II****9 Hours****TRANSDUCERS FOR MEASUREMENT OF PHYSICAL QUANTITIES**

Strain Gauge: Principle, Classification, Gauge factor, Derivation, Load cell: Principle, Construction and Operation, LVDT: Principle, Construction and Operation, Piezoelectric Sensor: Principle, Construction and Operation, Medical applications of Piezoelectric sensors, Flex sensors: Principle, Construction and Operation, Hall effect transducer: Principle, Construction and Operation and Applications.

**UNIT III****9 Hours****PRINCIPLES OF BIOSENSORS**

Biosensors: Definition, Block diagram, Genesis of Biosensors, Classification of Biosensors, Types, Immobilization of Bio receptor, Enzyme immobilization, Biocatalysts based biosensors: Introduction, principle, Glucose biosensor: Principle, Construction and Operation, Bioaffinity based sensor: Principle, Microbe biosensor: Principle, Construction and Operation.

**UNIT IV**

**9 Hours**

**APPLICATIONS OF BIOSENSORS**

Electrochemical biosensor: Principle, Construction and Operation, Biosensors for pathogen detection, Biosensors for cancer detection, Saliva based biosensors, DNA Biosensors, Biochips, Biosensors for environmental monitoring, Biosensors for disaster management, Futuristic approach of Biosensors.

**UNIT V**

**9 Hours**

**ADVANCE IN SENSING TECHNOLOGIES**

Smart Sensors: Introduction, Need, Architecture, Salient features, Lab on Chip ( LoC): Architecture, e-Nose: System description, OFC: Introduction, Total Internal reflection, Concepts of SPR, SPR sensors, Evanescence Sensor: Concepts, Grating sensors: principle and applications.

**Total: 45 Hours**

**Reference(s)**

1. Sawhney A.K, A Course in electrical and electronic measurements and instrumentation, Dhanpat Rai & Co (P) Ltd, Educational and Technical Publishers, 19th Revised edition 2011, Reprint 2014.
2. Patranabis D, Sensors and transducers, PHI, 2nd edition, 2004
3. Murty DVS, Transducer and instrumentation, PHI, 2nd edition, 2010.
4. U.A. Bakshi, A.V. Bakshi, Measurements and instrumentation, Technical Publications, 3rd revised edition, 2010
5. Paras N, Prasad, Introduction to biophotonics, John Wiley & Sons, 1st edition, 2003



**22BM041 DRUG DELIVERY SYSTEM****3 0 0 3****Course Objectives**

- To explain the basic principles for development of novel drug delivery systems.
- To emphasize the importance of various drug delivery systems and their usage in hospitals.
- To deal with the formulation and evaluation of Novel drug delivery systems

**Course Outcomes (COs)**

1. Apply Ficks laws for controlled drug delivery systems
2. Design and analyze the technology based CR systems
3. Apply biomaterial knowledge to design implantable therapeutic systems
4. Analyse transdermal drug delivery evaluation and implementation process
5. Analyse the modern technology to facilitate targeted drug delivery

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1		2	2			1						1	2	2	
2		2	3	2		1						1	2	2	
3		2	2	2		1						1	2	2	
4		3	2	2		1						1	2	2	
5		3	2	3		1						1	2	2	

**UNIT I****9 Hours****CONTROLLED DRUG DELIVERY**

Fundamentals of Controlled Release (CR) Drug Delivery, Rationale of sustained/controlled drug delivery, Physicochemical and biological factors influencing design and performance of CR products, therapeutic status of CDDS. Theory of mass transfer, Ficks first and second laws and their applications in drug release and permeation. Pharmacokinetic and pharmacodynamic basis of controlled drug delivery, bio availability assessment of CR systems.

**UNIT II****9 Hours****DESIGN AND FABRICATION OF TECHNOLOGY BASED CR SYSTEMS**

Strategies and design of oral controlled release delivery systems , oral systems based on dissolution, diffusion and dissolution, Ion exchange resins, Ph independent formulations ,altered density formulations, Bucco /mucoadhesive systems. Osmotic controlled oral drug delivery, Feedback regulated Drug Delivery Systems

**UNIT III****9 Hours****PARENTERAL SYSTEM**

Parenteral systems, biopharmaceutic considerations, design and development, polymeric microspheres dispersed drug delivery, Implantable therapeutic systems, Biocompatibility of polymers and carriers, Intrauterine devices and intravaginal devices

**UNIT IV**

**9 Hours**

**TRANSDERMAL DRUG DELIVERY SYSTEM**

Transdermal therapeutic systems (TTS) Drug absorption through skin, permeation enhancers, basic components of TTS, Approaches to development and kinetic evaluation, testing of transdermal patches, pressure sensitive adhesives, Iontophoresis, Sonophoresis and electroporation. Formulation and evaluation of TTS

**UNIT V**

**9 Hours**

**TARGETED DRUG DELIVERY**

History concept, Types and key elements, ideal carrier system and approach with special reference to organ targeting (e.g. brain, tumor, lung, liver and lymphatics), Basics of temperature, pH and magnetically induced targeting tactics. Vaccine delivery systems

**Total: 45 Hours**

**Reference(s)**

1. Tozer T N, Rowland M, Introduction of Pharmacokinetics and Pharmacodynamics The Quantitative Basis of Drug Therapy, Williams & Wilkins, 2006.
2. Howard C. Ansel, Nicholas G. Popovich, Lyold V. Allen , Pharmaceutical dosage forms and Drug Delivery system, 1st edition, 2014.
3. Jain N.K and Sharma S.N. A text book of professional pharmacy, 1st edition 1995.
4. Samuel Harder and GlennV. Buskirk. Pilot Plant Scale-Up Techniques. In The Theory and Practice of Industrial Pharmacy. 3rd edition., 1991
5. Remington, The Science and Practice of pharmacy, 20 th Edn, vol.I, pg.no.903- 913.

**22BM042 ELECTROMAGNETIC INTERFERENCE  
AND COMPATIBILITY**

**3 0 0 3**

**Course Objectives**

- To instil knowledge on the EMI coupling mechanism and its mitigation techniques
- To impart comprehensive insight about the current EMC standards
- To acquire knowledge on various measurement techniques for EMI mechanisms

**Course Outcomes (COs)**

1. Assess the impact of electromagnetic interference and its effects in human
2. Apply the suitable coupling mechanisms to reduce electromagnetic interference and compatibility
3. Apply appropriate methods to assess the electromagnetic interferences
4. Analyse the standards and regulations to be followed in electromagnetic interference generating systems
5. Apply instrumentation knowledge to test electromagnetic interferences

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	3	2	2				1				1	1	3	
2	1	2	2	2				1				1	1	2	
3	1	2	2	2				1				1	1	3	
4	1	3	2	2				1				1	1	3	
5	1	2	2	2				1				1	1	2	

**UNIT I**

**9 Hours**

**BASIC CONCEPTS**

Definition of EMI and EMC, Intra and Inter system EMI, Sources and victims of EMI, Conducted and Radiated EMI emission and susceptibility, Transient & ESD, Case Histories, Radiation Hazards to humans.

**UNIT II**

**9 Hours**

**COUPLING MECHANISM**

Common mode coupling, Differential mode coupling, Common impedance coupling, Ground loop coupling, Field to cable coupling, Cable to cable coupling, Power mains and Power supply coupling.

**UNIT III**

**9 Hours**

**EMI MITIGATION TECHNIQUES**

Shielding - principle, choice of materials for H, E and free space fields, and thickness, EMI gaskets, Bonding, Grounding circuits, system and cable grounding, Filtering, Transient EMI control devices and applications, PCB Zoning, Component selection, mounting, trace routing.

**UNIT IV**

**9 Hours**

**STANDARDS AND REGULATION**

Units of EMI; National and International EMI Standardizing Organizations - IEC, ANSI, FCC, CISPR, BIS, CENELEC; FCC standards; EN Emission and Susceptibility standards and specifications; MIL461E Standards.

**UNIT V**

**9 Hours**

**EMI TEST METHODS AND INSTRUMENTATION**

EMI test sites - Open area site; TEM cell; Shielded chamber; Shielded Anechoic chamber; EMI test receivers; Spectrum Analyzer; Transient EMI Test wave Simulators; EMI coupling Networks - Line Impedance Stabilization Networks; Feed through capacitors; Antennas and factors; Current probes and calibration factor; MIL-STD test methods; Civilian STD Test methods, Government policies.

**Total: 45 Hours**

**Reference(s)**

1. V.P. Kodali, Engineering EMC Principles, Measurements and Technologies, IEEE Press, Network, 2nd Edition, 2010.
2. Henry W.Ott., Noise Reduction Techniques in Electronic Systems, A Wiley Inter Science Publications, John Wiley and Sons, Network, 2009.
3. layton Paul, Introduction to Electromagnetic Compatibility, Wiley Interscience, 2006.
4. Daryl Gerke and William Kimmel, EDNs Designers Guide to Electromagnetic Compatibility, Elsevier Science and Technology Books, 2002.
5. Dr Kenneth L Kaiser, The Electromagnetic Compatibility Handbook, CRC Press 2005.

## 22BM043 INTERVENTIONAL AND DIAGNOSTIC RADIOLOGY

3 0 0 3

### Course Objectives

- To impart knowledge on the radiation techniques
- To impart comprehensive insight about the interventional radiology in different medical field
- To acquire knowledge on various practices in diagnostic radiology

### Course Outcomes (COs)

1. Assess the interaction of radiation with tissue
2. Apply radiology role in various diagnosis procedures
3. Apply radiology in vascular and gastrointestinal track
4. Apply radiology in traumatology
5. Analyze radiology in other organ system diagnosis and treatment

### Articulation Matrix

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1	2	2	2				1				1	3	2	
2	1	2	2	2				1				1	3	2	
3	1	2	2	2				1				1	3	2	
4	1	2	2	2				1				1	3	2	
5	1	3	2	2				1				1	3	2	

### UNIT I

9 Hours

#### INTRODUCTION

Introduction – Physical basics: Types of radiation, structure of matter and radioactive decay, interaction of radiation and matter, measurement of radiation, The effect of radiation on biological tissue: phases of radiation, radiation damage to the cell, the acute effect of radiation on human body, the chronic effect of radiation, carcinogenesis, the dangers of X-Rays

### UNIT II

9 Hours

#### RADIOLOGICAL DIAGNOSTIC PROCEDURES

Review of conventional diagnostic radiography: CT, MRI, Angiography and interventions, Ultrasound, contrast agent, Introduction to Neuroradiology: The brain and spinal cord, Mammography imaging and interventional diagnosis of the mammary gland using X-Ray mammography, Breast Sonography and MR mammography.

### UNIT III

9 Hours

#### INTERVENTIONAL RADIOLOGY IN VASCULAR AND GASTROINTESTINAL TRACK

Vascular diagnostics and interventional techniques, vascular interventional therapy, arterial access of angiography and intervention, arterial thrombolysis and mechanical thrombectomy, Angioplasty and stenting, stent grafting, Gastrointestinal track: Liver, gallbladder and biliary tree, Pancreas, spleen and gastrointestinal system radiological interventions.

**UNIT IV**

**9 Hours**

**INTERVENTIONAL RADIOLOGY IN TRAUMATOLOGY**

Traumatology: The basics Traumatology- interventional diagnosis: site specific trauma-inflammatory bone diseases, primary and secondary bone tumours, tumour like lesions and systemic skeletal diseases, Diseases of the joints.

**UNIT V**

**9 Hours**

**INTERVENTIONAL RADIOLOGY IN OTHER ORGAN SYSTEMS**

Interventional uro-radiology, haemodialysis fistula, Hepatobiliary interventions, Interventional radiology in gynaecology, salivary and lacrimal duct interventions, interventions in chest and interventional radiology in transplantation

**Total: 45 Hours**

**Reference(s)**

1. Raman Uberoi, Interventional radiology, Oxford University Press, 2009
2. John A Koufman, Michael J Lee, Vascular and Interventional radiology, Elsevier, 2014
3. Debra A. Gervais, Tarun Sabharwal Diagnostic and Interventional Radiology, Springer ,2016
4. Kieran Murphy, Fergus Robertson, Kieran Murphy, Fergus Robertson, Vascular Springer 2013
5. Interventional Radiology: Fundamentals of Clinical Practice Bradley B. Pua, Anne M. Covey, David C. Madoff, Oxford University Press, 2019

**22OCE01 ENERGY CONSERVATION AND  
MANAGEMENT**

**3 0 0 3**

**Course Objectives**

- To develop an understanding and analyze the energy data of industries
- To carryout energy accounting and balancing
- To conduct energy audit and suggest methodologies for energy savings and
- To utilize the available resources in optimal ways

**Course Outcomes (COs)**

1. Classify and characterize the various energy utilization techniques.
2. Identify suitable technique to provide an energy efficient system.
3. Identify the need for thermal systems with latest technologies.
4. Choose suitable techniques doe conserving energy with respect to emerging trends.
5. Assess the impact economics on the conservation of energy.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	1										1	3
2	1	3									1	3
3	1	3									2	3
4	1	3	2								3	3
5	1	2	2								1	3

**UNIT I**

**9 Hours**

**INTRODUCTION**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II**

**9 Hours**

**ELECTRICAL SYSTEMS**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III**

**9 Hours**

**THERMAL SYSTEMS**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and Encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

**UNIT IV**

**9 Hours**

**ENERGY CONSERVATION IN MAJOR UTILITIES**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

**UNIT V**

**9 Hours**

**ECONIMICS**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept .

**Total: 45 Hours**

**Reference(s)**

1. Energy Manager Training Manual (4 Volumes) available at [www.energymanagertraining.com](http://www.energymanagertraining.com), a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.
2. Witte. L.C., P.S. Schmidt, D.R. Brown, “Industrial Energy Management and Utilisation” Hemisphere Publ, Washington, 1988.
3. Callaghn, P.W. “Design and Management for Energy Conservation”, Pergamon Press, Oxford, 1981.
4. Dryden. I.G.C., “The Efficient Use of Energy” Butterworths, London, 1982
5. Turner. W.C., “Energy Management Hand book”, Wiley, New York, 1982.
6. Murphy. W.R. and G. Mc KAY, “Energy Management”, Butterworths, London 1987.



**22OCS01 OBJECT ORIENTED PROGRAMMING**

**3 0 0 3**

**Course Objectives**

- Understand the concepts of Object Oriented Programming
- Study the concepts of objects and classes.
- Familiarize in the types of constructors.

**Course Outcomes (COs)**

1. Identify the characteristics and data types of C++ language.
2. Develop programs using objects and classes for real world applications
3. Construct programs to implement operator overloading and inheritance techniques
4. Apply Polymorphism and File streams concepts to develop C++ program
5. Design applications using templates and apply exception handling mechanisms

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2			3									
2	1	2	3		3									
3	1	2	2		3									
4	1	2	3		3									
5	1	2	3		3									

**UNIT I**

**8 Hours**

**INTRODUCTION**

Need for object oriented programming - Procedural Languages vs. Object oriented approach - Characteristics Object oriented programming - C++ Programming Basics: Basic Program Construction - Output Using cout - Input with cin - Data types- Variables and Constants - Operators - Control Statements-Manipulators - Type conversion. Function Prototyping- call by reference, return by reference- Inline function- Default arguments - Function overloading.(sona)

**UNIT II**

**8 Hours**

**OBJECTS AND CLASSES**

Objects and Classes Simple Class - C++ Objects as Physical Objects - C++ Object as Data types-CONSTRUCTORS: Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments - Dynamic Initialization of Objects - Copy and Dynamic Constructors - Destructors(PSG) - Structures and Classes - Arrays and Strings

**UNIT III**

**9 Hours**

**OPERATOR OVERLOADING AND INHERITANCE**

Operator Overloading and Inheritance Need of operator overloading- Overloading Unary Operators-Overloading binary Operators - Overloading Special Operators - Data Conversion Inheritance: Derived Class and Base Class - Derived Class Constructors-Overriding Member Functions-Class Hierarchies- Public and Private Inheritance-Levels of Inheritance-Multiple Inheritance.

**UNIT IV**

**10 Hours**

**POLYMORPHISM AND FILE STREAMS**

Polymorphism and File Streams Virtual Function - Friend Function - Static Function-Assignment and Copy Initialization- Memory Management: new and delete Pointers to Objects, this Pointer-Streams - String I/O - Character I/O - Object I/O - I/O with Multiple Objects - File Pointers - Disk I/O with Member Functions- Error Handling in File I/O.

**UNIT V**

**10 Hours**

**TEMPLATES AND EXCEPTION HANDLING**

Templates: Introduction - Function Templates - Overloading Function Templates-, user defined template arguments(sona) - Class Templates - Exception Handling - Syntax, multiple exceptions, exceptions with arguments.

**Total: 45 Hours**

**Reference(s)**

1. Deitel & Deitel, C++ How to program, Prentice Hall,2005
2. Robert Lafore, Object Oriented Programming in-C++, Galgotia Publication.
3. D.S.Malik, C++ Programming, Thomson, 2007.
4. K.R. Venugopal, Rajkumar and T.Ravishankar, Mastering C++, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2006.
5. E.Balagurusamy, Object Oriented Programming with C++, Tata McGraw Hill Publishing.

**22OCS02 JAVA FUNDAMENTALS****3 0 0 3****Course Objectives**

- Implement applications based on core Java Concepts with examples
- Construct application using inheritance, packages and exception handling for real time problems.
- Integrate the Java I/O concepts to handle input and output operations.
- Develop programs to perform string manipulation in java.
- Design GUI with Java for event handling and database applications.

**Course Outcomes (COs)**

1. Demonstrate applications based on core Java Concepts with examples
2. Construct application using inheritance, packages and exception handling for real time problem
3. Explain the Java I/O concepts to handle input and output operations.
4. Develop programs to perform string manipulation in Java.
5. Design GUI with Java for event handling and database applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2		2									
2	2	3	2		2									
3	3	3	3		3									
4	2	2	2		2									
5	2	2	2		2									

**UNIT I****9 Hours****BASICS OF JAVA**

The Genesis of Java - Overview of Java - Data Types, Variables, and Arrays - Operators – Control Statements - Introducing Classes - Methods and Classes.

**UNIT II****9 Hours****INHERITANCE, PACKAGES AND EXCEPTIONS**

Inheritance: Basics - Using Super - Creating a Multilevel Hierarchy - Method overriding - Using Abstract Classes - Packages and Interfaces: Packages - Access Protection - Importing Packages- Interfaces Definitions and Implementations - Exception Handling: Types - Try and Catch - Throw.

**UNIT III****9 Hours****EXPLORING JAVA I/O**

I/O Basics - Reading Console Input -Writing Console output - Native Methods - I/ O Classes and Interfaces - File - The Byte Streams - The Character Streams - Using Stream I/ O - Serialization.

**UNIT IV**

**9 Hours**

**JAVA STRINGS**

String Handling: Special String operations and Methods - String Buffer - Exploring java.lang: Simple type Wrappers - System - Math - Collections Framework: Collections Interfaces and Classes – Utility Classes: String Tokenizer - Date and Time.

**UNIT V**

**9 Hours**

**GUI WITH JAVA**

Applet Basics - Applet Architecture - Applet Display Methods - Parameter Passing - Event Handling Mechanisms - Event Classes - Event Listener - Working with Windows, Graphics, Colors and Fonts - AWT Controls - Layout Managers and Menus – JDBC

**Total: 45 Hours**

**Reference(s)**

1. Herbert Schildt, Java 2-Complete Reference, Tata Mc Graw Hill, 2015.
2. Deitel & Deitel, Java How to Program, Prentice Hall of India, 2010.
3. Gary Cornell and Cay S.Horstmann, Core Java Vol.1 and Vol.2, Sun Microsystems Press, 2008.

**22OCS03 KNOWLEDGE DISCOVERY IN  
DATABASES**

**3 0 0 3**

**Course Objectives**

- Introduce the basic concepts of data warehousing.
- Impart knowledge about the data mining functionalities.
- Assess the strengths and weaknesses of association mining and cluster analysis.

**Course Outcomes (COs)**

1. Explain the concepts of Data Warehousing architecture and business analysis process.
2. Illustrate the process of Data Mining and preprocessing techniques for data cleansing.
3. Apply the association rules for mining the various kinds of data
4. Analyze Classification and Clustering algorithms for various problems with high dimensional data.
5. Illustrate the various data mining techniques on complex data objects

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2													
2	2	3	2											
3	2	2	2											
4	3	2	2	2										
5	2	2	2	2										

**UNIT I**

**9 Hours**

**DATA WAREHOUSING AND BUSINESS ANALYSIS**

Data warehousing Components -Building a Data warehouse -Data Warehouse and DBMS-Metadata-Multidimensional data model - Data Extraction, Cleanup and Transformation Tools - Reporting, Query tools and Applications - OLAP vs OLTP - OLAP operations - Data Warehouse Schemas: Stars, Snowflakes and Fact constellations.

**UNIT II**

**8 Hours**

**INTRODUCTION TO DATA MINING**

Introduction - Steps in knowledge discovery from databases process - Architecture of a Typical Data Mining Systems - Data Mining Functionalities - Classification of Data Mining Systems - Data mining on different kinds of data - Different kinds of pattern - Task Primitives - Integration of a Data Mining System with a Data Warehouse - Major issues in Data mining.

**UNIT III**

**9 Hours**

**ASSOCIATION RULE MINING**

Market Basket Analysis- Frequent Item Set Mining methods: Apriori algorithm - Generating Association Rules - A Pattern Growth Approach- Pattern mining in multilevel and multidimensional space - Mining Various Kinds Of Association Rules - Association Analysis to Correlation Analysis - Constraint Based Association Mining.

**UNIT IV**

**9 Hours**

**CLASSIFICATION AND CLUSTERING**

Decision Tree Induction - Bayesian Classification - Rule Based Classification - Classification by Back propagation - Support Vector Machines - Clustering: Types of data - Partitioning methods: k-means, k-medoid - Hierarchical Methods: distance based agglomerative and divisible clustering, BIRCH – Density Based Method: DBSCAN - Grid Based Method: STING.

**UNIT V**

**10 Hours**

**DATA MINING APPLICATIONS**

Mining complex data objects - Text Mining - Graph mining - Web mining - Spatial Data mining -Application and trends in data mining - Social impacts of Data mining.

**Total: 45 Hours**

**Reference(s)**

- 1 Jiawei Han, Micheline Kamber and Jian Pai , Data Mining: Concepts and Techniques, Morgan Kauffman, 3rd Edition, 2013.
- 2 Alex Berson and Stephen J Smith, Data Warehousing, Data Mining, and OLAP, Tata Mcgraw- Hill, 1997.
- 3 David Hand, Heikki Manila, Padhraic Symth, Principles of Data Mining, MIT Press, 2001.
- 4 Margaret H.Dunham, Data Mining: Introductory and Advanced Topics, Pearson Education 2003.

**22OCS04 E-LEARNING TECHNIQUES****3 0 0 3****Course Objectives**

- Understand the technologies involved in e-learning.
- Gain the fundamentals of e-learning techniques
- Determine the characteristics of Teaching-Learning Process

**Course Outcomes (COs)**

1. Acquire knowledge about the basic concepts of e-learning.
2. Explain the technology mediated communication in e-learning
3. Exemplify of e-learning and content the process management.
4. Analyze the teaching and learning processes in e-learning environment.
5. Assess the various applications of e-learning.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	2												
2	2	2	3											
3	3	3	3											
4	2	2	2											
5	2	2	2											

**UNIT I****9 Hours****INTRODUCTION**

Evolution of Education - Generations of Distance Educational Technology - Role of E-Learning - Components of e-learning: CBT, WBT, Virtual Classroom - Barriers to e-Learning Roles and Responsibilities: Subject Matter Expert - Instructional Designer - Graphic Designer - Multimedia Author - Programmer - System Administrator - Web Master

**UNIT II****9 Hours****TECHNOLOGIES**

Satellite Broadcasting - Interactive Television - Call Centers - Whiteboard Environment - Teleconferencing: Audio Conferencing - Video Conferencing -Computer Conferencing. Internet: E-mail, Instant Messaging, Chat, Discussion Forums, Bulletin Boards, Voice Mail, File Sharing, Streaming Audio and Video.

**UNIT III****9 Hours****MANAGEMENT**

Content: E-Content, Dynamic Content, Trends - Technology: Authoring, Delivery, Collaboration - Services: Expert Service, Information Search Service, Knowledge Creation Service - Learning Objects and E-Learning Standards. Process of E-Learning: Knowledge acquisition and creation, Sharing of knowledge, Utilization of knowledge - Knowledge Management in E-Learning.

**UNIT IV****9 Hours****TEACHING-LEARNING PROCESS**

Interactions: Teacher-Student - Student-Student - Student-Content - Teacher- Content - Teacher-Teacher - Content-Content Role of Teachers in E-Learning - Blended Learning -Cooperative Learning - Collaborative Learning - Multi Channel learning -Virtual University - Virtual Library.

**UNIT V**

**9 Hours**

**APPLICATIONS**

Customer service training - Sales training - Customer training - Safety training - IT training – Product training - Healthcare training.

**Total: 45 Hours**

**Reference(s)**

1. E-Learning: An Expression of the Knowledge Economy, Gaurav Chadha, S.M. Nafay Kumail, Tata McGraw-Hill Publication, 2002.
2. E-Learning: New Trends and Innovations, P.P. Singh, Sandhir Sharma, Deep & Deep Publications, 2005. 4. 4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002
3. E-Learning: Concepts, Trends and Applications, Epignosis LLC, LLC publications, 2014.
4. Michael Allen's Guide to E-Learning, Michael W. Allen, Michael Allen, Wiley Publication, 2002.



**22OCS05 SOCIAL TEXT AND MEDIA ANALYTICS**

**3 0 0 3**

**Course Objectives**

- Understand the basic ideas of Text mining.
- Analyze the methods and approaches used in analytics.
- Gain knowledge on various types of analytics like web, social network, and social media

**Course Outcomes (COs)**

1. Demonstrate the concepts and applications of text mining
2. Explain Content analysis and Sentiment analysis
3. Illustrate web analytics with a suitable model
4. Illustrate social network analytics with suitable example.
5. Illustrate social media analytics with suitable example.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3		2	3									
2	2	3		2	2									
3	2	3		3	3									
4	2	2	2	3	2									
5	2	3		2	3									

**UNIT I**

**7 Hours**

**TEXT MINING**

Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction, Text mining applications.

**UNIT II**

**9 Hours**

**METHODS**

Content Analysis-Natural Language Processing-Clustering & Topic Detection-Simple Predictive Modeling-Sentiment Analysis; Sentiment Prediction.

**UNIT III**

**9 Hours**

**WEB ANALYTICS**

Web analytics tools-Clickstream analysis-A/B testing, online surveys-Web search and retrieval-Search engine optimization-Web crawling and Indexing-Ranking algorithms-Web traffic models.

**UNIT IV**

**10 Hours**

**SOCIAL NETWORK ANALYTICS**

Social contexts: Affiliation and identity - Social network analysis - Social network and web data and methods. Graphs and Matrices - Basic measures for individuals and networks

**UNIT V**

**10 Hours**

**SOCIAL MEDIA ANALYTICS**

Information visualization - Making connections: Link analysis - Random graphs and network evolution.

**Total: 45 Hours**

**Reference(s)**

1. Ronen Feldman and James Sanger, The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data, Cambridge University Press, 2006.
2. Hansen, Derek, Ben Shneiderman, Marc Smith. Analyzing Social Media Networks with NodeXL: Insights from a Connected World, Morgan Kaufmann, 2011.
3. Avinash Kaushik. Web Analytics 2.0: The Art of Online Accountability, 2009.
4. Hanneman, Robert and Mark Riddle. Introduction to Social Network Method, 2005.
5. Wasserman, S. & Faust, K. Social network analysis: Methods and applications. New York: Cambridge University Press, 1994.
6. Monge, P. R. & Contractor, N. S. Theories of communication networks. New York: Oxford University, 2003

**21OEC04 PRINCIPLES OF COMPUTER  
COMMUNICATION AND NETWORKS**

**3 0 0 3**

**Course Objectives**

- To understand the concept of data communication and networking models.
- To study the various networking Components and Networks.
- To explore the routing, addressing and security and management aspects of computer networks.

**Course Outcomes (COs)**

1. Classify the types of computer networks and analyze the seven layers of OSI model.
2. Analyze the basic operations of Routing Algorithms and Routing devices
3. Analyze the local and wide area networking technologies.
4. Apply the ISDN and ATM interface connections in broadband networks.
5. Analyze the security and management techniques related with networks.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	1	2	1	1								
2	1	2	2	3								
3	1	1	2	3								
4	1	1	3									
5	1	2	3	3								

**UNIT I**

**9 Hours**

**NETWORK FUNDAMENTALS**

Types of Computer Networks: by Area, by Topology; Communication Services: Serial and Parallel, Synchronous and Asynchronous, Simplex and Duplex, Analog and Digital; Speed and Capacity; Multiplexing and Switching; Network Architecture: OSI Seven-Layer Network model.

**UNIT II**

**9 Hours**

**INTERNETWORKING AND COMPONENTS**

Routing Concepts: Routing Algorithms, RIP, RIP-2, OSPF and other routing Protocols; Switches and Hubs: Store and Forward Switch, Cut-Through Switch, Hybrid Switch, Performance of Switches ; Repeaters; Repeater Vs Hubs; Bridges: Standards, Bridges Vs Repeaters; Routers and Gateways.

**UNIT III**

**9 Hours**

**LOCAL AND WIDE AREA NETWORKING TECHNOLOGIES**

LAN Components and Topologies; Access Techniques; Transmission Protocols and Media; Ethernet and IEEE 802.3 Networks: History, 10-MBPS Ethernet, Switched Ethernet, 100-MBPS Ethernet, Gigabit Ethernet.

**UNIT IV**

**9 Hours**

**BROADBAND NETWORKS**

ISDN: Evolution, ISDN Channel and Interface Structures; Broadband ISDN: Basics, Principles and General Architecture; Asynchronous Transfer Mode(ATM): Introduction, Concepts, Components, Connection Supported by ATM network and Concept of Virtual Channel and Virtual Path, Traffic control and Congestion Control, Operation and Maintenance aspects.

**UNIT V**

**9 Hours**

**NETWORK SECURITY AND MANAGEMENT**

Security: Need of Security, Security Threats, Vulnerabilities, Methods, tools and Techniques for Attacks; Network Security: Levels of Security, Cryptosystems; Data Encryption Standard (DES), Public Key Cryptography, Firewalls; Network Management: Functions and Elements, Distribution of Management; Simple Network Management Protocol (SNMP), Remote Network Management Services.

**Total: 45 Hours**

**Reference(s)**

1. Michael A.Gallo, William M. Hancock, Computer Communications and Networking Technologies, 1 Ed, Thomson Learning, 2002.
2. Kenneth C. Mansfield, Jr.James L. Antonakos, An Introduction to Computer Networking, 1Ed, Prentice Hall of India, 2002
3. A Shanmugam, S Rajeev, Computer Communication Networks, 1Ed, ISTE Learning Materials Centre, 2001
4. Discrete-Time Signal Processing by Alan V. Oppenheim and Ronald W. Schaffer, 3rd edition, 2010, Prentice Hall
5. Digital Signal Processing by Sanjit Mitra, 4th edition, 2011, McGraw-Hill, New York, NY

**22OEI01 PROGRAMMABLE LOGIC CONTROLLER**

**3 0 0 3**

**Course Objectives**

- To impart knowledge about automation and architecture of PLC
- To understand the PLC programming using timers, counters and advanced PLC functions
- To familiarize the student with PLC based applications

**Course Outcomes (COs)**

1. Outline the fundamental Concepts of Automation
2. Conclude the architecture, interfacing and communication techniques of PLC
3. Execute the suitable PLC Programming languages
4. Attribute the various functions and instruction sets of PLC
5. Generate a suitable logical programming for given applications

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1		2	2		3							
2	2	1		2	2		3							
3	2	1		2	2		3							
4	2	1		2	2		3							
5	2	1		2	2		3							

**UNIT I**

**10 Hours**

**INTRODUCTION TO AUTOMATION**

Evolution of automation -Types of automation - Fixed, flexible and programmable automation - Batch process and continuous process - open loop system and closed loop system - Function of sensors - Proximity sensors: Capacitive and Inductive - Infrared and Laser Push-buttons and toggle switches - Actuators: Solenoid valve - servo motor - electromagnetic relays.

**UNIT II**

**9 Hours**

**ARCHITECTURE OF PLC**

Components of PLC - sink and source I/O cards - Processor - Memory: Types of memory, Input and Output modules: Discrete, Analog -Scan time of PLC -Interfacing computer and PLC: RS232, RS485, Ethernet - Selection criteria for PLC.

**UNIT III**

**8 Hours**

**PLC PROGRAMMING**

Programming languages - Ladder logic components: User and bit Instructions, branch instructions, internal relay instruction Boolean logic using ladder logic programming, Latching -Timers: On Delay timer, OFF Delay timer and Retentive timer - Counters: Up Counter and Down Counter.

**UNIT IV**

**10 Hours**

**ADVANCED PLC FUNCTONS**

Instructions in PLC: Program Control Instructions, Math Instructions, Data Manipulation Instructions: Data compare operations, Data transfer operations - Sequencer and Shift register instructions- Analog Instructions: PID Controller - Scaling Instructions.

**UNIT V**

**8 Hours**

**APPLICATIONS OF PLC**

Case Studies: Bottle filling system - Pick and place robot - Car Parking - Traffic light control (4 ways with pedestrian signal) -Elevators - Pneumatic stamping system - alarm annunciator system.

**Total: 45 Hours**

**Reference(s)**

1. F.D. Petruzella, Programmable Logic Controllers, Tata Mc-Graw Hill, Third edition, 2015.
2. Benjamin C Kuo, Automatic Control Systems, Prentice Hall of India, New Delhi, 2014.
3. John Park, Steve Mackay, Edwin Wright, Practical data communications for instrumentation and control, Newnes, Elsevier, 2015.
4. K. L.S. Sharma, Overview of Industrial Process Automation, Elsevier, 2014.
5. John W Webb and Ronald A Resis, Programmable Logic Controller, Prentice Hall of India Pvt. Ltd., New Delhi, 2013.

**22OME01 DIGITAL MANUFACTURING**

**3 0 0 3**

**Course Objectives**

- To understand the process of generating 3D Computer Aided Design (CAD) model by different method.
- To explain the constructional features and develop simple program for CNC lathe and Milling machines.
- To provide an exhaustive knowledge on various generic process and benefits of Additive Manufacturing.
- To familiarize about materials and process parameters of liquid and solid based AM techniques.
- To educate powder based methodology and emerging trends with case studies, applications of AM techniques.

**Course Outcomes (COs)**

1. Design a 3D model from the 2D data.
2. Develop a CNC program for simple components.
3. Generate stl file and manipulate parameters of AM machine
4. Select appropriate liquid or solid materials based AM process to the respective application
5. Select appropriate process to fabricate a functional/prototype for aerospace, automotive, electronics, manufacturing and medical applications.

**Articulation Matrix**

C O No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	2	2	2		2								1	2	
2	2	2	2		2								1	2	
3	2	2	2		2								1	2	
4	2	2	2		2								1	3	
5	2	2	2		2								1	2	

**UNIT I**

**9 Hours**

**CAD MODELING**

Introduction - Design process - Stages. CAD - Input and Output devices, Modeling methods - Wire frame modelling, Surface modelling, Solid modelling - Constructive Solid Geometry and Boundary Representation Techniques. CAD/CAM data exchange - IGES, STEP. Product Life cycle management (PLM).

**UNIT II**

**10 Hours**

**AUTOMATION AND CNC MACHINES**

Introduction to Automation - Definition, types, reasons for automating. CNC Machines - Principles, types, features, advantages, applications. CNC Machine structure - Linear motion bearings, Recirculating ball bearings, drive system, and control system. CNC Lathe and Milling programming - Linear and circular interpolation, threading and drilling programs.

**UNIT III**

**7 Hours**

**ADDITIVE MANUFACTURING**

Introduction - Impact of Additive Manufacturing (AM) and Tooling on Product Development - Distinction between AM and CNC Machining - The Generalized AM Process chain - CAD Model - Input file formats - Generation and Conversion of STL file - File Verification and Repair - Build File Creation - Part Construction - Part Cleaning and finishing - AM Benefits - Classification of AM process

**UNIT IV**

**8 Hours**

**LIQUID AND SOLID MATERIAL BASED SYSTEMS**

Stereo lithography Apparatus (SLA), Digital Light Processing (DLP), Fused Deposition Modelling (FDM) and Laminated Object Manufacturing (LOM) - Working Principle, Construction, Process, Materials and Applications

**UNIT V**

**11 Hours**

**POWDER BASED PROCESSES AND APPLICATIONS OF ADDITIVE MANUFACTURING**

Selective Laser Sintering (SLS), Color Jet Printing (CJP), Electron Beam Melting (EBM) and Laser Engineered Net Shaping (LENS) - Working Principle, Construction, Process Variables, Materials and Applications. Reverse Engineering using 3D scanner. Application of Additive Manufacturing in Medical field, Manufacturing, Automotive industries, Aerospace and Electronics and Retail industries.

**Total: 45 Hours**

**Reference(s)**

1. Ibrahim Zeid, R.Sivasubramania, CAD/CAM Theory and Practice, Tata McGraw Hill, 2010.
2. M. Aditan, B.S. Pabala, CNC Machines, New age International, 2012.
3. C. K. Chua, K. F. Leong and C. S. Lim, Rapid prototyping: Principles and applications, Cambridge University Press, 2010.
4. D. T.Pham, S. S.Dimov, Rapid manufacturing, Springer-Verlag, London, 2001.
5. I. Gibson, D. W. Rosen, and B. Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping and Direct Digital Manufacturing, Springer, 2015  
<http://www.springer.com/978-1-4939-2112-6>
6. [www.grabcad.com](http://www.grabcad.com), [www.all3dp.com](http://www.all3dp.com)



**22OME02 INDUSTRIAL PROCESS ENGINEERING****3 0 0 3****Course Objectives**

- To impart the knowledge on production planning methodologies and layout design
- To learn about production planning and its control methods
- To provide the knowledge of work study, process charts and ergonomic condition
- To impart the knowledge on inventory control and material handling
- To learn about system analysis and different types of maintenance processes

**Course Outcomes (COs)**

1. Select proper plant layout for the required production system
2. Plan the resources required for the production and to perform the control methods
3. Apply work study method, prepare charts to outline the process and develop ergonomic condition suitable for the processes.
4. Analyze the inventory required based on production needs and material handling
5. Perform system analysis and use different types of maintenance process for smooth operations.

**Articulation Matrix**

<b>C O No</b>	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>	<b>PO 7</b>	<b>PO 8</b>	<b>PO 9</b>	<b>PO1 0</b>	<b>PO1 1</b>	<b>PO1 2</b>	<b>PSO 1</b>	<b>PSO 2</b>	<b>PSO 3</b>
1	2	3	1		1									2	
2	3	3	1		2						2			2	
3	1	3	3		2									2	
4	2	3	1		2									2	
5	2	3	1		2									2	

**UNIT I****9 Hours****INDUSTRIAL ENGINEERING AND PRODUCTION SYSTEM**

Industrial engineering - Concept, History and development, Applications, Roles of Industrial engineer- Production management, Industrial engineering versus production management, operations management. Plant layout, Criteria for good layout, Types of layout - Process layout, Product layout, Combination layout and fixed position layout, Flow (material movement) pattern, Workstation Selection and design.

**UNIT II****10 Hours****PROCESS PLANNING AND PRODUCTION CONTROL**

Introduction to Process planning-Definition, Procedure, Process selection, Machine capacity, Process sheet. Process analysis - Group technology, classification and coding system, formation of component family - Production planning, loading, scheduling. Production control -dispatching, routing - Progress control bar, curve, Gantt chart, route and schedule chart.

**UNIT III****8 Hours****WORK STUDY AND ERGONOMICS**

Work study - Definition, Need, Advantages, objectives of method study and work measurement, method study procedure, Process chart - symbols, outline process chart, flow process chart, principles

of motion economy, ergonomics- applications of ergonomic principles in the shop floor- work benches- seating arrangement, Industrial physiology.

**UNIT IV**

**10 Hours**

**INVENTORY MANAGEMENT**

Inventory control, classification, management, objectives, functions. Economic order quantity, Economic batch quantity, inventory models, ABC analysis, Material Requirement Planning (MRPI), Manufacturing Resource Planning (MRPII), Operating cycle, lean manufacturing, Supply chain management - Material handling.

**UNIT V**

**8 Hours**

**SYSTEM ANALYSIS AND MAINTENANCE**

System concept - system analysis, systems engineering, value engineering, value control, types of values. Plant maintenance - objectives, importance. Maintenance engineer - duties, functions and responsibilities. Types - breakdown, scheduled, preventive and predictive - Plant maintenance schedule, Condition monitoring.

**Total: 45 Hours**

**Reference(s)**

1. Khanna O.P., Industrial Engineering and management, Dhanpat Rai Publications.,2010
2. Martand T.Telsang, Industrial Engineering and Production Management, S Chand Publishers,2006
3. Panneerselvam R., Production and operations management, Heritage Publishers, 2006
4. Ravi Shankar, Industrial Engineering and Management, Gолgotia Publications Pvt. Ltd., New Delhi, 2009

**22OME03 MAINTENANCE ENGINEERING**

**3 0 0 3**

**Course Objectives**

- To understand the principles, objectives and importance of maintenance adopted in industry for successful progress.
- To introduce different maintenance categories, its merits and types of lubrication.
- To expose the idea of condition monitoring, methods and instruments used for allied measurements.
- To learn about failure analysis and repair methods for few mechanical elements.
- To promote computerization in maintenance and inventory management.

**Course Outcomes (COs)**

1. Explain the principles, objectives and importance of maintenance adopted in industry.
2. Select the suitable maintenance category and lubrication type.
3. Apply the appropriate methods and instruments for condition monitoring.
4. Analyze the failures of mechanical systems and select suitable repair methods.
5. Utilize computers in maintenance and inventory management.

**Articulation Matrix**

<b>C O No</b>	<b>PO 1</b>	<b>PO 2</b>	<b>PO 3</b>	<b>PO 4</b>	<b>PO 5</b>	<b>PO 6</b>	<b>PO 7</b>	<b>PO 8</b>	<b>PO 9</b>	<b>PO1 0</b>	<b>PO1 1</b>	<b>PO1 2</b>	<b>PSO 1</b>	<b>PSO 2</b>	<b>PSO 3</b>
1	2	2												2	
2	2	2												2	
3					2	2	1							2	
4	1	2	1		2	2	2							2	
5	2	2	2		1	1	1							2	

**UNIT I**

**9 Hours**

**PRINCIPLES OF MAINTENANCE PLANNING**

Basic principles of maintenance planning - Objectives and principles of planned maintenance activity - Importance and benefits of sound maintenance systems - Maintenance organization - Maintenance economics.

**UNIT II**

**9 Hours**

**MAINTENANCE CATEGORIES AND LUBRICATION**

Maintenance categories - Comparative merits of each category - Preventive maintenance, Maintenance schedules, Repair cycle - Total Productive Maintenance - Principles and methods of lubrication.

**UNIT III**

**9 Hours**

**CONDITION MONITORING**

Condition based maintenance - Cost comparison with and without Condition Monitoring - Methods and instruments for condition monitoring - Noise, vibration, wear and temperature measurement.

**UNIT IV**

**9 Hours**

**FAILURE ANALYSIS AND REPAIR METHODS**

Failure analysis - Failures and their development - Role of Non Destructive Testing in failure analysis - Repair methods for bearings, cylinder block, fuel pump, shaft.

**UNIT V**

**9 Hours**

**COMPUTER AIDED MAINTENANCE MANAGEMENT**

Approach towards Computerization in maintenance - computer-aided maintenance management system (CAMMS) - Advantages of CAMMS - spare parts and inventory centre performance reporting.

**FURTHER READING**

Retrofitting, objectives, classification of retrofitting, cost effectiveness through retrofitting (economical aspects), circumstances leading to retrofitting, features and selection for retrofitting.

**Total: 45 Hours**

**Reference(s)**

1. Srivastava S.K, Maintenance Engineering, S Chand and Company, 2010.
2. Mishra R.C, Pathak K, Maintenance Engineering and Management, Second edition, Prentice Hall India Learning Pvt. Ltd., 2012.
3. Keith Mobley R, Lindley R. Higgins and Darrin J. Wikoff, Maintenance Engineering Handbook, Seventh edition, McGraw-Hill Professional, 2008.
4. Davies A, Handbook of Condition Monitoring: Techniques and Methodology, Springer, 2012.
5. Otegui Jose Luis, Failure Analysis, Fundamentals and Applications in Mechanical Components, Nineteenth edition, Springer, 2014.

**22OBT01 BIOFUELS****3 0 0 3****Course Objectives**

- To understand and explore the scope of biofuels the most efficient renewable source of energy.
- To develop the expertise in the technology pertaining to their generation and employment in order to surrogate the existing conventional fuels and hence strives towards sustainable development
- To give way to the bolster green technology and incline towards more ecofriendly options.

**Course Outcomes (COs)**

1. Apply the bio resources that can be used for the production of biofuels.
2. Analyze the physical and chemical properties of the biodiesel.
3. Analyze the mechanisms of improvising the quality and performance of engines using biofuels
4. Analyze the bio-fuel conversion technologies and their environmental attributes
5. Evaluate the designing aspects of major unit processes/operations of an integrated bio-refinery

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	1		2				3								1
2	2						1								3
3	1						3								2
4	2						3								3
5	1						1								

**UNIT I****9 Hours****CLASSIFICATION AND RESOURCES**

Introduction, biofuel as a renewable energy, classification of biofuels - First, second, third and fourth generation biofuels, different plant sources as biofuel feed stocks, Biogases, physical and chemical characteristics of vegetable oils - iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs energy.

**UNIT II****9 Hours****BIODIESEL**

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Trans esterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel - Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number.

**UNIT III****9 Hours****QUALITY BIODIESEL AND ENVIRONMENT**

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties.

**UNIT IV**

**9 Hours**

**BIOETHANOL AND BIOGASES**

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass - lignocellulose, sugarcane, sugar beet, corn, wheat starch, purification - wet and dry milling processes, saccharification-chemical and enzymatic. Production of bio methane and bio hydrogen.

**UNIT V**

**9 Hours**

**BIOREFINERIES**

Definition and types of bio-refineries, co-products of bio-refineries-oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of bio-refineries.

**Total: 45 Hours**

**Reference(s)**

1. Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology, McGraw Hill Professional, 2008.
2. Mousdale, Biofuels, CRC Press, 2008
3. Ahindra Nag, Biofuels Refining and Performance, McGraw-Hill Professional, 2007.
4. Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer, 2007

**22OFD01 TRADITIONAL FOODS****3 0 0 3****Course Objectives**

- Understand the importance of traditional foods and food habits
- Know the traditional processing of snack, sweet and dairy food products
- Infer the wide diversity and common features of traditional Indian foods and meal patterns.

**Course Outcomes (COs)**

1. Justify the processing methods of traditional foods in terms of its health benefits
2. Assess the production methods of traditional sweets, snacks and dairy products
3. Differentiate Traditional fermented foods products based on its raw material
4. Implement a large scale production of tradition foods for its increased consumption
5. Compare the health aspects of traditional foods with modern foods

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1													
2		1												
3	2	1	1											
4								2						
5								2						

**UNIT I****9 Hours****TRADITIONAL METHODS OF FOOD PROCESSING**

Introduction - food culture -geographical features and food. Traditional methods of milling grains - rice, wheat and corn - equipment and processes as compared to modern methods. Equipment and processes for edible oil extraction- comparison of traditional and modern methods. Energy costs, efficiency, yield, shelf life and nutrient content comparisons. Traditional methods of food preservation - sun-drying, osmotic drying, brining, pickling and smoking.

**UNIT II****9 Hours****TRADITIONAL SWEETS, SNACKS AND DAIRY PRODUCTS**

Production, formulation, preparation and processing of Indian traditional sweet and snack food products:-Rasgolla, Gulab jamun; formulation and preparation of namkeen, potato chips, banana chips. Acid coagulated and fermented dairy products- paneer, dahi, shrikhand, lassi - processing conditions, defects etc. Fat rich products- Butter, ghee and its processing.

**UNIT III****9 Hours****TRADITIONAL FERMENTED FOOD PRODUCTS**

Idli, Soya sauce, fish pickle, dry fish, meat and vegetable fermented products. Various alcohol based products. Ways to increase nutritional quality of food such as enrichment, fortification, fermentation and mutual supplementation. Best cooking and processing methods to retain nutrients

**UNIT IV**

**10 Hours**

**COMMERCIAL PRODUCTION OF TRADITIONAL FOODS**

Commercial production of traditional breads, snacks, ready-to-eat foods and instant mixes, frozen foods -types marketed, turnover; role of SHGs, SMES industries, national and multinational companies; commercial production and packaging of traditional beverages such as tender coconut water, neera, lassi, buttermilk, dahi. Commercial production of intermediate foods - ginger and garlic pastes, tamarind pastes, masalas (spice mixes), idli and dosa batters

**UNIT V**

**8 Hours**

**HEALTH ASPECTS OF TRADITIONAL FOODS**

Comparison of traditional foods with typical fast foods / junk foods - cost, food safety, nutrient composition, bioactive components; energy and environmental costs of traditional foods; traditional foods used for specific ailments /illnesses.

**Total: 45 Hours**

**Reference(s)**

1. Sen and Colleen Taylor, Food Culture in India, Greenwood Press, 2005.
2. Davidar, Ruth N. "Indian Food Science: A Health and Nutrition Guide to Traditional Recipes:" East West Books, 2001.
3. Steinkrus.K.H. Handbook of Indigenous Fermented Foods, CRC press, 1995.
4. Aneja. R.P, Mathur.BN, R.C. Chandan, and Banerjee.A.K. Technology of Indian Milk Products. Dairy India Year Book, 2009.



**22OFD02 FOOD LAWS AND REGULATIONS****3 0 0 3****Course Objectives**

- Introduce the concept of food hygiene, importance of safe food and laws governing it
- Learn common causes of food borne illness - viz. physical, chemical and biological and identification through food analysis
- Understand food inspection procedures employed in maintaining food quality

**Course Outcomes (COs)**

1. Analyse the food safety strategies and nutritional quality of the food
2. Check the food regulatory mechanism and mandatory laws for food products
3. Determine the national and international regulatory agencies
4. Understand and apply the voluntary regulatory standards
5. Assess the implementation of food safety for a food processing industry

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	2	1											
2		1				1	2	1						
3		1												
4	1	2												
5	1	2												

**UNIT I****10 Hours****INTRODUCTION**

Introduction, concept of food safety and standards, food safety strategies. Food hazards and contaminations - biological (bacteria, viruses and parasites), chemical (toxic constituents / hazardous materials) pesticides residues / environmental pollution / chemicals) and physical hazards. Preventive food safety systems - monitoring of safety, wholesomeness and nutritional quality of food. Prevention and control of physical, chemical and microbiological hazards. Principles of food safety - Establishment: design and facilities - emergency preparedness - Maintenance cleaning and sanitation - personal hygiene - packaging and labelling - transportation - traceability - recall procedure - visitor policy. Adulteration: Intentional and unintentional - Preservatives - antioxidants, sweeteners, flavours, colours, vitamins, stabilizers - indirect additives - organic residues - inorganic residues and contaminants.

**UNIT II****10 Hours****FOOD LAWS**

Indian and Food Regulatory Regime (Existing and new), PFA Act and Rules, Food Safety and Quality Requirements, Additives, Contaminants and Pesticide Residue. Food Safety and Standards Act, 2006, FSSAI roles and responsibilities, Essential Commodities Act, 1955, Global Scenario, Codex Alimentarius, WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR) WHO/FAO Expert Bodies (JECFA/ JEMRA/JMPR). Food safety inspection services (FSIS) and their utilization.

**UNIT III**

**10 Hours**

**REGULATIONS**

Introduction to OIE & IPPC, Other International Food Standards (e.g. European Commission, USFDA etc). WTO: Introduction to WTO Agreements: SPS and TBT Agreement, Export & Import Laws and Regulations, Export (Quality Control and Inspection) Act, 1963. Role of Agricultural and Processed Food Products Export Development Authority (APEDA), Customs Act and Import Control Regulations, Other Voluntary and mandatory product specific regulations, Other Voluntary National Food Standards: BIS Other product specific standards; AGMARK. Nutritional Labelling, Health claims.

**UNIT IV**

**10 Hours**

**STANDARDS**

Voluntary Quality Standards and Certification GMP, GHP, HACCP, GAP, Good Animal Husbandry Practices, Good Aquaculture Practices ISO 9000, ISO 22000, ISO 14000, ISO 17025, PAS 22000, FSSC 22000, BRC, BRCIOP, IFS, SQF 1000, SQF 2000. Role of NABL, CFLS.

**UNIT V**

**5 Hours**

**IMPLEMENTATION AND RISK ASSESSMENT**

Implementation of food safety for a desired food processing industry. Risk assessment studies: Risk management, risk characterization and communication.

**Total: 45 Hours**

**Reference(s)**

1. Singal RS (1997). Handbook of indices of food quality and authenticity. Woodhead Publ. Cambridge, UK.
2. Shapton DA (1994). Principles and practices of safe processing of foods. Butterworth Publication, London. Winton AL (1999) Techniques of food analysis, Allied Science Publications New Delhi.
3. Pomeranze Y (2004). Food analysis - Theory and Practice CBS Publications, New Delhi.
4. Jacob MB (1999). The chemical analysis of foods and food products. CBS Publ. New Delhi

**22OFD03 POST HARVEST TECHNOLOGY OF  
FRUITS AND VEGETABLES**

**3 0 0 3**

**Course Objectives**

- To understand the importance and different methods of post harvest handling and storage of fruits and vegetables.
- To gain knowledge on different preservation methods of fruits and vegetables
- To familiarize with the value added products from fruits and vegetables

**Course Outcomes (COs)**

1. Implement the different post harvest handling practices for the storage of fruits and vegetables
2. Analyze the suitable preservation method (sugar, salt or dehydration) to produce value added products from fruits and vegetables
3. Evaluate the requirement of low temperature and irradiation methods to preserve specific fruits and vegetables
4. Apply the concentration and fermentation methods to preserve fruits and vegetables
5. Implement the canning method to preserve fruits and vegetables

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	1	1	2	1			1							
2	1	1												
3	1	2												
4	1		1											
5	2	1	1											

**UNIT I**

**9 Hours**

**POST-HARVEST PRACTICES AND PROCESSING**

Maturity indices for harvesting; pathological spoilage's during storage, ripening and control measures, Post-harvest handling, sorting & grading, packaging, storage, transportation, Methods of pre-cooling, post-harvest treatments to hasten and delay ripening; Methods of storage at farm level - cold storage, controlled/modified atmosphere storage, Quality management, export requirements, Nutritive value, nutraceutical properties

**UNIT II**

**9 Hours**

**PRESERVATION AND VALUE ADDITION**

General principles and methods of fruit and vegetable preservation. Preservation using sugar: Principle and Preparation of jam, jelly, marmalade, squash, RTS, carbonated beverages, crush, nectar, cordial, fruit bar, preserves, candies and carbonated fruit beverages. Processing using salt: Principle - Brining - Preparation of pickles, chutney and sauces, ketchup.

**UNIT III**

**9 Hours**

**PRESERVATION BY LOW TEMPERATURE AND IRRADIATION**

Preservation by low temperature: definition, principle, methods - Refrigeration, freezing. Methods of freezing- changes during freezing. Preparation of frozen foods. Minimal Processing of Fruits and Vegetables - techniques involved - Preservation by irradiation: definition- principle, application, irradiation unit.

**UNIT IV**

**9 Hours**

**PRESERVATION BY DRYING**

Machineries involved in processing of fruits and vegetables products. Drying and dehydration: definition, principle, Types of driers: Solar, cabinet, spray drier, drum drier, fluidized bed drier. Preparation of product for dehydration. Dehydration principles and equipment. Preparation of fruits - powder production. Problems related to storage of dehydrated products.

**UNIT V**

**9 Hours**

**PRESERVATION BY CANNING**

Canning: principles, Types of cans, packing of canned products-preparation of canned products - general considerations in establishing a commercial fruit and vegetable cannery, machineries involved in canning and bottling unit- spoilage of canned foods. Bottling of fruit and vegetable. Precautions in canning operations.

**Total: 45 Hours**

**Reference(s)**

1. S.Ranganna, HandBook of Analysis and Quality Control for Fruit and Vegetable Products, McGraw Hill Education (India) Private Limited, Chennai, 2017
2. N.W. Desrosier, the Technology of Food Preservation, CBS Publisher & Distributions, New Delhi, 1987.
3. R.P. Srivastava and S. Kumar, Fruit and Vegetable Preservation: Principles and Practices, Second Edition, International Book Distribution Co., Lucknow, 1998.
4. G. Lal, G. Siddappa and G.L. Tondon, Preservation of Fruits and Vegetables, Indian Council of Agricultural Research, New Delhi, 1986.
5. Chakraverty, A.S. Mujumdar, G.S.V. Raghavan and H.S. Ramaswamy, Handbook of Post-harvest Technology, Marcel Dekker Press, USA, 2001.
6. D.K. Salunkhe, and S.S. Kadam, Handbook of Fruit Science and Technology: Production, Composition and Processing, Marcel Dekker, New York, 1995.

**22OFD04 CEREAL, PULSES AND OIL SEED  
TECHNOLOGY**

**3 0 0 3**

**Course Objectives**

- Understand the application of scientific principles in the processing technologies specific to the materials
- Understand the storage methods and handling techniques followed for cereals, pulses and oil seeds
- Develop the knowledge in the area of Cereals, pulses and oil seed processing and technology

**Course Outcomes (COs)**

1. Identify the specific processing technologies employed for cereals
2. Analyse the composition of millets and their nutritional importance
3. Relate the compositional changes and processing methods of pulses and legumes
4. Create the competence in processing of oilseeds technology
5. Relate the storage processing of food grains with quality aspects

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2		2		2								
2	1	2		2		1								
3	2	2		1		2								
4	2	3		2		2								2
5	2	2		2		3								

**UNIT I**

**9 Hours**

**CEREALS**

Cereal Grains- Basic agricultural aspects, structure and composition; Storage, Insect control; Processing: Wheat- milling, (Atta and maida), quality aspects of flour, wheat proteins and their function, rheology of flour; wheat based baked products - Bread, Biscuit, Cakes, Extruded products, Pizza, Chapatis, malting and malt products; Rice-Milling, Parboiling, Quick cooking rice, Traditional Indian Products- Puffed Rice, flaked rice, Idli/Dosa/vada mixes and other savouries; Corn- Wet and dry milling, Corn Products - Corn flakes, Corn starch, canned corn products, puffed product; Oats-Milling, Oat Products - Steel cut, rolled oats, quick cooking; Traditional and Fermented cereal products.

**UNIT II**

**9 Hours**

**OTHER CEREALS AND MILLETS**

Sorghum, Pearl Millet, Finger millet, Foxtail Kodo Millet - Basic agricultural millet, aspects, structure and composition; storage, insect control; processing - pearling, Milling, Malting, Malt based foods, flaked and fermented products; Traditional and Nutritional products based on finger millet.

**UNIT III**

**9 Hours**

**PULSES AND LEGUMES**

Basic agricultural aspects, structure, composition, storage, insect control, processing Milling/splitting, dhal milling, products - puffed, flakes, flour, legume-based traditional products, flour based Indian sweets and savouries, soya milk, soy protein Isolate, soya paneer

**UNIT IV**

**9 Hours**

**OIL SEEDS AND NUTS**

Basic agricultural aspects structure, composition, Storage, Insect control; processing: traditional and modern methods of oil extraction, refining, bleaching, deodorizing, hydrogenation; oil blends; applications of different oils and fats in food processing & products.

**UNIT V**

**9 Hours**

**STORAGE AND HANDLING**

Bag Storage - Advantages and Disadvantages, Cover Plinth Storage Structures, CAP storage (Cover and Plinth Storage). Protection against Rodents, Fungi, Pests and Mites. Fumigation Processes for bag storage piles. Bulk Storage in silos and large Bins. Conveyors and Elevators for feeding and discharging.

**Total: 45 Hours**

**Reference(s)**

1. Chakraverty, A.: Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta, 1995.
2. Delcour, Jan A. and R. Carl Hosney., Principles of Cereal Science and Technology, 3rd Edition, American Association of Cereal Chemists, 2010.
3. Karl Kulp, Handbook of Cereal Science and Technology, 2nd Rev. Edition, CRC Press, 2000.
4. N.L.Kent and A.D.Evans, Technology of Cereals (4th Edition) Elsevier Science (Pergaman),Oxford, UK, 1994.
5. Matz, Samuel A., The Chemistry and Technology of Cereals as Food and Feed, 2nd Edition,CBS, 1996.
6. Morris, Peter C. and J.H. Bryce., Cereal Biotechnology, CRC/Wood head publishing, 2004.

**22OFT01 FASHION CRAFTSMANSHIP****3 0 0 3****Course Objectives**

- To impart theoretical and practical knowledge about various handi-craft techniques
- To enhance innovative skills on hand crafts.
- To build confidence on doing handicrafts.

**Course Outcomes (COs)**

1. Outline the classification, techniques and criteria for selecting raw materials for making various handicraft materials and produce textile based handicrafts. Produce various decorative and appealing products
2. Design and construct various wall hangings and fashion accessories.
3. Design and construct toys and accessories
4. Design and construct head accessories, home furnishings and paintings
5. Design and construct various decorative and appealing products for interiors

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1	3				2		2	2		2	2	
2	3	2	3				1		2	3		2	2	
3	3	2	3				2		2	3		2	2	
4	3	2	3				2		2	3		2	2	
5	3	2	3				2		2	3		2	2	

**UNIT I****9 Hours****TECHNIQUES OF HANDICRAFT MATERIALS**

Definition of Handicraft, Classification: Reusable, Non reusable, Raw materials used in various craft materials: printed, embroidered, stitched and handmade, Criteria for selection of raw materials: material types and end uses.

**UNIT II****9 Hours****DECORATIVE AND APPEALING PRODUCTS - INTERIORS**

Designing and Construction procedures for following various decorative and appealing products: Wall hangings - String Art on plywood, Pressed Flower Art frames.

**UNIT III****9 Hours****DECORATIVE AND APPEALING PRODUCTS - ACCESSORIES**

Designing and Construction procedures for following various decorative and appealing products: Handbags, Hats, footwear.

**UNIT IV****9 Hours****DECORATIVE AND APPEALING PRODUCTS - ORNAMENTS**

Designing and Construction procedures for following various decorative and appealing products: Stone necklace using Macrame Technique, Tribal Jewellery using woollen threads, Floral Jewellery using Resin Technique, Fabric Jewellery using Tie and Dye Technique.

**UNIT V**

**9 Hours**

**DECORATIVE AND APPEALING PRODUCTS - FANCY ITEMS**

Designing and Construction procedures for following various decorative and appealing products: Jewellery Box, Utility Holder, Gift items. Lampshade decors from cardboard, Driftwood Frames for pictures and Mirrors.

**Total: 45 Hours**

**Reference(s)**

1. Handmade in India: A Geographic Encyclopaedia of India Handicrafts. Abbeville press; 1 edition (October 20,2009)
2. Encyclopaedia of Card making Techniques (Crafts), Search Press Ltd, illustrated edition, 2007
3. All about Techniques in Illustration, Barron Educational Series, 2001
4. Printing by Hand: A Modern Guide to printing with Handmade stamps, Stencils and Silk Screens, STC Craft/A Melanie Falick Book, 2008
5. Materials & Techniques in the Decorative Arts: An Illustrated Dictionary, University of Chicago Press, 2000
6. <https://www.marthastewart.com/274411/fashion-crafts>



**22OFT02 INTERIOR DESIGN IN FASHION****3 0 0 3****Course Objectives**

- To impart knowledge on interior design.
- To improve the design skills, sustainable with socially-conscious designs

**Course Outcomes (COs)**

1. Interpret the elements of interior design concepts and resolve the personality requirements
2. Develop graphical representations of interior design concepts
3. Resolve the space planning requirements of residential home as per CPWD guidelines
4. Determine the aesthetic requirements of interior design components.
5. Appraise the roles and responsibilities of interior designer.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	2	3		-	1							2	
2	3	2	3		2	3		2					3	
3	3	3	3		2	2		2					2	
4	3	3	3		2	3		2					2	
5	3	2			2			3					3	

**UNIT I****9 Hours****INTRODUCTION**

Interior designing - definition, importance, requirements and types - Structural design, Decorative Design -Designing interiors, Good taste; Design themes, types and application. Personality of the Home - Art elements - Line: types, characteristics and importance; form: size and shape, characteristics; Colour - sources, qualities, emotional effects, colour wheel and schemes.

**UNIT II****9 Hours****GRAPHICAL PRESENTATIONS**

3D composition; Isometric and Axonometric- Still life- Furniture Sketching- Object Drawing with color rendering - Interior elements, Lighting, plants. Perspective, Axonometric Isometric drawing. Orthographic Projection - Lifts and escalators.

**UNIT III****9 Hours****SPACE PLANNING**

Space planning concepts- interiors, circulation. Definition, application of ergonomic principals in interiors. Residential house space planning case study- CPWD guidelines. Lighting for different locations and activities, measurement, ventilation and indoor air quality, noise control methods.

**UNIT IV****9 Hours****INTERIOR COMPONENTS**

Application of colour in interiors; Texture - types and significance; Pattern: types and effects; Light - importance. Importance of Furniture Design for Interiors- Ancient Age / Middle Age / Contemporary. Doors, Windows, Staircase designs, False Ceiling, Partitions, Wall Panelling, Comics, Mosaic, Cladding- Flooring and Wall Cladding

**UNIT V**

**9 Hours**

**ROLES AND RESPONSIBILITIES OF INTERIOR DESIGNER**

Role of an Interior Designer- Responsibility towards society and need of an Interior Designer to better the environment- Ethics and Code of Conduct- Responsibility towards client, contractor and supplier, Estimation. Professional Fees- Work of an Interior Designer- Making of portfolio, JD Annual Design Awards.

**Total: 45 Hours**

**Reference(s)**

1. Joanna Gaines, *Homebody: A guide to creating spaces you never want to leave*, Harper design, 2018.
2. Erin gates, *Elements of Style: Designing a Home and a life*, Simon and Schuster, 2014.
3. Simon Dodsworth, *The Fundamentals of Interior Design*, AVA publishing, 2009.
4. V. Mary. Knackstedt, *The Interior Design Business Handbook: A Complete Guide to Profitability*, Wiley, New Jersey; 2006.
5. M. G. Shah, C. M. Kale, and S.Y. Patki, *Building Drawing with an Integrated Approach to Build Environment*, Tata McGraw Hill, 2002.
6. <https://eclectictrends.com>

**22OFT03 SURFACE ORNAMENTATION**

**3 0 0 3**

**Course Objectives**

- To familiarize the students about the various techniques of surface embellishment with relevance to garment embellishments.
- To aware of various types of embroidery and methods of producing it.
- To make the students confident about doing surface embellishment work

**Course Outcomes (COs)**

1. Analyze the raw material requirements for surface ornamentation and its application
2. Implement hand embroidery stitches on fabric and show the stitch development procedure in diagrammatic representations
3. Apply the machine and computerized embroidery stitches
4. Analyze the surface embellishment techniques and its application
5. Assess the quality maintenance parameters of all embroidered products and analyze the 6 traditional embroidery techniques

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	3	2					1						
2	2	3	2						2				2	2
3	2	3	2		3								2	2
4	2	2	2						2				2	2
5	2	2	2						2					2

**UNIT I**

**9 Hours**

**INTRODUCTION TO SURFACE ORNAMENTATION**

Introduction, Definition, Need, Types, Raw materials, Importance of surface ornamentation, Selection of needle, thread and fabric for hand embroidery and machine embroidery. various methods of surface embellishment- embroidery and surface ornamentation.

**UNIT II**

**9 Hours**

**HAND EMBROIDERY**

General rules for hand embroidery. Types of hand embroidery stitches-Running, Couching, Button hole, Satin, Long & Short, Wheat, Chain, Stem, Herringbone, Cross stitch, Knotted stitches, Fish bone, Fly stitch, Braids, Back, Hem, Seed, Needle weaving, Whip stitches.

**UNIT III**

**9 Hours**

**MACHINE EMBROIDERY**

General rules for machine embroidery. Types of frames and methods of transferring the designs. Attachments to sewing machines for embroidery, Types of machine embroidery stitches- Eyelet work, Cut work, patch work, Mirror work, Applique, Shaded embroidery, Shadow work, Bead and Sequins work, Vermicelli, Zigzag, Granite stitch. Computerized embroidery machine- Concept of design and development, software used in embroidery machines, process of designing, method and types of stitch application, punching and digitizing.

**UNIT IV**

**9 Hours**

**EMBELLISHMENT TECHNIQUES**

Materials used and Applications. Types of embellishment techniques- fabric painting-hand, Stencil-dabbing and Spraying. Dyeing and printing-advanced tie and dye techniques, batik and block printing. Trimmings and decorations-Laces, Pompons, Fringes, Tassels, Tucks, Show buttons, Crocheting.

**UNIT V**

**9 Hours**

**TRADITIONAL EMBROIDERIES OF INDIA AND CARE**

Care and maintenance of embroidered articles-care and maintenance methods for embroidered apparel, pressing. Traditional Embroideries of India-Phulkari, Kasuti, Kashmiri embroidery, Kutch work, Chikkankari, Kantha.

**Total: 45 Hours**

**Reference(s)**

1. Ruth Chandler, Modern Hand Stitching-Dozens of stitches with creative free-form variations,2014
2. Sophie Long, Mastering the Art of Embroidery: Traditional Techniques and Contemporary Applications for Hand and Machine Embroidery, Heritage Publishers, London, 2013
3. Christen Brown ,Embroidered & Embellished, C&T Publishing, 2013
4. Sheila Paine, Embroidered Textiles, Thames and Hudson Publisher, UK, 1990.
5. Gail Lawther, Inspirational Ideas for Embroidery on Clothes & Accessories, Search Press Ltd, UK, 1993.
6. <http://www.needlenthread.com/tag/hand-embroidery-stitches>

**22OPH05 PHYSICS OF SOFT MATTER****3 0 0 3****Course Objectives**

- To recognize the properties of soft matter and hard matter
- To understand the fundamental interactions of colloids and gels
- To explain the structure and phase behavior of liquid crystals and supramolecules
- To summarize the soft matter properties of structures and components of life

**Course Outcomes (COs)**

1. Identify the salient features of soft matter and hard matter
2. Exemplify the fundamental interactions and stability of colloids and gels
3. Illustrate the structure and properties of liquid crystals
4. Outline the aggregation and phase behavior of surfactants, polymers, copolymers and block copolymers
5. Analyze the soft matter behavior of nucleic acids, proteins, polysaccharides and membranes

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2	1												
3	2	2												
4	2	2												
5	2	2												

**UNIT I****9 Hours****CONDENSED MATTER**

Intermolecular forces-Condensation and freezing-mechanical response: Hookean solid-Newtonian liquid-viscoelasticity. Glasses: relaxation time-viscosity- glass forming liquids. Soft matter: length scales-fluctuations and Brownian motion

**UNIT II****9 Hours****COLLOIDAL DISPERSIONS & GELS**

Forces between colloidal particles: vander Waals forces-electrostatic double layer forces-steric hindrance-depletion interactions. Stability and phase behaviour: Crystallisation-strong colloids-weak colloids.Physical and chemical gels-classical theory of gelation-elasticity of gels

**UNIT III**

**9 Hours**

**LIQUID CRYSTALS**

Liquid crystal phases-distortions and topological defects-electrical and magnetic properties-polymer liquid crystals-Fredricks transition and liquid crystal displays

**UNIT IV**

**9 Hours**

**SUPRAMOLECULAR SELF ASSEMBLY**

Aggregation and phase separation-types of micelles- bilayers and vesicles. Phase behaviour of concentrated surfactant solutions-phase separation in polymers, copolymers and block copolymers

**UNIT V**

**9 Hours**

**SOFT MATTER IN NATURE**

Components and structures of life-Nucleic acids-proteins-interaction between proteins-polysaccharides-membranes

**Total: 45 Hours**

**REFERENCES**

1. Richard A L Jones, Soft Condensd Matter, Oxford University Press, UK, 2002
2. Masao Doi, Soft Matter Physics,Oxford University Press, UK, 2013.
3. Ian W. Hamley, Introduction to Soft Matter, John Wiley & Sons, 2007
4. A. Fernandez-Nieves, A M Puertas, Fluids, Colloids and Soft materials: An Introduction to Soft Matter Physics, John Wiley & Sons, 2016
5. Maurice Kleman, Oleg D. Lavrentovich, Soft Matter Physics: An Introduction, Springer-Verlag, New York, 2003.

**220CH01 CORROSION SCIENCE AND ENGINEERING**

**3 0 0 3**

**Course Objectives**

- Analyse the loss incurred due to corrosion in different sectors and terminologies related to corrosion
- Identify forms and types of corrosion with suitable mechanism
- Apply various methods of corrosion control, corrosion testing and monitoring

**Course Outcomes (COs)**

1. Explain if corrosion can occur under specific operating conditions in a given equipment or construction and indicate regions of immunity, corrosion and passivity of a metal
2. Compare different corrosion types on metals when exposed to air, water and at high temperatures (> 100 C)
3. Identify the corrosion mechanism on steel, iron, zinc and copper metal surfaces
4. Calculate the rate of corrosion on metals using electrochemical methods of testing
5. Propose the correct materials, design and operation conditions to reduce the likelihood of corrosion in new equipment and constructions

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	2						1							
3	1	3												
4	2	2												
5	3	3					1							

**UNIT I**

**9 Hours**

**CORROSION**

Importance of corrosion - spontaneity of corrosion - units of corrosion rate (mdd and mpy) - direct and indirect damage by corrosion - importance of corrosion prevention in industries - Pilling Bedworth ratio and its significance - passivation - area relationship in both active and passive states of metals - Pourbaix diagrams of Mg, Al and Fe and their advantages and disadvantages

**UNIT II**

**7 Hours**

**TYPES OF CORROSION**

Eight forms of corrosion: uniform, galvanic, crevice corrosion, pitting, intergranular corrosion, selective leaching, erosion corrosion and stress corrosion-Catastrophic oxidation corrosion

**UNIT III**

**9 Hours**

**MECHANISM OF CORROSION**

Hydrogen embrittlement - corrosion fatigue - filiform corrosion - fretting damage and microbes induced corrosion. Corrosion mechanism on steel, iron, zinc and copper metal surfaces

**UNIT IV**

**10 Hours**

**CORROSION RATE AND ITS ESTIMATION**

Rate of corrosion: Factors affecting corrosion. Electrochemical methods of polarization: Tafel extrapolation polarization and linear polarization. Weight loss method - testing for intergranular susceptibility and stress corrosion. Non destructive testing methods: Visual testing - liquid penetrant testing - magnetic particle testing - Ultrasonic monitoring, and eddy current testing

**UNIT V**

**10 Hours**

**CORROSION CONTROL METHODS**

Fundamentals of cathodic protection - types of cathodic protection(sacrificial anodic and impressed current cathodic protection). Stray current corrosion, problems and its prevention. Protective coatings: Metal coatings: Hot dipping (galvanizing, tinning and metal cladding) - natural inhibitors. Selection of suitable design for corrosion control

**Total: 45 Hours**

**Reference(s)**

1. Mouafak A. Zaher, "Introduction to Corrosion Engineering", CreateSpace Independent Publishing Platform, 2016.
2. E.McCafferty, "Introduction to Corrosion Science", Springer; 2010 Edition, January 2010.
3. R. Winstone Revie and Herbert H. Uhlig, "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", 4th Edition, John Wiley & Science, 2008.
4. Mars G. Fontana, "Corrosion Engineering", Tata McGraw Hill, Singapore, 2008
5. David E.J. Talbot (Author), James D.R. Talbot, "Corrosion Science and Technology", Second Edition (Materials Science & Technology), CRC Press; 2nd Edition, 2007.
6. <http://corrosion-doctors.org/Corrosion-History/Eight.html>



**22OCH02 POLYMER SCIENCE****3 0 0 3****Course Objectives**

- Explain the properties of different polymers with its mechanism
- Select the appropriate polymerization techniques to synthesize the polymers
- Identify suitable polymers for various industrial applications

**Course Outcomes (COs)**

1. Illustrate the types of mechanism of polymerization reactions and analyze the natural and synthetic polymers
2. Identify the suitable polymerization techniques to synthesize the high quality polymers
3. Identify the structure, thermal, and mechanical properties of polymers for different applications
4. Apply the polymer processing methods to design polymer products
5. Analyze the polymers used in electronic and biomedical applications.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	2	1												
2	1	2												
3	2	2												
4	1	1	2											
5	1	3	2											

**UNIT I****10 Hours****POLYMERS AND ELASTOMERS**

Classification of polymers - Mechanism: Addition polymerization - free radical, cationic, anionic and co-ordination (Ziegler-Natta) polymerization - copolymerization - condensation polymerization (nylon-6,6) - ring opening polymerization (nylon-6). Elastomers: Natural rubber and synthetic rubber: styrene-butadiene rubber (SBR), butyl, neoprene, thiocol rubbers. High performance polymers: polyethers, polyether ether ketone (PEEK), polysulphones and polyimides

**UNIT II****8 Hours****POLYMERIZATION TECHNIQUES**

Homogeneous and heterogeneous polymerization - bulk polymerization (PMMA, PVC) - solution polymerization - polyacrylic acid, suspension polymerization (ion-exchange resins) - emulsion polymerization (SBR) - advantages and disadvantages of bulk and emulsion polymerization. Melt solution and interfacial poly-condensation

**UNIT III****8 Hours****CHARACTERIZATION AND TESTING**

Characterization of polymers by Infrared Spectroscopy (IR) and Nuclear Magnetic Spectroscopy (NMR) - Thermal properties: TGA and DSC - Testing tensile strength - Izod impact - Compressive strength - Rockwell hardness - Vicot softening point - water absorption

**UNIT IV**

**9 Hours**

**POLYMER PROCESSING**

Moulding: Compression - injection - extrusion and blow mouldings. Film casting - calendering. Thermoforming and vacuum formed polystyrene - foamed polyurethanes. Fibre spinning: melt, dry and wet spinning. Fibre reinforced plastics fabrication: hand-layup - filament winding and pultrusion

**UNIT V**

**10 Hours**

**SPECIALITY POLYMERS**

Preparation and properties of heat resistant and flame retardant polymers. Polymers for electronic applications: liquid crystalline, conducting and photosensitive polymers – E waste management. Polymer for biomedical applications: artificial organs, controlled drug delivery, Scaffolds in tissue Engineering –waste management.

**Total: 45 Hours**

**Reference(s)**

1. V. R. Gowarikar, N. V. Viswanathan and Jayadev Sreedhar, "Polymer Science", New Age International (P) Ltd., New Delhi, 2021
2. Joel R. Fried, "Polymer Science and Technology", Prentice Hall of India (P). Ltd., 2014
3. F. W. Billmeyer, "Text Book of Polymer Science", John Wiley & Sons, New York, 2008
4. Barbara H. Stuart, "Polymer Analysis", John Wiley & Sons, New York, 2008
5. George Odian , "Principles of Polymerization", John Wiley & Sons, New York, 2004
6. R. J. Young and P. A. Lovell, "Introduction to Polymers", CRC Press, New York, 2011
7. Common Biocompatible Polymeric Materials for Tissue Engineering and Regenerative Medicine (2019), Materials Chemistry and Physics <https://doi.org/10.1016/j>.

**22OCH03 ENERGY STORING DEVICES****3 0 0 3****Course Objectives**

- Compare the energy density of commercialized primary and secondary batteries.
- Classify the fuel cells and compare their efficiency in different environmental conditions.
- Demonstrate the various energy storage devices and fuel cells.

**Course Outcomes (COs)**

1. Find the parameters required for operation of a cell to evaluate the capacity of energy storage devices.
2. Identify the electrodes, electrolyte and cell reactions of different types of primary, secondary batteries and infer the selection criteria for commercial battery systems with respect to commercial applications.
3. Differentiate fuel cells based on its construction, production of current and applications.
4. Compare different methods of storing hydrogen fuel and its environmental applications.
5. Classify the solar cell based on the materials used in it.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
1	3	1												
2	2	3					1							
3	3	1												
4	2	2					1							
5	3	3					1							

**UNIT I****6 Hours****BASICS OF CELLS AND BATTERIES**

Components - classification - operation of a cell - theoretical cell voltage - capacity - specific energy - energy density of lithium and lead acid battery - charge efficiency- charge rate - charge retention - closed circuit voltage - open circuit voltage current density - cycle life - discharge rate-over charge-over discharge

**UNIT II****10 Hours****BATTERIES FOR PORTABLE DEVICES AND ELECTRIC VEHICLES**

Primary batteries: zinc-carbon - magnesium, and mercuric oxide - recycling/safe disposal of used cells. Secondary batteries: lead acid - nickel-cadmium - lithium ion batteries - rechargeable zinc alkaline battery. Reserve batteries: Zinc-silver oxide - lithium anode cell - photogalvanic cells. Battery specifications for cars and automobiles. Extraction of metals from battery materials.

**UNIT III**

**10 Hours**

**TYPES OF FUEL CELLS**

Importance and classification of fuel cells: Description, working principle, components, applications and environmental aspects of the following types of fuel cells: alkaline fuel cells - phosphoric acid - solid oxide - molten carbonate and direct methanol fuel cells

**UNIT IV**

**10 Hours**

**HYDROGEN AS A FUEL**

Sources and production of hydrogen: Electrolysis and photocatalytic water splitting. Methods of hydrogen storage: High pressurized gas - liquid hydrogen type - metal hydride. Hydrogen as engine fuel - features, application of hydrogen technologies in the future – limitations.

**UNIT V**

**9 Hours**

**ENERGY AND ENVIRONMENT**

Future prospects of renewable energy and efficiency of renewable fuels - economy of hydrogen energy. Solar Cells: First, second, third and fourth generation solar cell - photobiochemical conversion cell.

**Total: 45 Hours**

**Reference(s)**

1. N. Eliaz, E. Gileadi, Physical Electrochemistry, Fundamentals, Techniques and Applications, Wiley, 2019.
2. J. Garche, K. Brandt, Electrochemical Power sources: Fundamentals Systems and Applications, Elsevier, 2018
3. S.P. Jiang, Q. Li, Introduction to Fuel Cells, Springer, 2021.
4. A. Iulianelli, A. Basile, Advances in Hydrogen Production, Storage and Distribution, Elsevier, 2016.
5. M.M. Eboch, The Future of Energy, From Solar Cells to Flying Wind Farms, Capstone, 2020.

**22OMA01 GRAPH THEORY AND COMBINATORICS**

**3 0 0 3**

**Course Objectives**

- This course comprehends the graphs as a modeling and analysis tool in computer science & Engineering
- It introduces the structures such as graphs & trees and techniques of counting and combinations, which are needed in number theory based computing and network security studies in Computer Science.

**Programme Outcomes (POs)**

- Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. Recognize the basic ideas of Graph and its characteristics.
2. Assess the characteristics of trees and its properties.
3. Predict the coloring of graphs and its applications in the respective areas of engineering.
4. Compute the permutations and combinations in the engineering field.
5. Demonstrate the types of generating functions and their applications in engineering.

**Articulation Matrix**

C O No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	1	2													
2	1	3													
3	2	3													
4	2	3													
5	3	3													

**UNIT I**

**9 Hours**

**INTRODUCTION**

Graphs - Introduction - Isomorphism - Sub graphs - Walks, Paths, Circuits - Connectedness - Components - Euler graphs - Hamiltonian paths and circuits - Trees - Properties of trees - Distance and centers in tree - Rooted and binary trees.

**UNIT II** **9 Hours**

**TREES, CONNECTIVITY**

Spanning trees - Fundamental circuits - Spanning trees in a weighted graph - cut sets - Properties of cut set - All cut sets - Fundamental circuits and cut sets - Connectivity and separability - Network flows - 1-Isomorphism - 2-Isomorphism - Combinational and geometric graphs - Planer graphs - Different representation of a planer graph.

**UNIT III** **9 Hours**

**MATRICES, COLOURING AND DIRECTED GRAPH**

Chromatic number - Chromatic partitioning - Chromatic polynomial - Matching - Covering - Four color problem - Directed graphs - Types of directed graphs - Digraphs and binary relations - Directed paths and connectedness - Euler graphs.

**UNIT IV** **9 Hours**

**PERMUTATIONS**

Fundamental principles of counting - Permutations and combinations - Binomial theorem - combinations with repetition - Combinatorial numbers - Principle of inclusion and exclusion - Derangements - Arrangements with forbidden positions.

**UNIT V** **9 Hours**

**GENERATING FUNCTIONS**

Generating functions - Partitions of integers - Exponential generating function - Summation operator - Recurrence relations - First order and second order - Non-homogeneous recurrence relations - Method of generating functions.

**Total: 45 Hours**

**Reference(s)**

1. Narsingh Deo, Graph Theory: With Application to Engineering and Computer Science, Prentice Hall of India, 2003
2. Grimaldi R.P., Discrete and Combinatorial Mathematics: An Applied Introduction, Addison Wesley, 1994.
3. Rosen K.H., Discrete Mathematics And Its Applications, McGraw Hil, 2007
4. Clark J. & Holton D.A., A First Look at Graph Theory, Allied Publishers, 1995.
5. Mott J.L., Kandel A. & Baker T.P., Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India, 1996.
6. Liu C.L., Elements of Discrete Mathematics, McGraw Hill, 1985.

**22OGE01 PRINCIPLES OF MANAGEMENT**

**3 0 0 3**

**Course Objectives**

- To develop cognizance about importance of management principles.
- Extract the functions and responsibilities of managers.
- To Study and understand the various HR related activities.
- Learn the application of the theories in an organization.
- Analyze the position of self and company goals towards business.

**Course Outcomes (COs)**

1. Students will be able to understand the basic concepts of Management.
2. Have some basic knowledge on planning process and its Tools & Techniques.
3. Ability to understand management concept of organizing and staffing.
4. Ability to understand management concept of directing.
5. Ability to understand management concept of controlling.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1									2		3				
2									2		2				
3									2		2				
4									3		2				
5									2		2				

**UNIT I**

**9 Hours**

**INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS**

Definition of Management Science or Art Manager Vs Entrepreneur-types of managers - Managerial roles and skills Evolution of Management Scientific, Human Relations, System and Contingency approaches Types of Business organization - Sole proprietorship, partnership, Company - public and private sector enterprises - Organization culture and Environment Current Trends and issues in Management.

**UNIT II**

**9 Hours**

**PLANNING**

Nature and purpose of planning - Planning process - Types of planning – Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

**UNIT III**

**9 Hours**

**ORGANISING**

Nature and purpose – Formal and informal organization - Organization chart - Organization Structure Types - Line and staff authority - Departmentalization - Delegation of authority - Centralization and decentralization - Job Design - Human Resource - Management - HR Planning, Recruitment, Selection, Training and Development, Performance Management, Career planning and management

**UNIT IV**

**9 Hours**

**DIRECTING**

Foundations of individual and group behaviour - Motivation-Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership-types and theories of leadership - Communication-Process of communication - Barrier in communication Effective communication-Communication and IT.

**UNIT V**

**9 Hours**

**CONTROLLING**

System and process of controlling - Budgetary and non-Budgetary control techniques - Use of Computers and IT in Management control - Productivity problems and management - Control and Performance-Direct and preventive control - Reporting.

**Total: 45 Hours**

**Reference(s)**

1. Robbins S, Management, (13th ed.), Pearson Education, New Delhi, 2017.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, Fundamentals of Management, Pearson Education, 7th Edition, 2011.
3. Robert Kreitner and Mamata Mohapatra, Management, Biztantra, 2008.
4. L. M. Prasad, Principles and Practice of Management. 7th Edition, Sultan Chand & Sons, 2007.
5. P. C. Tripathi and P. N. Reddy, Principles of Management, Fourth Edition, Tata McGraw Hill, 2008.



**22OGE02 ENTREPRENEURSHIP DEVELOPMENT I****3 0 0 3****Course Objectives**

- Learn the basics and scope of the Entrepreneurship
- Understand the generation of ideas of the Entrepreneurship
- Evolve the legal aspects of the business
- Learn to analyze the various business finance
- Learn the basics of the Operations Management

**Course Outcomes (COs)**

1. Analyze the role of entrepreneurship in economic development.
2. Explain the types of ideas that to be used for entrepreneurship development.
3. Examine the legal aspects of business and its association.
4. Examine the sources of business and its analysis.
5. Analyze the different modes of operation management.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1						1	2		2						
2						1	2		2						
3						1	2		2						
4						1	2		2						
5						1	2		2						

**UNIT I****9 Hours****BASICS OF ENTREPRENEURSHIP**

Nature, scope and types of Entrepreneurship, Entrepreneur Personality Characteristics, Entrepreneurship process. Role of entrepreneurship in economic development

**UNIT II****9 Hours****GENERATION OF IDEAS**

Creativity and Innovation, Lateral Thinking, Generation of Alternatives, Fractional, Reversal Method, Brain Storming, Analogies

**UNIT III****9 Hours****LEGAL ASPECTS OF BUSINESS**

Contract act-Indian contract act, Essential elements of valid contract, classification of contracts, sale of goods act- Formation of contract of sale, negotiable instruments- promissory note, bills and cheques, partnership, limited liability partnership (LLP), companies act-kinds, formation, memorandum of association, articles of association.

**UNIT IV****9 Hours****BUSINESS FINANCE**

Project evaluation and investment criteria (cases), sources of finance, financial statements, break even analysis, cash flow analysis.

**UNIT V**

**9 Hours**

**OPERATIONS MANAGEMENT**

Importance – functions - deciding on the production system - facility decisions: plant location, plant layout (cases), capacity requirement planning - inventory management (cases) - lean manufacturing, Six sigma.

**Total: 45 Hours**

**Reference(s)**

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill Publishing Company Limited, New Delhi: 2000.
3. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006

**22OGE03 ENTREPRENEURSHIP DEVELOPMENT  
II**

3 0 0 3

**Course Objectives**

- Evolve the marketing mix for promotion the product / services
- Handle the human resources and taxation
- Learn to analyze the taxation
- Understand the Government industrial policies and supports
- Preparation of a business plan

**Course Outcomes (COs)**

1. Examine the strategies and plans in marketing management.
2. Analyze the cases involved in human resource management.
3. Classify the direct and indirect taxes in business.
4. Analyze the supports given by government for improving the business.
5. Examine the various steps involved in preparing the business plan.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1						1	2		2						
2						1	2		2						
3						1	2		2						
4						1	2		2						
5						1	2		2						

**UNIT I****9 Hours****MARKETING MANAGEMENT**

Marketing environment, Segmentation, Targeting and positioning, Formulating marketing strategies, Marketing research, marketing plan, marketing mix (cases)

**UNIT II****9 Hours****HUMAN RESOURCE MANAGEMENT**

Human Resource Planning (Cases), Recruitment, Selection, Training and Development, HRIS, Factories Act 1948 (an over view)

**UNIT III****9 Hours****BUSINESS TAXATION**

Direct taxation, Income tax, Corporate tax, MAT, Tax holidays, Wealth tax, Professional tax (Cases). Indirect taxation, Excise duty, Customs, Sales and Service tax, VAT, Octroi, GST (Cases)

**UNIT IV**

**9 Hours**

**GOVERNMENT SUPPORT**

Industrial policy of Central and State Government, National Institute - NIESBUD, IIE, EDI. State Level Institutions - TIIC, CED, MSME, Financial Institutions

**UNIT V**

**9 Hours**

**BUSINESS PLAN PREPARATION**

Purpose of writing a business plan, Capital outlay, Technical feasibility, Production plan, HR plan, Market survey and Marketing plan, Financial plan and Viability, Government approvals, SWOT analysis.

**Total: 45 Hours**

**Reference(s)**

1. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi: 2005
2. Philip Kotler., Marketing Management, Prentice Hall of India, New Delhi: 2003
3. Aswathappa K, Human Resource and Personnel Management - Text and Cases, Tata McGraw Hill: 2007.
4. Jain P C., Handbook for New Entrepreneurs, EDII, Oxford University Press, New Delhi: 2002.
5. Akhileshwar Pathak, Legal Aspects of Business, Tata McGraw Hill: 2006.
6. <http://niesbud.nic.in/agencies.html>

**22OGE04 NATION BUILDING, LEADERSHIP AND  
SOCIAL RESPONSIBILITY**

**3 0 0 3**

**Course Objectives**

- To understand the importance of National Integration, Patriotism and Communal Harmony
- To outline the basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality
- To analyze the different types of responsibility role of play for the improvement of society

**Course Outcomes (COs)**

1. Understand religio-cultural diversity of the country and its impact on the lives of the people and their beliefs
2. Acquire a sense of responsibility, smartness in appearance and improve self confidence
3. Develop the sense of self-less social service for better social & community life
4. Apply the importance of Physical and Mental health and structure of communication organization and various mode of communication
5. Acquire awareness about the various types of weapon systems in the Armed Forces.

**Articulation Matrix**

C O No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
1	2		1				1					3			
2	2		2				2					2			
3	2		1				1					2			
4	2		3				3					3			
5	2		1				1					2			

**UNIT I**

**9 Hours**

**NATIONAL INTEGRATION**

Importance & Necessity, Factors Affecting National Integration, Unity in Diversity. Threats to National Security. Water Conservation and Rain Harvesting, Waste Management and Energy Conservation. Leadership Capsule-Traits-Indicators-Motivation-Moral Values-Honor Code-Case Studies: Shivaji, Jhansiki Rani, Case Studies–APJ Abdul kalam, Deepa Malik, Maharana Pratap, N Narayan Murthy Ratan Tata Rabindra Nath Tagore, role of NCC cadets in 1965 war.

**UNIT II**

**9 Hours**

**PERSONALITY DEVELOPMENT AND LEADERSHIP**

Intra & Interpersonal skills - Self-Awareness- &Analysis, Empathy, Critical & creative thinking, Decision making and problem solving, Communication skills, Group Discussion – coping with stress and emotions, changing mindset, Public Speaking, Time Management, Social skills, Career counseling, SSB procedure and Interview skills.

**UNIT III**

**9 Hours**

**SOCIAL SERVICE, COMMUNITY DEVELOPMENT AND ENVIRONMENTAL AWARENESS**

Basics of social service and its need, Types of social service activities, Objectives of rural development programs and its importance, NGO's and their contribution in social welfare, contribution of youth and NCC in Social welfare. Protection of children & women safety, Road/ Rail Travel Safety, New initiatives, Cyber and mobile security awareness.

Disaster management Capsule-Organization-Types of Disasters-Essential Services-Assistance-Civil Defence Organization

**UNIT IV**

**9 Hours**

**HEALTH, HYGIENE AND COMMUNICATION**

Sanitation, First Aid in Common Medical Emergencies. Health, Treatment and Care of Wounds. Yoga-Introduction, Definition, Purpose, Benefits. Asanas-Padamsana, Siddhasana, Gyan Mudra, Surya Namaskar, Shavasana, Vajrasana, Dhanurasana, Chakrasana, Sarvaangasana, Halasanaetc.

Obstacle Training Contact: Obstacle training - Intro, Safety measures, Benefits, Straight balance, Clear Jump, Gate Vault, ZigZagBalance, High Wall etc.

COMMUNICATION: Basic Radio Telephony (RT) Procedure-Introduction, Advantages, Disadvantages, Need for standard- Procedures-Types of Radio Telephony Communication-Radio telephony procedure, Documentation.

**UNIT V**

**9 Hours**

**ARMED FORCES AND NCC GENERAL**

Introduction to Digital Signal Processors- Basic Classification-Features TMS320C6713 Architecture-Functional Unit-Pipelining- Addressing Modes -Instruction set Simple Assembly Language Program.

**Total: 45 Hours**

**Reference(s)**

1. Director General NCC Website: <https://indiancc.nic.in/ncc-general-elective-subject-course-design/>
2. Grooming Tomorrow's Leaders, published by DG, NCC. <https://indiancc.nic.in/>
3. Youth in Action, published by DG, NCC. <https://indiancc.nic.in/>
4. The Cadet, Annual Journal of the NCC. <https://indiancc.nic.in/>
5. Précis Issued by respective Service Headquarters on specialized subject available to PI Staff as reference material. <https://indiancc.nic.in/>

**22BM0XA REAL TIME BIOSENSORS  
INTERFACING**

**1 0 0 1**

**Course Objectives**

- To understand the concepts of embedded programming
- To identify the type of sensor for interfacing in real time data monitoring

**Program Outcomes (POs)**

- a. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- b. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

**Course Outcomes (COs)**

1. To identify the types of sensors used and its characteristics
2. To acquire the knowledge on sensor interfacing in real time data acquisition

**Articulation Matrix**

CO No	P O1	P O2	P O3	P O4	P O5	P O6	P O7	P O8	P O9	PO 10	PO 11	PO 12	PS O1	PS O2	PSO 3
1	1													2	3
2	1	2												2	2

**7 Hours**

**EMBEDDED PROGRAMMING IN SENSOR INTERFACE**

Embedded IoT Programming, Open source hardware, Digital Sensor Interfacing applications (Pulse Sensor, Heart Rate, Blood Pressure), Analog sensor Interface (ECG,EMG), Actuator Interfacing

**8 Hours**

**APPLICATION DEVELOPMENT**

Application Development using Analog & Digital sensors, Data collection and visualization for real-time systems, Open source IoT cloud and end device, Real time data monitoring application development.

**Total: 15 Hours**

**Reference(s)**

1. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 3rd Edition,2014.
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Pearson Education India; 2nd Edition,2015.
3. Joseph J. Carr and John M. Brown, Introduction to Biomedical equipment technology, Pearson Education, 4th Edition,2014.

**22BM0YA OCCUPATIONAL SAFETY AND HEALTH IN  
PUBLIC HEALTH EMERGENCIES**

3 0 0 3

**Course Objectives**

- Students will be able to know about Occupational safety and health (OSH)
- Students will be able to discuss about risks faced by emergency responders during disease outbreaks and other emergencies
- Students will be able to create awareness on necessary strategies for managing OSH in emergency situations

**Course Outcomes (COs)**

1. Practice the occupational safety measures by the scientific knowledge to overcome the risks faced by emergency responders
2. Apply appropriate strategies and tools in Occupational safety and healthcare
3. Analyse common risks for safety and health in emergencies
4. Adapt appropriate occupational safety practices in chemical accidents
5. Guide Occupational safety measures in radiation incidents

**Articulation Matrix**

CO No	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1		3	2	1				1				2		2	
2		2	2	2				1				2		2	
3		3	2	2				1				2		2	
4		2	2	2				1				2		2	
5		3	2	2				1				2		2	

**UNIT I****9 Hours****MANAGEMENT ASPECTS**

Management system approach to occupational safety and health hazards and risks – rights, duties and responsibilities of employers and workers during outbreaks and emergencies – Emergency responders health monitoring and surveillance

**UNIT II****9 Hours****STRATEGIES AND TOOLS**

International Health Regulations, 2005 – Incident command system for managing outbreaks and emergencies – Occupational safety and health controls – Strategies for infection prevention and control

**UNIT III****9 Hours****COMMON RISKS FOR SAFETY AND HEALTH IN EMERGENCIES**

Vector-borne diseases, water and food-borne diseases, Vaccine-preventable diseases – Heat stress - Slips, trips and falls - Road traffic injuries – Ergonomic hazards - Violence – Psychological stress during outbreaks and injuries

**UNIT IV****9 Hours****OCCUPATIONAL SAFETY AND HEALTH IN CHEMICAL INCIDENTS**

Emergencies caused by chemical incidents – occupational safety and health hazards and risks of chemicals – Personal Protective Equipment – Decontamination of emergency response personnel – medical surveillance of emergency responders



**UNIT V**

**9 Hours**

**OCCUPATIONAL SAFETY AND HEALTH IN RADIATION INCIDENTS**

Sources and scenarios of radiation incidents – guidance for protection of emergency responders -  
Occupational health surveillance of persons occupationally exposed to radiation in emergencies

**Total: 45 Hours**

**Reference(s)**

1. Emergency responder health monitoring and surveillance. National Response Team technical assistance document. Atlanta (GA): National Institute for Occupational Safety and Health; 2012.
2. Emergency response framework (ERF). Geneva: World Health Organization; 2013
3. Guidelines on occupational safety and health management systems, second edition. Geneva: International Labour Organization; 2009.
4. OSH management system: a tool for continual improvement. Geneva: International Labour Organization; 2011
5. OECD Environmental Outlook to 2050: the consequences of inaction. Paris: Organization for Economic Co-operation and Development; 2012.

**22BM0YB AMBULANCE AND EMERGENCY  
MEDICAL SERVICE MANAGEMENT**

**3 0 0 3**

**Course Objectives**

- Understand the ambulance & transport management and allied services.
- Compare the ambulance design and equipment, transportation and corporate Profit.
- Carry-out various acts governing transport management.

**Course Outcomes (COs)**

1. Identify ambulance services, types and allied services
2. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.
3. Understand the Emergency response team, Transportation interfaces, Transportation Service Characteristics & regulatory reforms involved.
4. Identify ambulance services, types and allied services
5. Formulate minimum ambulance rescue equipment and developing a transportation Strategy.

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2	2												2	
2	2													3	
3		2												2	
4	2	2													
5	2												2		

**UNIT I**

**9 Hours**

**INTRODUCTION**

Introduction-transportation ambulance types-Advanced Life Support Ambulance-Basic Life Support Ambulance-Patient Transport Ambulance-Emergency services-Ambulances-Allied services-telephone management

**UNIT II**

**9 Hours**

**AMBULANCE DESIGN AND EQUIPMENT**

Design and Equipment of Ambulances -Minimum Ambulance Rescue Equipment-Emergency drugs medicines Recruitment validation Training to handle in house Ambulance emergency procedures Checklist measures Roles of paramedics, midwives, community nurses, hospice workers in emergency handling via ambulance

**UNIT III**

**9 Hours**

**TRANSPORTATION REGULATION FOR EMERGENCY MEDICAL SERVICE**

Crisis Management-Anxiety & Stress Management-the Emergency response team-police assistance- Information handling & processing-Establishing customer service levels - Developing and Reporting customer service standards - Impediments to an Effective customer Service strategy - Improving customer Service Performance Transportation

**UNIT IV**

**9 Hours**

**AMBULANCE PREVENTIVE MAINTENANCE**

Legal obligations Switch Console Front, Main Electrical, Patient Compartment Climate Oxygen system On board Suction system 110/12 VOLT system, Modular Body, Medical

Equipment - Cot & Stretcher, safety belts-driver(s), passenger, Patients-child restraint device-incubator

**UNIT V**

**9 Hours**

**THE MOTOR VEHICLE ACT**

The Motor Vehicle Act, 1988- Rules of the road Regulations 1989- Overall Dimensions of Motor Vehicles (Prescription of conditions for exemption) Rules 1991-Use of Red light on the top front of the vehicle

**Total: 45 Hours**

**Reference(s)**

1. Fawcett, "Supply Chain Management", Pearson Education India, 01-Sep-2008 - 600 pages.
2. B. Feroz, A. Mehmood, H. Maryam, S. Zeadally, C. Maple and M. A. Shah, "Vehicle-Life Interaction in Fog-Enabled Smart Connected and Autonomous Vehicles," in IEEE Access, vol. 9, pp. 7402-7420, 2021, doi: 10.1109/ACCESS.2020.3049110.
3. R. Jin, T. Xia, X. Liu, T. Murata and K. -S. Kim, "Predicting Emergency Medical Service Demand With Bipartite Graph Convolutional Networks," in IEEE Access, vol. 9, pp. 9903-9915, 2021, doi: 10.1109/ACCESS.2021.3050607.
4. Les Pringle, "Call the Ambulance", Transworld Publishers, 2010.
5. Edward J. Bardi, John Joseph Coyle, Robert A. Novack "Management of Transportation", Thomson/South-Western, 2006

**22BM0YC HOSPITAL AUTOMATION**

**3 0 0 3**

**Course Objectives**

- Introduce the concepts of hospital systems and need for central monitoring
- Exemplify the power generation, utility and protection systems.
- Apply the distributed and central monitoring functions in hospital environment

**Course Outcomes (COs)**

1. Identify the factors in central power generating and monitoring systems
2. Analyze the sensors and actuators for the automation systems
3. Classify the equipment types and its applications.
4. Apply software tools and digital computer for monitoring of parameters and medical data handling
5. Design central monitoring station for hospitals for control and surveillance applications

**Articulation Matrix**

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	2													2	
2		2												2	
3		2											3		
4		2												2	
5	3													2	

**UNIT I**

**9 Hours**

**AUTOMATION IN HEALTHCARE**

Introduction to automation Role of automation in healthcare Remote Patient Monitoring Maximizing resources on patient care Reducing variability, Automating clinician and patient interactions through products.

**UNIT II**

**9 Hours**

**POWER GENERATION AND MEDICAL GAS PRODUCTION**

Power generator, Battery : Maintenance and troubleshooting, energy conservation and monitoring system - Automation in dryer, compressor, air conditioning, lighting, heating systems.

**UNIT III**

**9 Hours**

**AUTOMATION IN PIPING**

Monitoring of flow and pressure of medical gas System components Vacuum control units Automatic changeover system - Types of Outlets - Leakage test- Prevention and safety automation.

**UNIT IV**

**9 Hours**

**INSTRUMENTATION SYSTEMS**

Optical sensors , Pressure Sensors - Ultrasonic Sensors - Tactile Sensors - Thermal sensors -Biosensor - Linear Actuators, Central monitoring station - Alarm system - Regulation and standards.

**9 Hours**

**UNIT V  
APPLICATIONS**

Business intelligence & executive dashboards - Radio-Frequency Identification (RFID)- based patient and asset tracking solutions - Tablet-based applications for bed side access to doctors/nurses - Healthcare CRM for patient relationship management - Patient kiosk, tele-health – HIS integration.

**Total: 45 Hours**

**Reference(s)**

1. Khandpur RS, Handbook of Biomedical Instrumentation, Prentice Hall of India, New Delhi, 3rd edition, 2014.
2. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education India, Delhi, 4th edition 2008
3. Curtis Johnson D Process Control Instrumentation Technology, Prentice Hall of India, 8th edition 2006
4. John V. Grimaldi and Rollin H. Simonds., Safety Management, All India Travelers Book seller, New Delhi, 1989
5. N.V. Krishnan, Safety in Industry, Jaico Publisher House, 1996.